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Manager
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10 CFR 50.36(a)

April 30, 2025

ATTN: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: **Annual Radioactive Effluent Release Report – 2024**
San Onofre Nuclear Generating Station (SONGS), Units 1, 2 and 3
Docket Nos. 50-206, 50-361 and 50-362

In accordance with 10 CFR 50.36(a), Southern California Edison (SCE) is submitting the Annual Radioactive Effluent Release Report - 2024 (ARERR) for SONGS, Units 1, 2, and 3 (Enclosure 1). The period of the report is January 1, 2024 through December 31, 2024. A separate ARERR was submitted for the SONGS Independent Spent Fuel Storage Installation (ISFSI) on February 26, 2025 which had no effluent releases.

The net result from the analysis of these effluent releases indicates that SONGS has met all the requirements of the applicable regulations that ensure adequate protection of the health of members of the public.

There are no commitments in this letter or the enclosure.

If you have any questions, please contact me at (949) 368-6274.

Sincerely,

M. Morgan

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NRR
NMSS

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Enclosures:

1) San Onofre Nuclear Generation Station, Annual Radioactive Effluent Release Report – 2024
2) Offsite Dose Calculation Manual, San Onofre Nuclear Generating Station (SONGS), SO123-ODCM Revision 20, August 2024
3) Offsite Dose Calculation Manual, San Onofre Nuclear Generating Station (SONGS), SO123-ODCM-A Revision 16, September 2023
4) Offsite Dose Calculation Manual, San Onofre Nuclear Generating Station (SONGS), SO123-ODCM-B Revision 11, August 2024

cc: J. Monninger, Regional Administrator, NRC Region IV
J. Fassel, California Department of Public Health

Enclosure 1

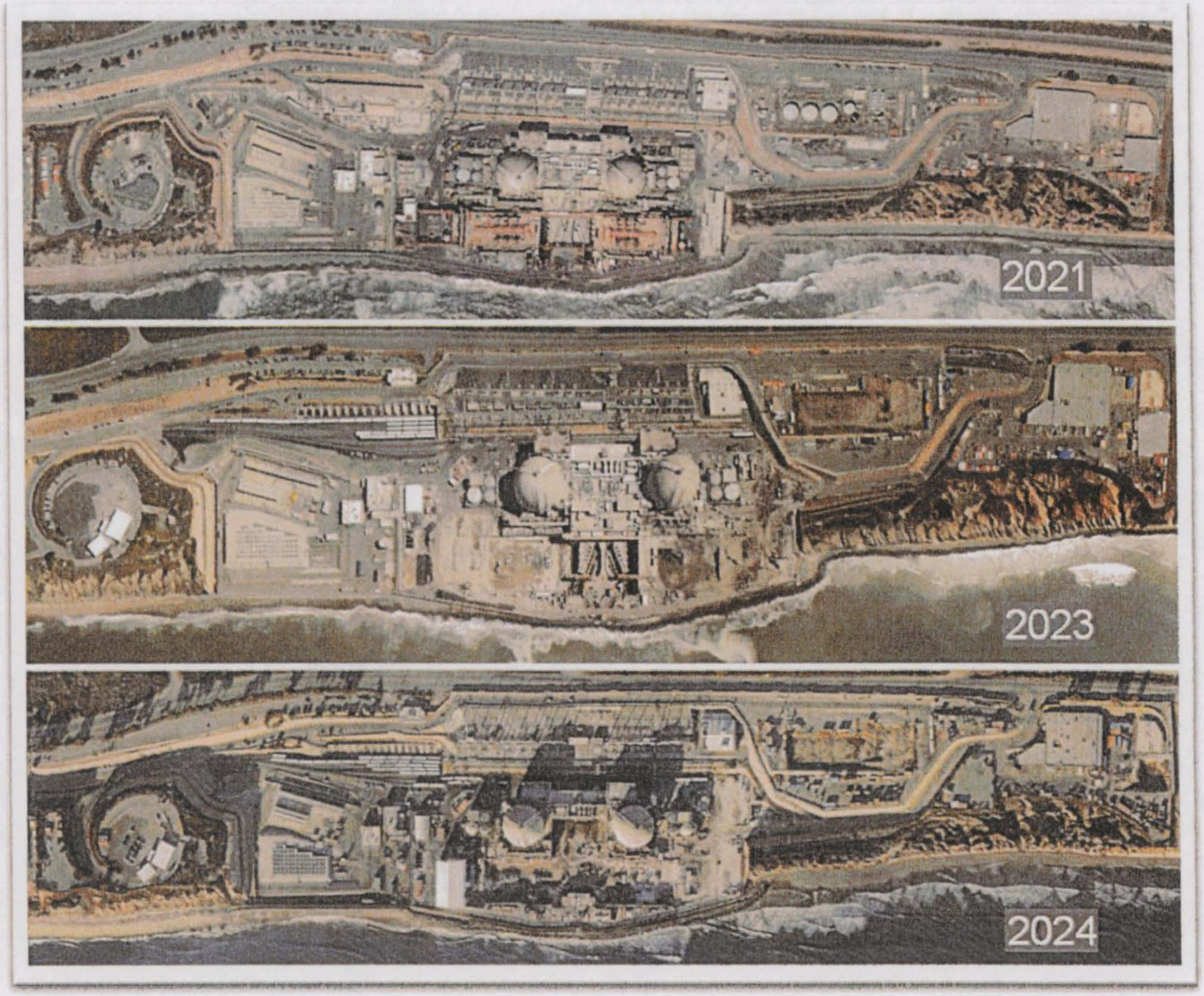
San Onofre Nuclear Generation Station

Annual Radioactive Effluent Release Report

2024

January – December

San Onofre Nuclear Generating Station



2024

Annual Radioactive Effluent Release Report

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ATTACHMENTS

1.0 LIST OF ACRONYMS AND DEFINITIONS

1. Alpha Particle (α): A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude of a helium nucleus.
2. AREOR: Annual Radiological Environmental Operating Report
3. ARERR: Annual Radioactive Effluent Release Report
4. BWR: Boiling Water Reactor
5. Composite Sample: A series of single collected portions (aliquots) analyzed as one sample. The aliquots making up the sample are collected at time intervals that are very short compared to the composite period.
6. Control: A sampling station in a location not likely to be affected by plant effluents due to its distance and/or direction from the Plant.
7. Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based on total counts accumulated.
8. Curie (Ci): A measure of radioactivity; equal to 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.
9. Direct Radiation Monitoring: The measurement of radiation dose at various distances from the plant is assessed using thermoluminescent dosimeters (TLDs), optically stimulated luminescent dosimeters (OSLDs), and/or pressurized ionization chambers.
10. Grab Sample: A single discrete sample drawn at one point in time.
11. Indicator: A sampling location that is potentially affected by plant effluents due to its proximity and/or direction from the plant.
12. Ingestion Pathway: The ingestion pathway includes milk, fish, drinking water and garden produce. Also sampled (under special circumstances) are other media such as vegetation or animal products when additional information about particular radionuclides is needed.
13. ISFSI: Independent Spent Fuel Storage Installation
14. LLD: Lower Limit of Detection. An *a priori* measure of the detection capability of a radiochemistry measurement based on instrument setup, calibration, background, decay time, and sample volume. An LLD is expressed as an activity concentration. The MDA is used for reporting results. LLD are specified by a regulator, such as the NRC and are typically listed in the ODCM.
15. MDA: Minimum Detectable Activity. For radiochemistry instruments, the MDA is the *a posteriori* minimum concentration that a counting system detects. The smallest concentration or activity of radioactive material in a sample that will yield a net count above instrument background and that is detected with 95% probability, with only 5% probability of falsely concluding that a blank observation represents a true signal.

16. MDC: Minimum Detectable Concentration. Essentially synonymous with MDA for the purposes of radiological monitoring.

17. Mean: The sum of all of the values in a distribution divided by the number of values in the distribution, synonymous with average.

18. microcurie (μCi): 3.7 x 10^4 disintegrations per second, or 2.22 x10^6 disintegrations per minute.

19. millirem (mrem): 1/1000 rem; a unit of radiation dose equivalent in tissue.

20. milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X- or gamma radiation.

21. N/A: Not Applicable

22. NEI: Nuclear Energy Institute

23. NRC: Nuclear Regulatory Commission

24. ODCM: Offsite Dose Calculation Manual

25. OSLD: Optically Stimulated Luminescence Dosimeter

26. Protected Area: A 10 CFR 73 security term is an area encompassed by physical barriers and to which access is controlled for security purposes. The fenced area immediately surrounding the plant and around ISFSI are commonly classified by the licensee as "Protected areas." Access to the protected area requires a security badge or escort.

27. PWR: Pressurized Water Reactor

28. REC: Radiological Effluent Control

29. REMP: Radiological Environmental Monitoring Program

30. Restricted Area: A 10 CFR 20 defined term where access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

31. TEDE: Total Effective Dose Equivalent (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

32. TLD: Thermoluminescent Dosimeter

33. Unrestricted Area: An area, access to which is neither limited nor controlled by the licensee.

2.0 EXECUTIVE SUMMARY

San Onofre Nuclear Generating Station (SONGS) Radiological Effluent Control (REC) Program was established to limit the quantities of radioactive material that may be released based on calculated radiation doses or dose rates. Dose to Members of the Public due to radioactive materials released from the plant is limited by Licensee Controlled Specifications,10 CFR 20, and by 40 CFR 190. Operational doses to the public during 2024 were calculated to be within the limits required by regulation and compared to other sources of radiation dose and pose no health hazard. These doses are summarized and compared to the regulatory limits in Section 2.1 Comparison to Regulatory Limits.

The Annual Radioactive Effluent Release Report (ARERR) is published per ODCM requirements and provides data related to plant operation, including: quantities of radioactive materials released in liquid and gaseous effluents; radiation doses to members of the public; solid radioactive waste shipped offsite for processing or direct disposal; and other information as required by site licensing documents.

In 2024, the gaseous effluent dose assessments for locations from the Land Use Census showed that the critical receptor for San Onofre Nuclear Generating Station, is a person of any age group, due to Inhalation and Ground Plane pathways, located 1.1 mi NW of SONGS. The maximum hypothetical Annual Organ Dose calculated for this receptor was 1.24E-04 mrem, to the Skin.

The maximum hypothetical dose calculated to any organ due to radioactive liquid effluents was 1.94E-02 mrem, for the Bone of a Child due to Ingestion of Fish and Shellfish.

Solid radioactive waste shipped offsite for processing or direct disposal included 5.51E+03 Curies and 3.27E+04 m^3, shipped in 465 shipments.

In addition to monitoring radioactive effluents, SONGS has a Radiological Environmental Monitoring Program (REMP) that monitors for levels of radiation and radioactive materials in the local environment. Data from the REMP is published in the Annual Radiological Environmental Operating Report (AREOR).

2.1 Comparison to Regulatory Limits

During 2024 all liquid and gaseous radioactive effluents from San Onofre Nuclear Generating Station were well below regulatory limits, as summarized in Table 1 and Table 2.

Table 1, San Onofre Nuclear Generating Station Units 2/3 Dose Summary[1]

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Liquid Effluent Dose Limit, Total Body	Limit	3 mrem	3 mrem	3 mrem	3 mrem	6 mrem
	Total Body Dose	2.72E-03	0.00E+00	1.65E-03	1.78E-03	6.16E-03
	% of Limit[2]	0.09%	0.00%	0.06%	0.06%	0.10%
Liquid Effluent Dose Limit, Any Organ	Limit	10 mrem	10 mrem	10 mrem	10 mrem	20 mrem
	Max Organ Dose	1.67E-02	0.00E+00	2.05E-03	3.17E-03	1.94E-02
	% of Limit[2]	0.17%	0.00%	0.02%	0.03%	0.10%
Gaseous Effluent Organ Dose Limit (Iodine, Tritium, Particulates with > 8-day half-life)	Limit	15 mrem	15 mrem	15 mrem	15 mrem	30 mrem
	Max Organ Dose	1.24E-04	0.00E+00	0.00E+00	0.00E+00	1.24E-04
	% of Limit[2]	0.00%	0.00%	0.00%	0.00%	0.00%

Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for SONGS[3]

	Whole Body	**Thyroid**	**Max Other Organ**
Gaseous Dose[4]	1.07E-04	1.06E-04	1.08E-04
Liquid Dose	6.16E-03	1.35E-03	1.94E-02
Unit 1 Outfall Dose	7.96E-02	N/A	N/A
Direct Shine Dose	0.00E+00	0.00E+00	0.00E+00
Total Site Dose[5]	**8.59E-02**	**1.46E-03**	**1.95E-02**
Limit	**25 mrem**	**75 mrem**	**25 mrem**
% of Limit[2]	**0.34%**	**0.00%**	**0.08%**

[1] Table 1 demonstrates compliance with 10 CFR Part 50, App. I Limits. All doses are in mrem.
[2] Percentages rounded to the nearest 0.01%.
[3] Table 2 is a summation of Units 1, 2 & 3 to show compliance with 40 CFR Part 190 Limits. All doses are in mrem.
[4] Gaseous dose values in Table 2 include organ dose from tritium and particulates.
[5] There are no other fuel cycle sources within 5 miles of SONGS.

3.0 INTRODUCTION

3.1 About Nuclear Power

Commercial nuclear power plants are generally classified as either Boiling Water Reactors (BWRs) or Pressurized Water Reactors (PWRs), based on their design. A BWR includes a single coolant system where water used as reactor coolant boils as it passes through the core and the steam generated is used to turn the turbine generator for power production. A PWR, in contrast, includes two separate water systems: radioactive reactor coolant and a secondary system. Reactor coolant is maintained under high pressure, preventing boiling. The high-pressure coolant is passed through a heat exchanger called a steam generator where the secondary system water is boiled, and the steam is used to turn the turbine generator for power production. SONGS included three PWR units, which were permanently shut down and are in the process of being decommissioned.

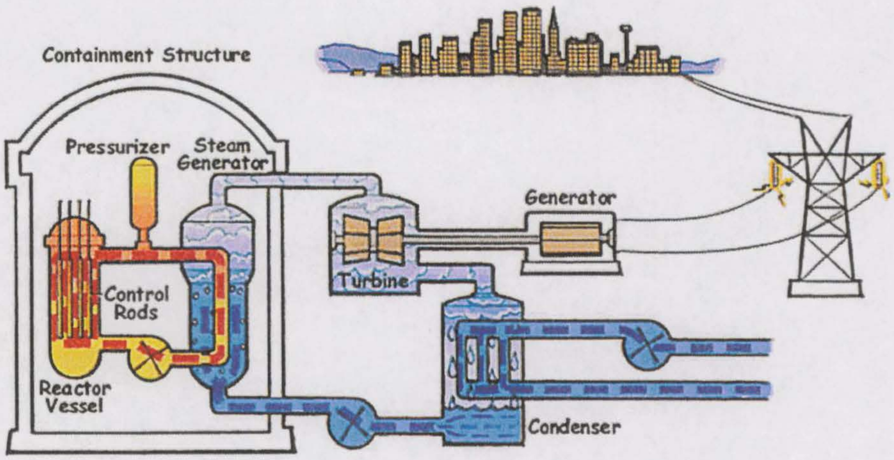

Figure 1, Pressurized Water Reactor (PWR) [1]

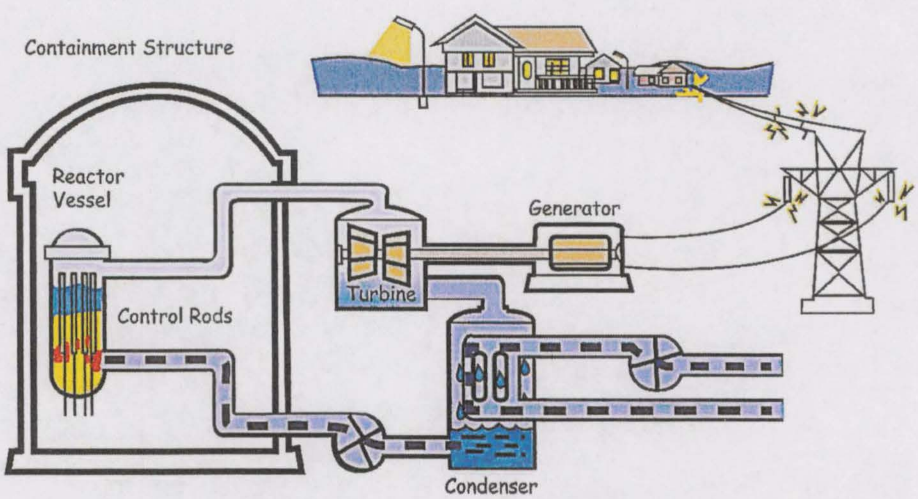

Figure 2, Boiling Water Reactor (BWR) [2]

3.1 (Continued)

Electricity is generated by a nuclear power plant similarly to the way that electricity is generated at other conventional types of power plants, such as those powered by coal or natural gas. Water is boiled to generate steam; the steam turns a turbine that is attached to a generator and the steam is condensed back into water to be returned to the boiler. What makes nuclear power different from these other types of power plants is that the heat is generated by fission and decay reactions occurring within and around the core containing fissionable uranium (U-235).

Nuclear fission occurs when certain nuclides (primarily U-233, U-235, or Pu-239) absorb a neutron and break into several smaller nuclides (called fission products) as well as producing some additional neutrons.

Fission results in production of radioactive materials including gases and solids that must be contained to prevent release or treated prior to release. These effluents are generally treated by filtration and/or hold-up prior to release. Releases are generally monitored by sampling and by continuously indicating radiation monitors. The effluent release data is used to calculate doses in order to ensure that dose to the public due to plant operation remains within required limits.

3.2 About Radiation Dose

Ionizing radiation, including alpha, beta, and gamma radiation from radioactive decay, has enough energy to break chemical bonds in tissues and result in damage to tissue or genetic material. The amount of ionization that will be generated by a given exposure to ionizing radiation is quantified as dose. Radiation dose is generally reported in units of millirem (mrem) in the US.

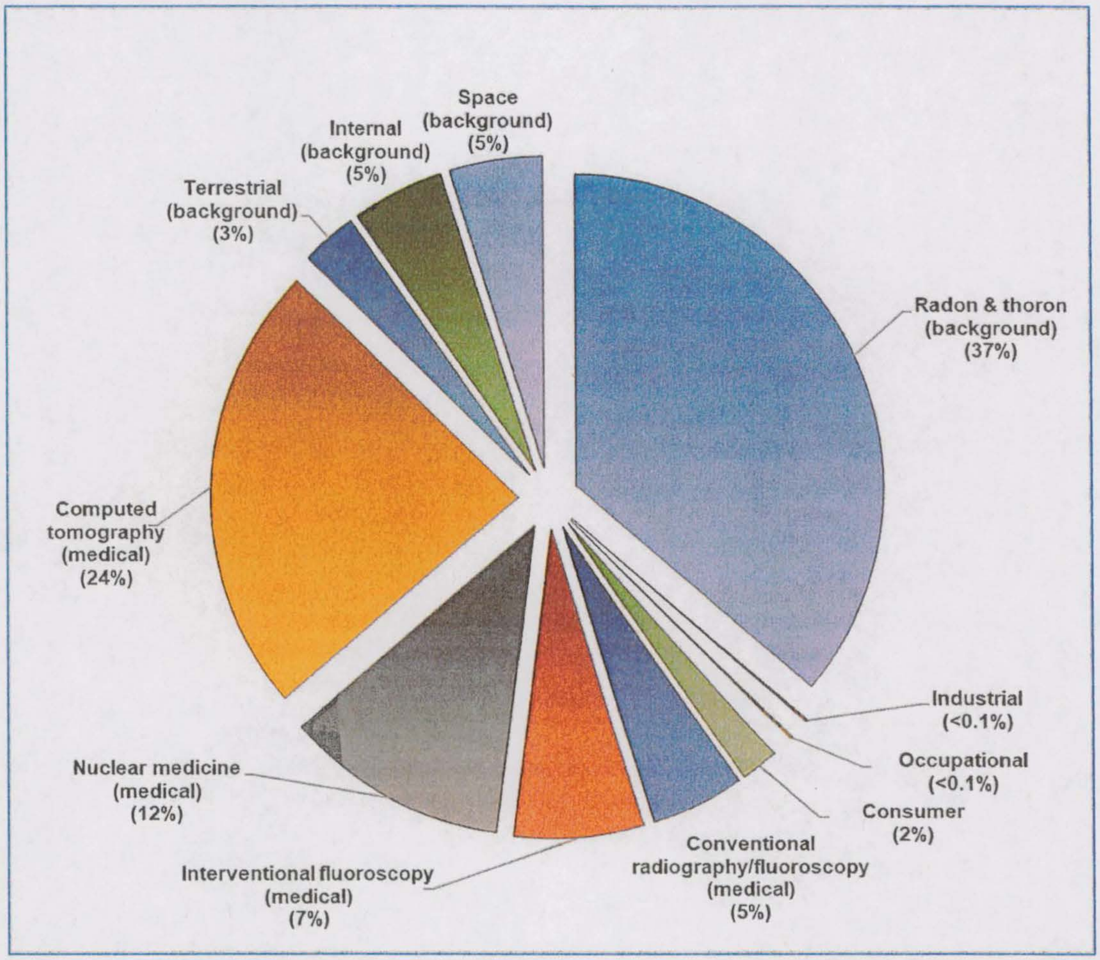

Figure 3, Sources of Radiation Exposure (NCRP Report No. 160) [3]

3.2 (Continued)

The National Council on Radiation Protection (NCRP) has evaluated the population dose for the US and determined that the average individual is exposed to approximately 620 mrem per year [3]. There are many sources for radiation dose, ranging from natural background sources to medical procedures, air travel, and industrial processes. Approximately half (310 mrem) of the average exposure is due to natural sources of radiation including exposure to radon, cosmic radiation, and internal radiation and terrestrial due to naturally occurring radionuclides. The remaining 310 mrem of exposure is due to man-made sources of exposure, with the most significant contributors being medical (48% of total mrem per year) due to radiation used in various types of medical scans and treatments. Of the remaining 2% of dose, most is due to consumer activities such as air travel, smoking cigarettes, and building materials. A small fraction of this 2% is due to industrial activities including generation of nuclear power.

Readers that are curious about common sources and effects of radiation dose that they may encounter can find excellent sources of information from the Health Physics Society, including the Radiation Fact Sheets [4], and from the US Nuclear Regulatory Commission website [5].

3.3 About Dose Calculation

Concentrations of radioactive material in the environment resulting from plant operations are very small and it is not possible to determine doses directly using measured activities of environmental samples. To overcome this limitation, dose calculations based on measured activities of effluent streams are used to model the dose impact for Members of the Public due to plant operation and effluents. There are several mechanisms that can result in dose to Members of the Public, including: Ingestion of radionuclides in food or water; Inhalation of radionuclides in air; Immersion in a plume of noble gases; and Direct Radiation from the ground, the plant or from an elevated plume.

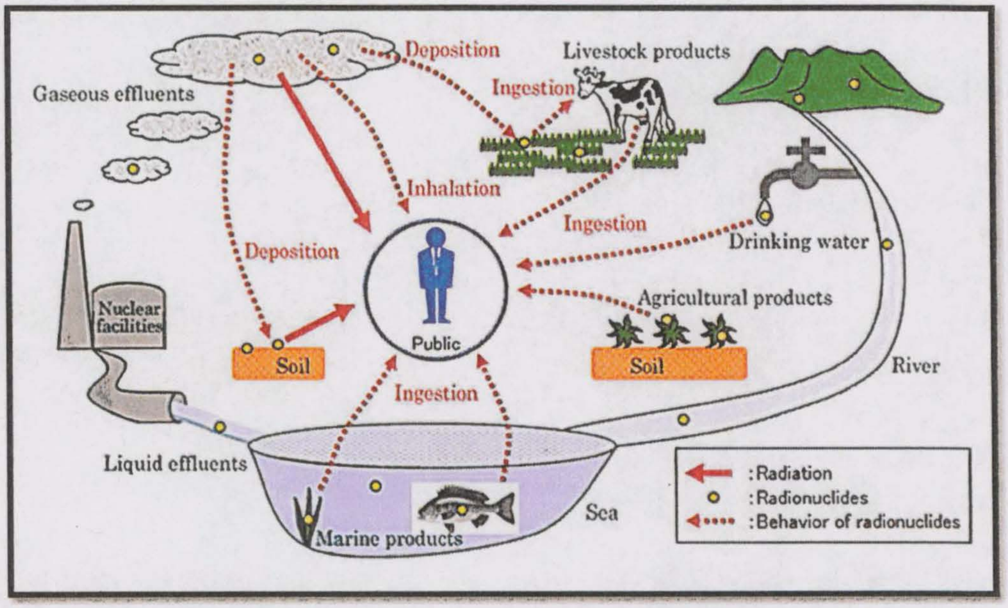

Figure 4, Potential exposure pathways to Members of the Public due to Plant Operations [6]

Each plant has an Offsite Dose Calculation Manual (ODCM) that specifies the methodology used to obtain the doses in the Dose Assessment section of this report. The dose assessment methodology in the ODCM is based on NRC Regulatory Guide 1.109 [7] and NUREG-0133 [8]. Doses are calculated by determining what the nuclide concentration will be in air, water, on the ground, or in food products based on plant effluent releases. Release points are continuously monitored to quantify what concentrations of nuclides are being released. For gaseous releases meteorological data is used to determine how much of the released activity will be present at a given location outside of the plant either deposited onto the ground or in gaseous form. Intake patterns and nuclide bio-concentration factors are used to determine how much activity will be transferred into animal milk or meat. Finally, human ingestion factors and dose factors are used to determine how much activity will be consumed and how much dose the consumer will receive. Inhalation dose is calculated by determining the concentration of nuclides and how much air is breathed by the individual.

3.3 (Continued)

For liquid releases, dilution and mixing factors are used to model the environmental concentrations in water. Drinking water pathways are modeled by determining the concentration of nuclides in the water at the point where the drinking water is sourced (e.g., taken from wells, rivers, or lakes). Fish and invertebrate pathways are determined by using concentration at the release point, bioaccumulation factors for the fish or invertebrate and an estimate of the quantity of fish consumed.

Each year a Land Use Census is performed to determine what potential dose pathways currently exist within a five-mile radius around the plant, the area most affected by plant operations. The Annual Land Use Census identifies the locations of vegetable gardens, nearest residences, milk animals and meat animals. The data from the census is used to determine who is likely to be most exposed to radiation dose as a result of plant operation.

There is significant uncertainty in dose calculation results, due to modeling dispersion of material released and bioaccumulation factors, as well as assumptions associated with consumption and land-use patterns. Even with these sources of uncertainty, the calculations do provide a reasonable estimate of the order of magnitude of the exposure. Conservative assumptions are made in the calculation inputs such as the number of various foods and water consumed, the amount of air inhaled, and the amount of direct radiation exposure from the ground or plume, such that the actual dose received are likely lower than the calculated dose. Even with the built-in conservatism, hypothetical doses calculated for the maximum exposed individual due to plant operation are a very small fraction of the annual dose that is received due to other sources. The calculated doses due to plant effluents, along with REMP results, serve to provide assurance that radioactive effluents releases are not exceeding safety standards for the environment or people living near the plant.

4.0 DOSE ASSESSMENT FOR PLANT OPERATIONS

4.1 Regulatory Limits

Regulatory limits are detailed in station licensing documents such as the plant Licensee Controlled Specifications and the Offsite Dose Calculation Manual (ODCM). These documents contain the limits to which SONGS must adhere. In addition, SONGS strives to keep dose "as low as is reasonably achievable" (ALARA) and actions are taken to reduce the amount of radiation released to the environment. Liquid and gaseous release data show that the dose from SONGS is well below the ODCM limits. The instantaneous concentration of liquid radioactive material released shall be limited to ten times the concentration specified in 10 CFR 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the total concentration released shall be limited to 2.0×10^{-4} microcuries/ml.

The annual whole body, skin and organ dose was computed using the 2024 source term using the dose calculation methodology provided in the ODCM. The calculated doses due to gaseous effluents are used to demonstrate compliance with offsite dose limits. The results are presented in Table 1, San Onofre Nuclear Generating Station Units 2/3 Dose Summary and Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for SONGS.

4.2 Regulatory Limits for Gaseous Effluent Doses:

1. Fission and activation gases:

    a. Noble gases dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:

        1) Less than or equal to 500 mrem/year to the total body

        2) Less than or equal to 3000 mrem/year to the skin

    b. Noble gas air dose due to noble gases released in gaseous effluents, from each reactor unit, to areas at and beyond the site boundary shall be limited to the following:

        1) Quarterly

            a) Less than or equal to 5 mrads gamma

            b) Less than or equal to 10 mrads beta

        2) Yearly

            a) Less than or equal to 10 mrads gamma

            b) Less than or equal to 20 mrads beta

4.2 (Continued)

2. Iodine, tritium, and all radionuclides in particulate form with half-lives greater than 8 days.

    a. The dose rate for iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from the site to areas at and beyond the site boundary shall be limited to the following:

        1) Less than or equal to 1500 mrem/yr to any organ

    b. The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 DAYS in gaseous effluents released, from each reactor unit, to areas at and beyond the site boundary shall be limited to the following:

        1) Quarterly

            a) Less than or equal to 7.5 mrem to any organ

        2) Yearly

            a) Less than or equal to 15 mrem to any organ

4.3 Regulatory Limits for Liquid Effluent Doses

1. The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit, to unrestricted areas shall be limited to the following:

    a. Quarterly

        1) Less than or equal to 1.5 mrem total body

        2) Less than or equal to 5 mrem critical organ

    b. Yearly

        1) Less than or equal to 3 mrem total body

        2) Less than or equal to 10 mrem critical organ

4.4 40 CFR 190 Regulatory Dose Limits for a Member of the Public

1. Total Dose (40 CFR 190)

   a. The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC in the unrestricted area due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to the following:

      1) Less than or equal to 25 mrem, Total Body or any Organ except Thyroid.

      2) Less than or equal to 75 mrem, Thyroid.

4.5 Onsite Doses (Within Site Boundary)

SONGS classifies individuals within the site boundary as either occupationally exposed individuals or members of the public. This section evaluates dose to non-occupationally exposed workers and members of the public that may be onsite for various reasons. While within controlled or restricted areas, the limits from Sections 4.1 through 4.4 do not apply; however, 10 CFR 20.1301 dose limit of 100 mrem per year TEDE and dose rate limit of 2 mrem per hour from external sources continue to apply. Occupancy times within the controlled areas are generally sufficiently low to compensate for increase in the atmospheric dispersion factor above the site boundary. Dose rates are controlled and monitored to ensure that visitors entering within the Owner Controlled Area fence receive only a small fraction of 10 CFR 20 dose limits. Revision 20 of the ODCM added a definition for Unrestricted Area, which includes "any area within the Site Boundary used for ... recreational purposes." Based on this definition, the beach walking path has been classified as an Unrestricted Area and that pathway has been included in the dose calculations in Table 1 and Table 2. The likely most exposed Member of the Public within Controlled areas would be a worker in the switchyard. A maximum occupancy time of 500 hours/year conservatively represents use of the area by this group. Direct radiation dose is estimated from the average occupancy-corrected dose of supplemental TLDs located around the switchyard.

Table 3, Onsite Doses (Within Site Boundary)

Location	Sector	Approx. Distance (Meters)	X/Q (s/m^3)	Effective Dose (mrem)	External Dose (mrem)	Total (mrem)
				Iodine, Particulate, C-14 & H-3	TLD	
Switchyard	NNW to E	150	3.90E-4	1.72E-05	2.06E+00	2.06E+00

5.0 SUPPLEMENTAL INFORMATION

5.1 Gaseous Batch Releases

5.1.1 SONGS Units 2/3

No gaseous batch releases occurred from SONGS during 2024.

5.2 Liquid Batch Releases

5.2.1 SONGS Units 2/3

Number of batch releases	16
Total time period for batch releases	13,192 minutes
Maximum time period for a batch release	1,398 minutes
Average time period for batch releases	824 minutes
Minimum time period for a batch release	94 minutes

5.3 Abnormal Releases

5.3.1 Gaseous Abnormal Releases

No Abnormal gaseous releases occurred from SONGS during 2024.

5.3.2 Liquid Abnormal Releases

Number of releases	1
Total activity released	0.008 Ci

Low-level tritium activity was identified in groundwater near the Site Boundary during 2024. The estimated activity flowing offsite from this location is reported as an Abnormal Release. Tritium was first identified in a sample obtained on April 25, 2024. The wells with detectable tritium activity were also analyzed for gamma or hard-to-detect nuclides (Fe-55, Ni-63, or Sr-90) and no licensed material was detected besides tritium. The reported activity of 0.008 Ci of tritium does not change the reported quantity of 28.4 Ci of tritium in Table 9 for monitored batch releases during 2024. The average concentration at the site boundary was less than 100 pCi/l and the actual dose consequence is not significant compared to doses due to normal effluent releases or dose limits. Additional information is provided in Section 6.0.

5.4 Land Use Census Changes

No significant changes were identified in the Land Use Census during 2024. Potential critical receptors and Controlling Location Factors remained consistent with those previously identified.

5.5 Meteorological Data

Meteorological monitoring is no longer performed at SONGS.

5.6 Effluent Radiation Monitors Out of Service Greater Than 30 Days

Effluent Radiation Monitor Name	Number of Days Out of Service	Date Range Out of Service	Reason Out of Service >30 Days	Additional Notes
Liquid Radwaste Radiation Monitor 2/3RT-7813 and Flow Indicator FE7643	73	12/15/2023 – 02/26/2024	The monitor was intentionally secured, and release pathway isolated during Out of Service (OOS) periods.	No releases occurred via this path while instruments were OOS.
	136	02/27/2024 – 07/11/2024		
	62	10/11/2024 – 12/11/2024		
Minor Liquid Pathway Effluent Line Process Flow Rate Measurement Device	42	01/01/2024 – 2/12/2024	Flow meter declared administratively non-Functional with release path isolated. Surveillances were not performed on instrument while line was isolated.	Instrument was also reported non-Functional from 11/02/2023 – 12/31/2023 in the 2023 ARERR. No releases occurred via this path while instrument was OOS.
	34	02/13/2024 – 03/18/2024		
	49	03/18/2024 – 05/06/2024		
	177	05/06/2024 – 10/30/2024		
	35	10/30/2024 – 12/4/2024		

Note: While daily Channel Checks are not required if releases are not in process for the Minor Liquid Pathway and Liquid Radwaste Effluent Line Flow Rate Measuring Devices, Operations administratively declares the instruments non-Functional to ensure that the instruments are verified Functional prior to performing a release. The entire period of non-Functionality is reported here based on the declared status. The Liquid Radwaste flowmeter becomes non-Functional per ODCM requirements when the quarterly Functional Test is not performed, while the Minor Liquid Pathway flowmeter becomes non-Functional per ODCM requirements when the Annual Calibration requirement is not met. The Liquid Radwaste Radiation Monitor becomes non-Functional when daily Channel Checks are not performed. Because these pathways were isolated during the entire periods of non-Functionality, there is no consequence to the reported non-Functionality.

5.7 Offsite Dose Calculation Manual (ODCM) Changes

The SONGS ODCM and Appendix B were revised during 2024. The current ODCM and both Appendices have been included in their entirety. Note that ODCM Appendix A Rev 16 (revised in 2023) does not include change bars because every page was updated in its entirety. The other ODCM documents include change bars.

Date of Change	Revision	Description of Change
8/19/2024	20	• Deletion of Plant Vent Stack gaseous effluent pathway • Addition of Tent Ventilation effluent pathway • Addition of Open-Air Demolition monitoring requirements • Revision of effluent sampling and instrumentation requirements to support the above changes • Addition of alternate REMP air sample locations AS-20 and AS-21 near the Site Boundary
8/19/2024	App. B Rev. 11	• Updated REMP Bases • Deleted sections that were no longer applicable

5.8 Process Control Program (PCP) Changes

There were no changes to the Process Control Program in 2024.

5.9 Radioactive Waste Treatment System Changes

Date of Change	System	Description of Change
4/4/24	Plant Vent Stack (PVS)	The Plant Vent Stack was permanently retired from service on 4/4/24 to support electrical and mechanical isolation of the Auxiliary Buildings in preparation for demolition.
8/7/24	Material Handling Facility (MHF) Ventilation	The Material Handling Facility (MHF) is a large tent-like structure that is used to provide shelter for loading rail cars with demolition debris. The ventilation system has a design flow rate of 35,000 cfm and includes particulate air sampling to quantify radioactive releases.
8/21/24	Open-Air Demolition	The site began the Open-Air Demolition (OAD) process in 2024. The OAD process involves demolishing structures that have been prepared through decontamination to be safely demolished outside of a monitored enclosure. Air particulate samplers are included around the demolition area to monitor for radioactive effluent releases.

5.10 Other Supplemental Information

5.10.1 Outside Tanks

No outside tanks exceeded Storage Tank Radioactivity Monitoring Program limits during 2024.

5.10.2 Carbon-14

Carbon-14 (C-14) is a naturally occurring radionuclide with a 5,730-year half-life. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Nuclear power plants also produce C-14, but the amount is infinitesimal compared to what has been distributed in the environment due to weapons testing and what is produced by natural cosmic ray interactions.

Because SONGS did not operate during 2024, no C-14 was generated. Therefore, the estimated release of C-14 is 0 Curies.

5.10.3 Errata/Corrections to Previous ARERRs

No errors were identified during 2024 that required corrections to previous ARERRs.

6.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

San Onofre Nuclear Generating Station has developed a Groundwater Protection Initiative (GPI) program in accordance with NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document [9]. The purpose of the GPI is to ensure timely detection and an effective response to situations involving inadvertent radiological releases to groundwater in order to prevent migration of licensed radioactive material off-site and to quantify impacts on decommissioning. During 2024, SONGS collected and analyzed groundwater samples in accordance with site procedural requirements.

This section is included in this report to communicate the results of NEI 07-07 Radiological Groundwater Monitoring Program. Monitoring wells installed as part of GPI program are sampled and analyzed as summarized in Table 4, Groundwater Protection Program Monitoring Well Sample Schedule. Well locations are shown in Attachment 3, Groundwater Well Maps. In addition to reporting results from NEI 07-07 monitoring wells, voluntary communications to offsite governmental agencies per NEI 07-07 Objective 2.2, are also reported as part of this report. It is important to note, samples and results taken in support of NEI 07-07 groundwater monitoring program are not part of the Radiological Environmental Monitoring Program (REMP) but should be reported as part of ARERR.

Table 4, Groundwater Protection Program Monitoring Well Sample Schedule[6]

Well Name	Tritium	Gamma
PA 1	Quarterly	Quarterly
PA 2	Quarterly	Quarterly
PA 3	Quarterly	Quarterly
PA 4	Quarterly	Quarterly
NIA 1	Quarterly	Annually
NIA 2	Quarterly	Annually
NIA 3	Annually	Annually
NIA 4	Annually	Annually
NIA 5	Annually	Annually
NIA 6	Annually	Annually
NIA 7	Annually	Annually
NIA 10	Annually	Annually
NIA 11	Annually	Annually
NIA 12	Quarterly	Annually
NIA 13	Quarterly	Annually
NIA 14	Annually	Annually
NIA 15	Annually	Annually
OCA 1	Quarterly	-
OCA 2	Quarterly	-
OCA 3	Quarterly	-

[6] Analyses for Hard-to-detect nuclides (Ni-63, Fe-55, and Sr-90) and gross alpha are performed if tritium and gamma results indicate contamination from plant-related nuclides.

Radiological Groundwater Monitoring Program tritium results are summarized in Table 5, Groundwater Protection Program Monitoring Well Tritium Results.

Table 5, Groundwater Protection Program Monitoring Well Tritium Results

Well Name	Number of Positive Detections	Number of Analyses	Average Concentration[7,8] (pCi/L)	Maximum Concentration[8] (pCi/L)
PA 1	0	5	<MDA	<MDA
PA 2	14	15	3,180	3,960
PA 3	0	5	<MDA	<MDA
PA 4	0	4	<MDA	<MDA
NIA 1	0	4	<MDA	<MDA
NIA 2	0	4	<MDA	<MDA
NIA 3	0	1	<MDA	<MDA
NIA 4	0	1	<MDA	<MDA
NIA 5	0	1	<MDA	<MDA
NIA 6	0	1	<MDA	<MDA
NIA 7	0	1	<MDA	<MDA
NIA 10	0	1	<MDA	<MDA
NIA 11	0	1	<MDA	<MDA
NIA 12	0	4	<MDA	<MDA
NIA 13	0	4	<MDA	<MDA
NIA 14	0	1	<MDA	<MDA
NIA 15	0	1	<MDA	<MDA
OCA 1	0	4	<MDA	<MDA
OCA 2	0	4	<MDA	<MDA
OCA 3	0	4	<MDA	<MDA
MW-8 [9]	10	10	12,000	19,100

Tritium was detected in PA-2 well during the April 2024 sample event. Supplemental sampling was performed at PA-2 and at nearby MW-8 well. MW-8 is located approximately 20 feet north of PA-2 well and extends deeper into the water table. Gamma and hard-to-detect analyses for PA-2 and MW-8 did not identify activity of any licensed material besides tritium. Supplemental wells were drilled near the location of PA-2 and MW-8 during December 2024 and results from the new wells will be discussed in the 2025 ARERR. No other groundwater monitoring locations had detectable tritium or gamma emitting isotope activity in 2024.

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[7] Results <MDA are not included in the average concentration calculation.

[8] MDA values vary for each sample. All tritium MDAs for offsite analysis of groundwater samples taken during 2024 were < 500 pCi/L. All tritium MDAs for supplemental, onsite analyses were <2,000 pCi/l.

[9] Supplemental samples were taken at MW-8 to assess positive activity in nearby PA-2 well.

The issue was entered into the Corrective Action Program for formal evaluation and tracking and an Abnormal Release is being reported in Section 5.3.2 to account for migration of licensed material across the Site Boundary. The source of the tritium in the wells has not been determined. A downward trend of tritium has been observed since first observation of higher concentrations in MW-8 and the decreasing trend suggests that the source of activity is not actively being released to the environment. As part of the assessment of potential sources, the site identified potential work practices that could result in loss of licensed material to groundwater and addressed those items to ensure that leakage to the ground would be prevented.

Tritium was the only nuclide identified in groundwater and Section 5.3.2 reports that a bounding quantity of approximately 0.008 Ci of tritium was released from the Site Boundary in groundwater during 2024. This value was calculated using the methodology described in RG-4.25 [10]. Monitoring Wells PA-2 and MW-8 are located near the Site Boundary and corrections for transit time and decay are relatively small. Groundwater flows to the Pacific Ocean from SONGS with estimated linear flow rates between 82 and 135 feet/year.

The calculated dose for groundwater release is less than that calculated for routine liquid effluent releases and does not represent a significant dose pathway for Members of the Public. Groundwater at SONGS is not a potential source of drinking water, based on proximity to the ocean. Due to the relatively low concentrations of tritium observed and the decreasing trend of tritium concentration resulting from natural attenuation, remediation was not pursued in this case.

Additional wells were drilled in the area to characterize the extent of the plume. Based on current sample results, the plume is confined to a width of about 60' and no more than 28' below the water table. Information about the extent of the plume was used to develop the release estimate for 2024.

6.1 Voluntary Notification

On 9/5/2024, San Onofre Nuclear Generating Station made a voluntary NEI 07-07 notification to State/Local officials, NRC, and to other stakeholders required by site procedures.

The voluntary communication was made based on elevated tritium levels detected in groundwater. The tritium concentrations detected did not exceed reporting thresholds in the NEI 07-07 Communication Protocol, the ODCM, nor the concentration limit (1E-3 µCi/ml for tritium in water) from 10 CFR 20 Appendix B, Table 2, Column 2. The voluntary communication was made to ensure that stakeholders were notified in a timely manner that tritium had been identified in groundwater at the site and that the cause and extent was under investigation.

Subsequent monitoring found that no gamma or hard-to-detect nuclides (besides tritium) were identified in the affected wells and that tritium concentrations decreased during the remainder of 2024.

7.0 Bibliography

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[12] "40 CFR 190 - Environmental Radiation Protection Standards for Nuclear Power Operation," US Environmental Protection Agency, Washington, DC.

[13] "10 CFR 20 - Standards for Protection Against Radiation," US Nuclear Regulatory Commission, Washington, DC.

[14] "40 CFR 141 - National Primary Drinking Water Regulations," US Environmental Protection Agency, Washington, DC..

[15] "NUREG-0324 - XOQDOQ, Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," Nuclear Regulatory Commission, September, 1977.

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[17] "NUREG-1302 - Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," Nuclear Regulatory Commission, April 1991.

[18] "Regulatory Guide 4.13 - Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications, Revision 2," Nuclear Regulatory Commision, June, 2019.

[19] "Regulatory Guide 4.15 - Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment," Nuclear Regulatory Commission, July, 2007.

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

1.0 GASEOUS EFFLUENTS

Table 6, Gaseous Effluents Summation of All Releases SONGS [10]

A.	Fission & Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error %
1.	Total Release[11]	Ci	N/A	N/A	N/A	N/A	N/A
2.	Average release rate for the period	μCi/sec	N/A	N/A	N/A	N/A	
B.	Iodine[11]						
1.	Total Iodine – 131	Ci	N/A	N/A	N/A	N/A	N/A
2.	Average release rate for the period	μCi/sec	N/A	N/A	N/A	N/A	
C.	Particulates						
1.	Particulates with half-lives > 8 days	Ci	5.13E-05	<LLD	<LLD	<LLD	30%
2.	Average release rate for the period	μCi/sec	6.52E-06	N/A	N/A	N/A	
D.	Tritium						
1.	Total Release	Ci	<LLD	<LLD	<LLD	<LLD	N/A
2.	Average release rate for the period	μCi/sec	N/A	N/A	N/A	N/A	
E.	Gross Alpha						
1.	Total Release	Ci	<LLD	<LLD	<LLD	<LLD	N/A
F.	Carbon-14						
1.	Total Release	Ci	0	0	0	0	

[10] % of limit is provided in Table 1, San Onofre Nuclear Generating Station Units 2/3 Dose Summary
[11] Noble gases and iodines are no longer produced at SONGS.

Table 7, Gaseous Effluents – Ground Level Release Continuous Mode SONGS

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Particulates						
Co-60	Ci	1.09E-05	<LLD	<LLD	<LLD	1.09E-05
Ni-63	Ci	2.15E-05	<LLD	<LLD	<LLD	2.15E-05
Cs-137	Ci	1.89E-05	<LLD	<LLD	<LLD	1.89E-05
Total for Period	**Ci**	**5.13E-05**	**<LLD**	**<LLD**	**<LLD**	**5.13E-05**
Tritium						
H-3	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	<LLD

2.0 LIQUID EFFLUENTS

Table 8, Liquid Effluents – Summation of All Releases SONGS[12]

A.	Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error %
1.	Total Release	Ci	2.42E-03	<LLD	4.51E-04	6.49E-04	24%
2.	Average diluted concentration	μCi/mL	5.99E-10	N/A	2.20E-10	2.79E-10	
B.	Tritium						
1.	Total Release	Ci	1.79E+00	<LLD	1.47E+01	1.19E+01	16%
2.	Average diluted concentration	μCi/mL	4.43E-07	N/A	7.16E-06	5.12E-06	
C.	Dissolved & Entrained Gases						
1.	Total Release[13]	Ci	N/A	N/A	N/A	N/A	N/A
2.	Average diluted concentration	μCi/mL	N/A	N/A	N/A	N/A	
D.	Gross Alpha Activity						
1.	Total Release	Ci	<LLD	<LLD	<LLD	<LLD	N/A
E.	Volume of Waste Released (prior to dilution)						
1.	Batch Release Volume	Liters	1.28E+06	3.86E+05	2.43E+06	2.51E+06	
2.	Continuous Release Volume	Liters	1.24E+07	1.03E+04	0.00E+00	2.10E+04	
F.	Volume of Dilution Water Used During Period	Liters	4.04E+09	2.62E+09	2.05E+09	2.32E+09	

[12] % of limit is provided in Table 1, San Onofre Nuclear Generating Station Units 2/3 Dose Summary

[13] Noble gases are no longer produced at SONGS.

Table 9, Batch Mode Liquid Effluents SONGS

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
Co-60	Ci	1.33E-03	<LLD	8.75E-05	2.59E-04	1.67E-03
Ni-63	Ci	7.70E-04	<LLD	<LLD	<LLD	7.70E-04
Cs 137	Ci	3.26E-04	<LLD	3.64E-04	3.90E-04	1.08E-03
Total for Period	Ci	**2.42E-03**	**<LLD**	**4.51E-04**	**6.49E-04**	**3.52E-03**
Tritium						
H-3	Ci	**1.79E+00**	**<LLD**	**1.47E+01**	**1.19E+01**	**2.84E+01**
Gross Alpha						
Alpha	Ci	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**

Table 10, Continuous Mode Liquid Effluents SONGS

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
Total for Period	Ci	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**
Tritium						
H-3	Ci	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**
Gross Alpha						
Alpha	Ci	**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**

Attachment 2, Solid Waste Information

1.0 SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

Table 11, Types of Solid Waste Summary SONGS

Types of Waste	Total Volume (m^3)	Total Activity (Ci)	Est. Total Error (%)
a. Spent resins, filter sludges, evaporator bottoms, etc.	3.82E+01	2.94E+01	30%
b. Dry Active Waste (DAW), compactable and non-compactable	3.27E+04	9.40E+01	30%
c. Irradiated components	6.02E+00	5.39E+03	30%
d. Other	0.00E+00	0.00E+00	N/A

2.0 ESTIMATE OF MAJOR NUCLIDE COMPOSITION (BY WASTE TYPE) ONLY >1% ARE REPORTED.

Table 12, Major Nuclides SONGS

Major Nuclide Composition	%	Curies
a. Spent resins, filter sludges, evaporator bottoms, etc.		
Carbon-14	4.47%	1.31E+00
Iron-55	15.06%	4.41E+00
Cobalt-60	42.33%	1.24E+01
Nickel-59	1.54%	4.52E-01
Nickel-63	38.48%	1.01E+01
Cs-137	2.12%	6.20E-01
b. Dry Active Waste (DAW), compactable and non-compactable	%	Curies
Carbon-14	1.08%	1.00E+00
Iron-55	43.25%	4.01E+01
Cobalt-60	9.30%	8.62E+00
Nickel-63	31.06%	2.88E+01
Cesium-137	15.31%	1.42E+01
c. Irradiated components	%	Curies
Iron-55	13.72%	7.36E+02
Cobalt-60	60.19%	3.23E+03
Nickel-63	26.09%	1.40E+03
d. Other	%	Curies

3.0 SOLID WASTE DISPOSITION

Table 13, Solid Waste Disposition SONGS

Number of Shipments	Mode of Transportation	Destination
417	Rail [1]	Energy*Solutions* LLC, Clive Disposal Facility (BWF), Clive, UT
10	Tractor Trailer [1]	Energy*Solutions* LLC, Clive Disposal Facility (BWF), Clive, UT
30	Tractor Trailer [1]	Energy*Solutions* LLC, Clive Disposal Facility (CWF), Clive, UT
2	Tractor Trailer [2]	Energy*Solutions* LLC, Clive Disposal Facility (TF), Clive, UT
2	Tractor Trailer [3]	Energy*Solutions* LLC, Bear Creek Operations, Bear Creek, TN
4	Tractor Trailer [4]	Waste Control Specialists LLC, Texas CWF, Andrews, TX

Note 1: During 2024, 457 shipments were made from Energy*Solutions* - San Onofre directly to the Clive Disposal Facility, Bulk Waste Facility (BWF) and Containerized Waste Facility (CWF) for direct burial.

Note 2: During 2024, 2 shipments were made to the Clive Disposal Facility, Treatment Facility (TF) for treatment/liquid solidification/verification prior to burial at the Clive BWF.

Note 3: During 2024, 2 shipments were made to the Bear Creek Operations Facility for treatment/drying/incineration/verification prior to being sent to Energy*Solutions* Clive for burial.

Note 4: During 2024, 4 shipments of irradiated hardware were made to the Texas Compact Waste Facility (CWF) for burial.

4.0 IRRADIATED FUEL DISPOSITION

Table 14, Irradiated Fuel Shipments Disposition SONGS

Number of Shipments	Mode of Transportation	Destination
None	No shipments of irradiated fuel made in 2024	N/A

Attachment 3, Groundwater Well Maps

Figure 5, SONGS Groundwater Monitoring Well Locations.

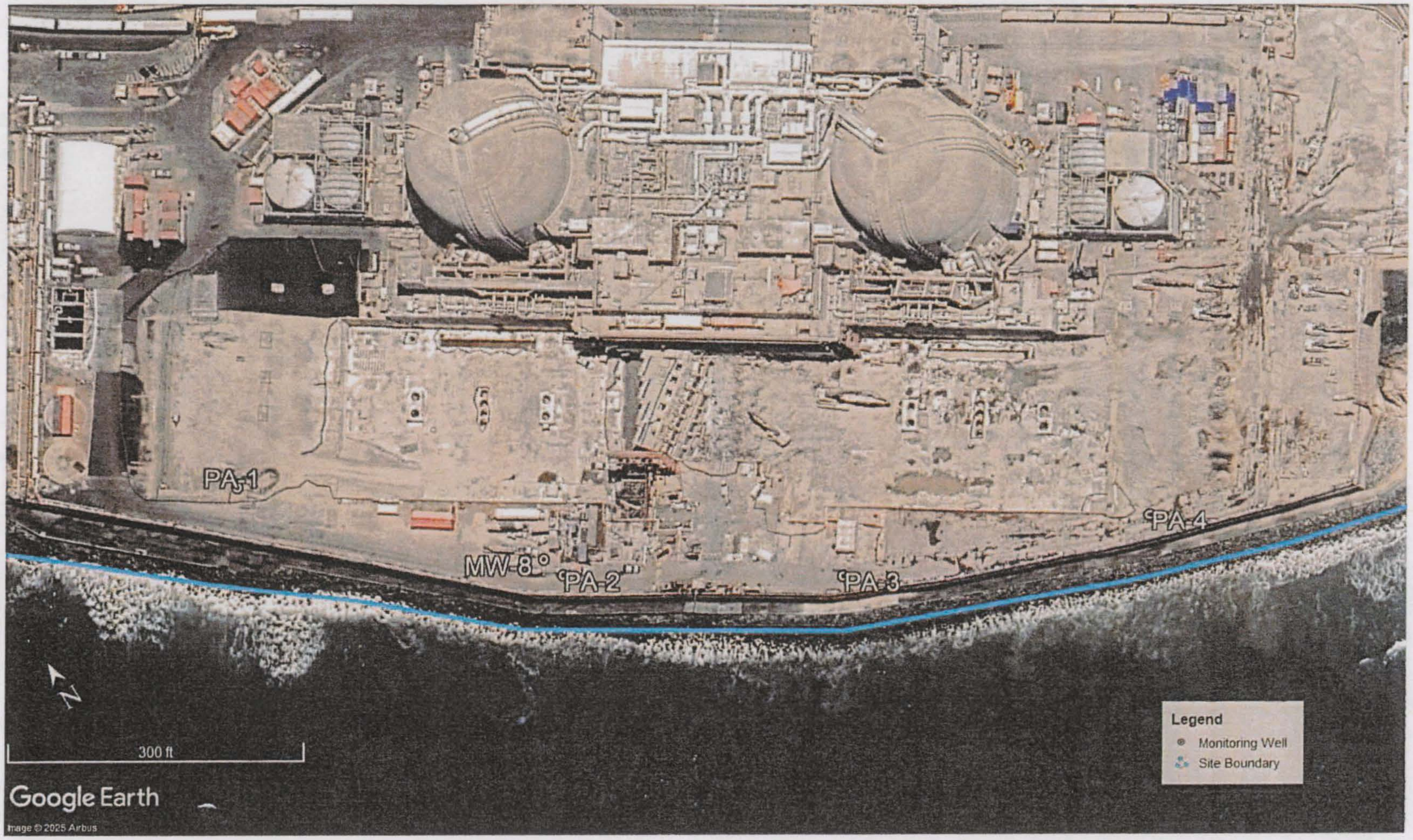

Figure 6, SONGS Restricted Area Well Locations.

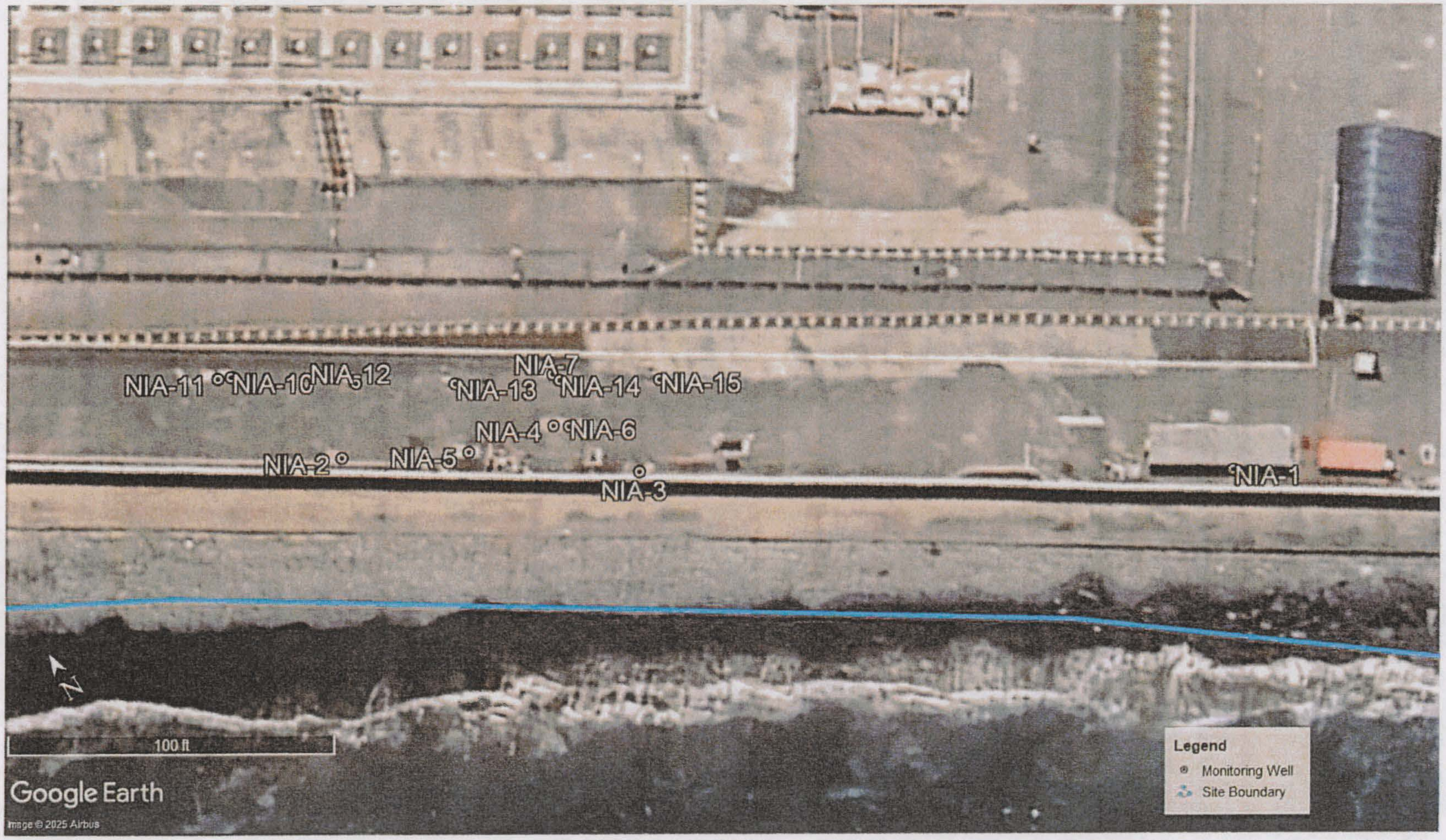

Figure 7, SONGS North Industrial Area Well Locations.

Enclosure 2

Offsite Dose Calculation Manual

San Onofre Nuclear Generation Station

SO123-ODCM Revision 20, August 2024

August 19, 2024

Mr. Fred Bailly

SUBJECT: San Onofre Nuclear Generating Station (SONGS) Offsite Dose Calculation Manual (ODCM) and Appendices: SO123-ODCM Revision 20 and SO123-ODCM-B Revision 11

In accordance with Licensee Controlled Specification 5.5.2.1, revisions to the SONGS Offsite Dose Calculation Manual and Appendices have been prepared and reviewed for your approval.

ODCM effluent screens and evaluations were performed to ensure the site's regulatory requirements of the Licensee Controlled Specifications and license basis were not challenged. These changes to the ODCM and Appendices have been documented in the SDS Electronic Documentation Management System.

This revision incorporates the following:

- Deletion of Plant Vent Stack gaseous effluent pathway
- Addition of Tent Ventilation effluent pathway
- Addition of Open Air Demolition monitoring requirements
- Revision of effluent sampling and instrumentation requirements to support the above changes
- Addition of alternate REMP air sample locations AS-20 and AS-21 near the Site Boundary

None of the changes in these revisions will adversely affect the accuracy or reliability of effluent dose calculations or set point determinations. Your approval for these revisions is requested.

Please contact ODCM/REMP Specialist if there are any questions.

Gary Huff
ODCM/REMP Specialist (SDS)

Greg Ferrigno
Radiation Protection Manager (SDS)

Sandra J. Sewell
Manager, Radiation Protection and Waste Contract Management (SCE)

Approved by: ______________________
Fred Bailly
Vice President Decommissioning and Chief Nuclear Officer (SCE)

Attachment
cc: eDMRM
NRA File

Throughout the document, change bars indicate the following types of changes:

A Addition
D Deletion
F Editorial/Format change
R Revision

Page	Description of Changes	Type of Change
1-12	Corrected subscript formatting in Equation (1-5).	F
1-13	Corrected subscript formatting in Equation (1-6).	F
2-2	Deleted Plant Vent Stack tritium requirement and added Tent Ventilation and OAD tritium requirement as N/A. Clarified "Continuous" gaseous release sources. Added OAD sample analysis requirements.	R
2-4	Deleted footnote "e" related to Plant Vent Stack.	D
2-4	Added footnote related to OAD Sampler requirements.	A
2-15	Corrected "dosed" to "dose" in definition for Equation (2-9).	F
4-6	Deleted Action 4.2.a. regarding gaseous effluent radiation monitor setpoints, which no longer apply to SONGS.	D
4-7, 4-9	Revised Tables 4-3 and 4-4. Deleted Plant Vent Stack requirements due to permanent retirement of that system. Updated applicability for CDV Process Flow Monitoring to At All Times. Revised use of applicability references and footnotes related to the table. Added Tent Ventilation System and OAD sampler requirements. Added footnote (1) to CDV and Tent Ventilation System Process Flow Monitoring lines to clarify the definition of Functionality for these devices. Deleted footnote reference "***" related to recorder functionality (from table header).	R
4-8	Revised notes related to Table 4-3. Added footnote(1) related to process flow rate monitoring for the CDV and Tent Ventilation systems. Revised Applicability reference "**" to address Tent Ventilation requirement applicability. Revised footnote reference"***" to apply to applicability of OAD sampler requirements. Added Actions 41 and 42 related to OAD Sampler requirements.	R
4-10	Revised notes related to Table 4-4. Revised Applicability note "**" to apply to Tent Ventilation System applicability and note "***" to apply to OAD Sampler requirement applicability. Revised footnote(1) to clarify CDV and Tent Ventilation Process Flow Monitoring Functionality.	R
4-13	Revised Figure 4-6 to Delete Plant Vent Stack release pathway and add Tent Ventilation System pathway. Deleted clarifying text related to PVS.	R
5-3	Revised Table 5-1 airborne particulate requirement to state "3 samples from close to the site boundary locations…" consistent with NUREG-1301 wording.	R
5-17	Revised Airborne monitoring locations in Table 5-4. Added AS-20 and AS-21 as alternate air sample locations for E and ESE sectors.	R
5-18	Revised name of Local Crops 2 to "Vista/Oceanside (CONTROL)"	F

5-21 through 5-24	Revised Figures 5-1 through 5-4 with updated sample locations. Local Crops 2 location moved to current primary sample location	R
6-3	Added definition of Unrestricted Area based on NUREG-1301.	A
Appendix B	Revised Section 3.0 (REMP Bases) to add alternate air sample locations AS-20 and AS-21. Deleted discussion of soil and drinking water.	R
Appendix B	Deleted Section 4.0 (Approval of Offsite Dose Calculation Manual Changes).	D

OFFSITE DOSE CALCULATION MANUAL

NUCLEAR ORGANIZATION

SAN ONOFRE NUCLEAR GENERATING STATION (SONGS)

SO123-ODCM
Revision 20
08/2024

ODCM

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INTRODUCTION

The OFFSITE DOSE CALCULATION MANUAL (ODCM) implements guidance from NUREG-0472 and NUREG-1301. The ODCM enumerates dose and concentration specifications, instrument requirements, as well as describes the methodology and parameters to be used in the calculation of offsite doses from radioactive liquid and airborne effluents consistent with RG-1.109 and NUREG 0133. In order to meet release limits, it additionally provides calculations for liquid effluent monitoring instrumentation alarm/trip setpoints. The environmental section contains the requirements for the radiological environmental monitoring program.

The ODCM will be maintained at the Site for use as a document of Specifications and acceptable methodologies and calculations to be used in implementing the Specifications. Changes in the calculational methods or parameters will be incorporated into the ODCM in order to assure that the ODCM represents current methodology.

1.0 **LIQUID EFFLUENTS**

1.1 CONCENTRATION

SPECIFICATION

1.1.1 The concentration of radioactive material released from the site (see Figure 1-2) shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2.

APPLICABILITY: At all times

ACTION:

a. With the concentration of radioactive material released from the site exceeding the above limits, immediately restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

SR 1.1.1.1 Radioactive liquid wastes shall be sampled and analyzed according to the sampling and analysis program of Table 1-1.

SR 1.1.1.2 The results of the radioactivity analyses shall be used in accordance with the methodology and parameters in Section 1.4 to assure that the concentrations at the point of release are maintained within the limits of Specification 1.1.1.

TABLE 1-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
A. Batch Waste Release[d,h]	P Each Batch	P Each Batch	Principal Gamma Emitters[f]	$5x10^{-7}$
	P Each Batch	M Composite[b,g]	H-3 Gross Alpha	$1x10^{-5}$ $1x10^{-7}$
	P Each Batch	Q Composite[b,g]	Sr-90 Ni-63 Fe-55	$5x10^{-8}$ $1x10^{-6}$ $1x10^{-6}$
B. Batch Release[d,h] Minor Liquid Pathway	P Each Batch	P Each Batch	Principal Gamma Emitters[f]	$5x10^{-7}$
	P Each Batch	M Composite[b,g]	H-3 Gross Alpha	$1x10^{-5}$ $1x10^{-7}$
	P Each Batch	Q Composite[b,g]	Sr-90 Ni-63 Fe-55	$5x10^{-8}$ $1x10^{-6}$ $1x10^{-6}$
C. Continuous Release[e,h] North Industrial Area Yard Drain Sump	3 x W Grab Sample	W Composite[b,g]	Principal Gamma Emitters[f]	$5x10^{-7}$
	3 x W Grab Sample	M Composite[b,g]	H-3 Gross Alpha	$1x10^{-5}$ $1x10^{-7}$
	3 x W Grab Sample	Q Composite[b,g]	Sr-90 Fe-55 Ni-63	$5x10^{-8}$ $1x10^{-6}$ $1x10^{-6}$

TABLE 1-1 (Continued)

TABLE NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66S_b}{E * V * 2.22 \times 10^6 * Y * e^{-\lambda \Delta t}}$$

where:

LLD	=	"a priori" lower limit of detection as defined above (as microcurie per unit mass or volume),
S_b	=	standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),
E	=	counting efficiency (as counts per transformation),
V	=	sample size (in units of mass or volume),
2.22×10^6	=	number of transformations per minute per microcurie,
Y	=	fractional radiochemical yield (when applicable),
λ	=	radioactive decay constant for the particular radionuclide, and
Δt	=	elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples).

The value of S_b used in the calculation of the LLD for a particular measurement system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance.

Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of the measurement system and not as a posteriori (after the fact) limit for a particular measurement[#].

[#]For a more complete discussion of the LLD, and other detection limits, see the following:

(1) HASL Procedures Manual, HASL-300 (revised annually).

(2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination – Application to Radiochemistry" Anal. Chem. 40, 586-93 (1968).

(3) Hartwell, J. K., "Detection Limits for Radioisotopic Counting Techniques," Atlantic Richfield Hanford Company Report ARH-2537 (June 22, 1972).

TABLE 1-1 (Continued)

TABLE NOTATION (Continued)

b. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

c. DELETED

d. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analyses, each batch shall be isolated, and then thoroughly mixed, by a method described in the ODCM, to assure representative sampling.

e. A continuous release is the discharge of liquid wastes of a nondiscrete volume; e.g., from a volume of system that has an input flow during the continuous release.

f. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Co-58, Co-60, Zn-65, Cs-134, Cs-137, Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

g. Prior to analysis, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

h. There shall be no liquid discharges across the beach; liquid may only be discharged through the approved outfall(s).

1.0 **LIQUID EFFLUENTS** (Continued)

1.2 DOSE

SPECIFICATION

1.2.1 The dose or dose commitment to an individual from radioactive materials in liquid effluents released, from each unit, from the site (see Figure 1-2) shall be limited:

a. During any calendar quarter to less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ, and

b. During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

APPLICABILITY: At all times

ACTION:

a. With calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a Special Report which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions taken to reduce the releases and the proposed actions to be taken to assure that subsequent releases will be in compliance with Specification 1.2.1.

SURVEILLANCE REQUIREMENT

SR 1.2.1.1 Dose Calculation. Cumulative dose contributions from liquid effluents shall be determined in accordance with Section 1.5 at least once per 31 days.

1.0 **LIQUID EFFLUENTS** (Continued)

1.3 LIQUID WASTE TREATMENT

SPECIFICATION

1.3.1 The portable liquid radwaste treatment system shall be FUNCTIONAL. The appropriate portions of the system shall be used to reduce the radioactive materials in liquid wastes prior to their discharge when the projected doses due to the liquid effluent from the site (see Figure 1-2) when averaged over 31 days, would exceed 0.06 mrem to the total body or 0.2 mrem to any organ.*

APPLICABILITY: At all times

ACTION:

a. With radioactive liquid waste being discharged without treatment and in excess of the above limits, prepare and submit to the Commission within 30 days, a Special Report which includes the following information:

1. Explanation of why liquid radwaste was being discharged without treatment, identification of the non-FUNCTIONAL equipment or subsystems and the reason for non-FUNCTIONALITY,

2. Action(s) taken to restore the non-FUNCTIONAL equipment to FUNCTIONAL status, and

3. Summary description of action(s) taken to prevent a recurrence.

SURVEILLANCE REQUIREMENTS

SR 1.3.1.1 Doses due to liquid releases shall be projected at least once per 31 days, in accordance with Section 3.1.

SR 1.3.1.2 The appropriate portions of the portable liquid radwaste treatment system shall be demonstrated FUNCTIONAL by operating the liquid radwaste treatment system equipment for at least 15-minutes prior to processing liquids. The processed liquids shall then be evaluated for batch release.

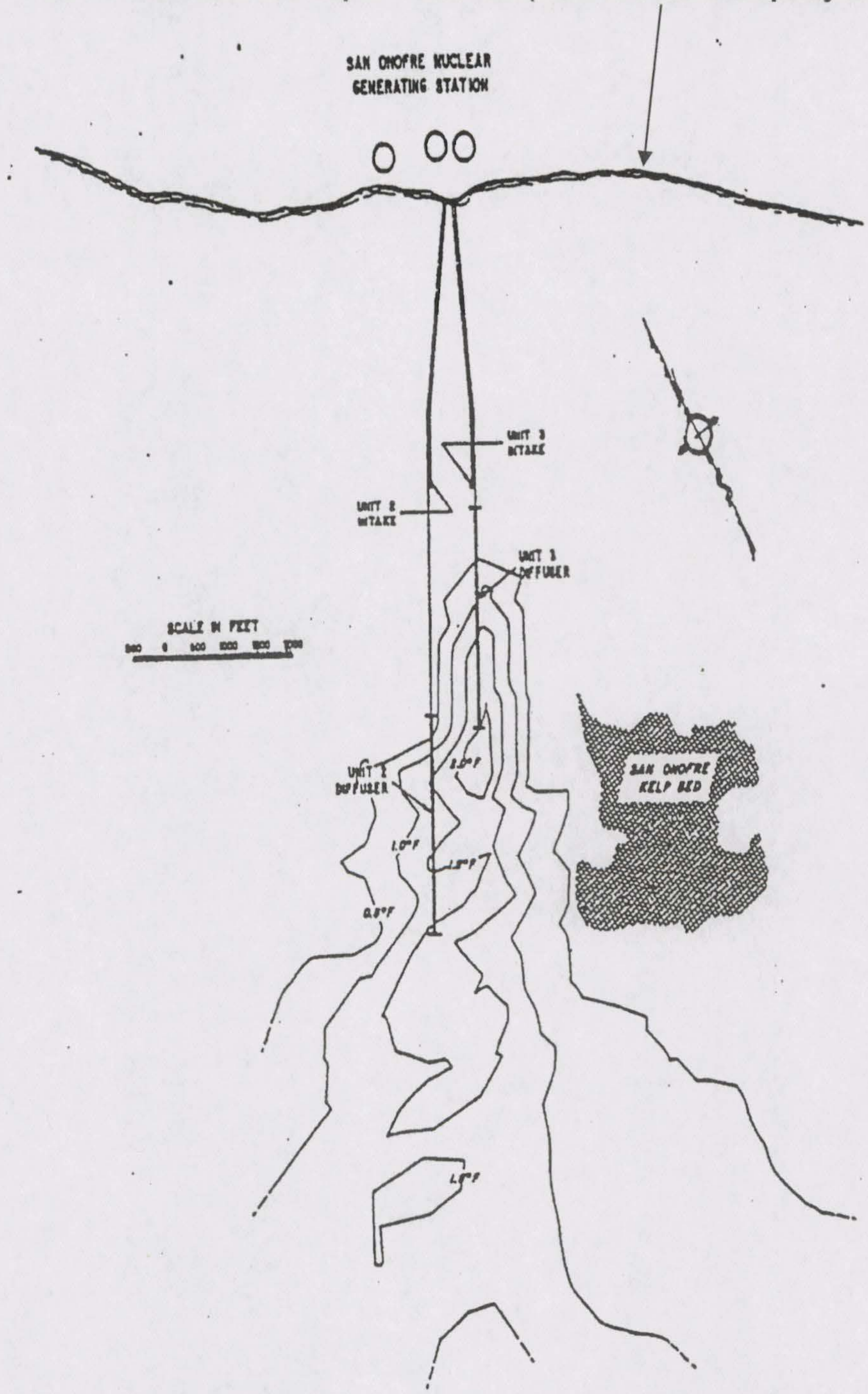
*Per unit

SITE BOUNDARY FOR LIQUID EFFLUENTS

Figure 1-2

NIA, UNIT 2 & UNIT 3

SITE BOUNDARY for Liquid Effluents (waterfront on Property Line)



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1.0 **LIQUID EFFLUENTS** (Continued)

1.4 LIQUID EFFLUENT MONITOR METHODS OF SETPOINT CALCULATION

Liquid Effluent Line Monitor provides alarm and automatic termination of release prior to exceeding the concentration limits specified in 10 CFR 20, Appendix B, Table II, Column 2 at the release point to the unrestricted area. To meet this specification and for the purpose of implementation of Specification 1.1.1, the alarm/trip setpoints for liquid effluent monitors and flow measurement devices are set to assure that the following equation is satisfied:

$$\left[\frac{C_m R}{F+R}\right] \leq \mathrm{MPC_{eff}} \qquad \textbf{(1-1)}$$

where:

C_m = setpoint, representative of a radionuclide concentration for the radiation monitor measuring the radioactivity in the waste effluent line prior to dilution and subsequent release, µCi/ml

R = permissible waste effluent flow rate at the radiation monitor location, in volume per unit time in the same units as for F

F = dilution water flow in volume per unit time.
= 7,000 gpm per saltwater dilution pump*

*The value used in the determination of F takes into account factors such as frictional losses, pump inefficiency, and tidal flow, and provides reasonable assurance that the radioactive release concentration is not underestimated. For radwaste discharges, the dilution water flow of 14,000 gpm shall be used and aligned to the same outfall.

NOTE: Since the values of R are much smaller than F, the term (F + R) in equation (1-1) may be replaced by F.

1.0 **LIQUID EFFLUENTS** (Continued)

1.4 LIQUID EFFLUENT MONITOR METHODS OF SETPOINT CALCULATION (Continued)

MPC_{eff} = effective effluent maximum concentration permissible limit (µCi/ml) at the release point to the unrestricted area for the radionuclide mixture being released:

$$= \left[\frac{1}{\sum_{i=1}^{n}\frac{F_i}{MPC_i}}\right] \qquad \textbf{(1-2)}$$

where:

n = number of radionuclides identified in sample analysis

F_i = fractional concentration of the i^{th} radionuclide as obtained by sample analysis including gamma isotopes, tritium, and hard-to-detect results.

MPC_i = MPC of the i^{th} radionuclide (10 CFR 20, App B, Table II, Column 2)

Administrative values are used to reduce each setpoint to account for the potential activity released simultaneously from the following release points:

RW_{7813} = 0.75 Radwaste Effluent discharge

M = 0.05 Minor Liquid Pathway

Y = 0.19 NIA Yard Drain Sump

The values provided here are the default Administrative factors. The values may be changed by ODCM/Effluent Specialist and documented in an approved setpoint transmittal. The Minor Liquid Pathway Administrative factor has been maintained here for conservatism; the Administrative factor serves to limit the maximum factors for the remaining discharge pathways.

The sum of the administrative values is limited to 1.0 to ensure that the total concentration from all release points to the plant discharge will not result in a release exceeding the limits of 10 CFR 20, Appendix B, Table II, Column 2. The administrative values shall be assigned such that:

$(RW_{7813} + M + Y) < 1.0.$

The administrative values shall be periodically reviewed based on actual release data and revised as necessary.

1.0 **LIQUID EFFLUENTS** (Continued)

1.4 LIQUID EFFLUENT MONITOR METHODS OF SETPOINT CALCULATION (Continued)

The waste flow (R) and monitor setpoint (C_m) are set to meet the condition of equation (1-1) for the MPC_{eff} limit. The method by which this is accomplished as follows:

STEP 1: The isotopic concentration for each batch tank (or sump) to be released is obtained from the sum of the measured concentrations in the tank (or sump) as determined by analysis.

Note: Batch release setpoints are determined based on a grab sample obtained from the tank proposed for release. Continuous release and routine setpoints may be determined by a grab sample, composite samples, long-term source term concentrations, or other assumed source term, depending on the purpose and ODCM/REMP Specialist judgment.

$$\mathrm{C} = \left(\textstyle\sum_i \mathrm{C}'_{\gamma\mathrm{i}}\right) + (\mathrm{C}_\alpha)+(\mathrm{C}_\mathrm{s})+(\mathrm{C}_\mathrm{t})+(\mathrm{C}_\mathrm{Fe})+(\mathrm{C}_\mathrm{Ni}) \qquad \textbf{(1-3)}$$

where:

C = total concentration in each batch tank, µCi/ml

$\Sigma_i C'_{\gamma i}$ = sum of the measured concentrations for each radionuclide, i, in the gamma spectrum

C_α = gross alpha concentration determined in the previous monthly composite sample, µCi/ml

C_s = Sr-90 concentration as determined in the previous quarterly composite sample, µCi/ml

C_t = H-3 concentration as determined in the previous monthly composite sample, or as measured in the sample taken prior to release, µCi/ml

C_{Fe} = Fe-55 concentration as determined in the previous quarterly composite sample, µCi/ml

C_{Ni} = Ni-63 concentration as determined by isotopic analysis in the previous quarterly composite sample, µCi/ml

1.0 **LIQUID EFFLUENTS** (Continued)

1.4 LIQUID EFFLUENT MONITOR METHODS OF SETPOINT CALCULATION (Continued)

STEP 2: The effective MPC (MPC_{eff}) for each batch tank (or sump) is determined using:

$$MPC_{eff} = \frac{1}{\Sigma_i\left(\frac{C_{\gamma i}/C}{MPC_{\gamma i}}\right)+\left(\frac{C_S/C}{MPC_S}\right)+\left(\frac{C_t/C}{MPC_t}\right)+\left(\frac{C_\alpha/C}{MPC_\alpha}\right)+\left(\frac{C_{Fe}/C}{MPC_{Fe}}\right)+\left(\frac{C_{Ni}/C}{MPC_{Ni}}\right)} \quad \textbf{(1-4)}$$

where: the MPC values represent the limiting concentrations of the appropriate radionuclide from 10 CFR 20, Appendix B, Table II, Column 2:

$MPC_{\gamma i}$,	=	the limiting concentration of the appropriate gamma-emitting radionuclide
MPC_s,	=	3E-7 µCi/ml for Sr-90
MPC_t,	=	3E-3 µCi/ml for H-3
MPC_{Fe},	=	8E-4 µCi/ml for Fe-55
MPC_α,	=	3E-8 µCi/ml for alpha
MPC_{Ni}	=	3E-5 µCi/ml for Ni-63

STEP 3: The setpoint, C_m (µCi/ml) for each radioactivity monitor may now be specified based on the respective values of C, $\Sigma_i C'_{\gamma i}$, F, MPC_{eff}, and R to provide compliance with the limits of 10 CFR 20, Appendix B, Table II, Column 2.

1.0 **<u>LIQUID EFFLUENTS</u>** (Continued)

1.4 LIQUID EFFLUENT MONITOR METHODS OF SETPOINT CALCULATION (Continued)

1.4.1 Batch Setpoint Determination: Radwaste Discharge Line Monitor (2/3RT-7813)

The value for C_m, the concentration limit at the detector, is determined by using:

$$C_m \leq \frac{(RW_{7813})(F)(\Sigma_i C'_{\gamma i})}{(R)\left(C/_{MPC_{eff}}\right)} \quad \textbf{(1-5)}$$

where:

RW_{7813} = Radwaste Effluent discharge administrative value

F = dilution water flow in volume per unit time
= 7,000 gpm per saltwater dilution pump**

** The value used in the determination of F takes into account factors such as frictional losses, pump inefficiency, and tidal flow, and provides reasonable assurance that the radioactive release concentration is not underestimated on the pre-release permit. For radwaste discharges, the dilution water flow of 14,000 gpm shall be used and aligned to the same outfall throughout the actual effluent release period.

C = total concentration in each batch sample

$\Sigma_i C'_{\gamma i}$ = total gamma isotopic concentration, μCi/ml

R = maximum effluent discharge flow rate
120 gpm (administrative discharge flow rate limit)

MPC_{eff} = from equation (1-4)

NOTE: If $C_m \leq \Sigma_i C'_{\gamma i}$, then no release is possible. To increase C_m, increase the administrative value RW_{7813}, and/or increase dilution flow F (by running more dilution pumps in the applicable discharge structure), and/or decrease the effluent flow rate R and recalculate C_m using the new RW_{7813}, F, R as applicable and equation (1-5).

1.4.2 Continuous Release Setpoint Determination: NIA Yard Drain Sump Monitor (2/3RT-2101)

There is one Yard Drain Sump on site, located in the North Industrial Area. It is released through the Unit 2 outfall.

The value for C_{YDS}, the concentration limit at the detector, is determined by using:

$$C_{YDS} \leq \frac{(Y)(F)(\Sigma_i C'_{yi})}{(R)\left({}^{C}/_{MPC_{eff}}\right)} \qquad \textbf{(1-6)}$$

where:

C_{YDS}	=	instantaneous concentration at detector 2/3RT-2101 in µCi/ml
Y	=	NIA Yard Drain Sump administrative value
F	=	dilution water flow in volume per unit time
	=	7,000 gpm per saltwater dilution pump
$\Sigma_i C'_{yi}$	=	total gamma isotopic concentration, µCi/ml (STEP 1)
R	=	effluent flow rate, gpm, typical flow rates:
	=	4100 gpm
C	=	total concentration, µCi/ml
MPC_{eff}	=	value of MPC_{eff} from equation (1-4) for the sample analysis

NOTE: If $C_{YDS} \leq \Sigma_i C'_{yi}$, then no release is possible. To increase C_{YDS}, increase the administrative value, Y, and/or increase dilution flow F (by running more dilution pumps), and/or decrease the effluent flow rate, R, and recalculate C_{YDS} using the new Y, F, R as applicable and equation (1-6). A minimum of 7,000 gpm flow shall be used for continuous releases. If there is a loss of dilution flow, then operations start another pump or SHALL terminate all continuous liquid effluent releases.

For NIA YDS releases, the process flow rate (R) is significant compared to dilution flow rate (F) and (F+R) may be used in place of F in equation (1-6).

1.0 **LIQUID EFFLUENTS** (Continued)

1.5 DOSE CALCULATION FOR LIQUID EFFLUENTS

1.5.1 Total Organ Dose Calculation for Liquid Effluents

The liquid releases considered in the following dose calculations are described in Section 1.4. The dose commitment to an individual from radioactive materials in liquid effluents released to unrestricted areas are calculated for the purpose of implementing Specification 1.2.1 using the following expression.

$$D_{\tau a}(liquid) = \sum_i \left[A_{i\tau a} \sum_j \left(\Delta t_j C_{ij} F_j \right) \right] \quad \textbf{(1-7)}$$

where:

$A_{i\tau a}$ = Site-related ingestion dose commitment factor to the total body or an organ, τ, for each identified principal gamma and beta emitter, i, for age group, a, in mrem/hr per μCi/ml. Adult dose factors, provided in Table 1-4, are used for routine and annual dose calculations. Annual dose calculations also use Teen and Child dose factors from Tables 1-5 and 1-6.

C_{ij} = average concentration of radionuclide, i, in the undiluted liquid effluent during time period, $_j$, in μCi/ml.

$D_{\tau a}$ = dose commitment to the total body or an organ, τ, and age group, a, from the liquid effluent in mrem.

F_j = near field average dilution factor (actually mixing ratio) for C_{ij} during the time period, $_j$. This factor is the ratio of the average undiluted liquid waste flow during time period, $_j$, to the average flow from the site discharge structure to unrestricted receiving waters,

$$\text{or: } \left(\frac{\text{average liquid radioactive waste flow}}{\text{discharge structure exit flow}} \right)$$

Δt_j = length of the j^{th} time period over which C_{ij} and F_j are averaged for all liquid releases, in hours.

1.5.2 Dose Factor Related to Liquid Effluents ($A_{i\tau a}$)

Total organ doses in Section 1.5.1 are determined using $A_{i\tau}$ factors. NUREG-0133 presents $A_{i\tau}$ for adult age group only, assuming this will be the limiting age class and only the critical organ is assumed to be used to demonstrate compliance with 10 CFR 50, Appendix I requirements. Teen and Child age classes are limiting for some nuclides in the current source term. For completeness, and to allow determination of 40 CFR 190 doses to the likely most-exposed member of the public, $A_{i\tau}$ has been tabulated for Adult, Teen, and Child age groups. $A_{i\tau}$ values for the Adult continue to be used for monthly dose calculations in the Effluent Reporting software. The dose factor inputs have been updated from RG-1.109 values in some cases and values from NUREG-0172 and/or NUREG/CR-4013 have been substituted where appropriate.

$$A_{i\tau a} = k_0(U_{Fa}BF_i + U_{Ia}BI_i)DF_{i\tau a} \quad \textbf{(1-8)}$$

where:

$A_{i\tau a}$ = Ingestion dose commitment factor due to liquid effluents in mrem/hr per pCi/ml.

k_0 = Unit conversion factor, $1.14 \times 10^5 = 10^6$ pCi/μCi x 10^3 ml/kg / 8760 hr/yr.

U_{Fa} = Fish Consumption for Maximum Exposed Individual, in kg/yr, from Table E-5 of RG 1.109.

Age Group (a)	U_{Fa} (kg/yr)
Adult	21
Teen	16
Child	6.9

U_{Ia} = Other Seafood Consumption for Maximum Exposed Individual, in kg/yr, from Table E-5 of RG-1.109.

Age Group (a)	U_{Ia} (kg/yr)
Adult	5
Teen	3.8
Child	1.7

BF_i = Bioaccumulation factor for nucliude (i) in saltwater fish, in pCi/kg per pCi/l, from Table A-1 of RG-1.109 or Table 3.1 of NUREG/CR-4013.

BI_i = Bioaccumulation factor for nucliude (i) in saltwater invertebrates, in pCi/kg per pCi/l, from Table A-1 of RG-1.109 or Table 3.1 of NUREG/CR-4013.

$DF_{i\tau a}$ = Dose conversion factor for ingestion of nuclide (i), organ (τ), and age group (a), in mrem/pCi, from Table E-11 through E-13 of RG-1.109 as updated by NUREG-0172.

Dose factors for each age group are presented in Tables 1-4 Through 1-6. Where no dose factor is shown in the table, no Dose Conversion Factor ($DF_{i\tau a}$) is available for the organ/nuclide combination. Infant ingestion of seafood is 0 kg/yr and no table is provided for $A_{i\tau a}$ for the Infant age group.

<u>**TABLE 1-4**</u>

ADULT DOSE COMMITMENT FACTORS*, A_{iT}
(mrem/hr per μCi/ml)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	GI-LLI
H-3		**1.61E-01**	**1.61E-01**	**1.61E-01**	**1.61E-01**	**1.61E-01**	**1.61E-01**
Mn-54		7.06E+3	1.35E+3		2.10E+3		2.16E+4
Fe-55	**5.12E+04**	3.54E+04	8.24E+03			1.97E+04	2.03E+04
Co-58		6.04E+02	1.35E+03				**1.22E+04**
Co-60		1.73E+03	3.83E+03				**3.26E+04**
Ni-63	**4.97E+04**	3.45E+03	1.67E+03				7.19E+02
Zn-65	1.61E+05	**5.13E+05**	2.32E+05		3.43E+05		3.23E+05
Sr-90	**1.41E+05**		2.84E+03				3.55E+03
Sb-125	1.77E+02	1.97E+00	4.21E+01	1.80E-01		1.36E+02	**1.95E+03**
Cs-134	6.85E+03	**1.63E+04**	1.33E+04		5.28E+03	1.75E+03	2.85E+02
Cs-137	8.78E+03	**1.20E+04**	7.87E+03		4.08E+03	1.35E+03	2.32E+02
Ce-144	1.79E+02	7.48E+01	9.60E+00		4.43E+01		**6.05E+04**

TABLE 1-5

TEEN DOSE COMMITMENT FACTORS, $A_{i\tau}$
(mrem/hr per µCi/ml)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLI
H-3		**1.24E-01**	**1.24E-01**	**1.24E-01**	**1.24E-01**	**1.24E-01**	**1.24E-01**
Mn-54		6.95E+03	1.38E+03		2.07E+03		**1.43E+04**
Fe-55	**5.35E+04**	3.79E+04	8.85E+03			2.41E+04	1.64E+04
Co-58		5.99E+02	1.38E+03				**8.26E+03**
Co-60		1.73E+03	3.90E+03				**2.26E+04**
Ni-63	**5.15E+04**	3.64E+03	1.75E+03				5.79E+02
Zn-65	1.46E+05	**5.07E+05**	2.36E+05		3.24E+05		2.15E+05
Sr-90	**1.26E+05**		2.52E+03				2.87E+03
Sb-125	1.87E+02	2.04E+00	4.36E+01	1.78E-01		1.64E+02	**1.45E+03**
Cs-134	7.02E+03	**1.65E+04**	7.67E+03		5.25E+03	2.01E+03	2.06E+02
Cs-137	9.40E+03	**1.25E+04**	4.35E+03		4.25E+03	1.65E+03	1.78E+02
Ce-144	1.94E+02	8.02E+01	1.04E+01		4.79E+01		**4.87E+04**

TABLE 1-6

CHILD DOSE COMMITMENT FACTORS, $A_{i\tau}$
(mrem/hr per µCi/ml)

Radionuclide	Bone	Liver	Total Body	Thyroid	Kidney	Lung	Gi-LLI
H-3		**1.03E-01**	**1.03E-01**	**1.03E-01**	**1.03E-01**	**1.03E-01**	**1.03E-01**
Mn-54		**5.47E+03**	1.46E+03		1.53E+03		4.59E+03
Fe-55	**7.18E+04**	3.81E+04	1.18E+04			2.15E+04	7.06E+03
Co-58		4.91E+02	1.50E+03				**2.86E+03**
Co-60		1.44E+03	4.26E+03				**7.99E+03**
Ni-63	**6.85E+04**	3.67E+03	2.33E+03				2.47E+02
Zn-65	1.55E+05	**4.12E+05**	2.56E+05		2.59E+05		7.23E+04
Sr-90	**1.40E+05**		2.81E+03				1.25E+03
Sb-125	2.33E+02	1.79E+00	4.87E+01	2.15E-01		1.30E+02	**5.55E+02**
Cs-134	8.51E+03	**1.40E+04**	2.95E+03		4.33E+03	1.55E+03	7.53E+01
Cs-137	**1.19E+04**	1.14E+04	1.68E+03		3.71E+03	1.33E+03	7.13E+01
Ce-144	2.59E+02	8.11E+01	1.38E+01		4.49E+01		**2.11E+04**

NOTES:

Where no value is given, no organ dose factor data are available.

Bold values represent critical organ dose rates for a given nuclide.

1.0 **LIQUID EFFLUENTS** (Continued)

1.6 REPRESENTATIVE SAMPLING

Prior to sampling of a batch release, each batch shall be thoroughly mixed to assure representative sampling in accordance with the requirements of RG-1.21 and NUREG-0800, Section 11.5. The methodology for mixing and sampling is described in SDS-CH2-PGM-1005 and SDS-CH2-PCD-1004.

2.0 **GASEOUS EFFLUENTS**

2.1 DOSE RATE

SPECIFICATION

2.1.1 The dose rate in unrestricted areas due to radioactive materials released in gaseous effluents from the site (see Figure 2-2) shall be limited to the following:

a. DELETED

b. For Tritium and for radioactive materials in particulate form: Less than or equal to 1500 mrem/yr to any organ.

APPLICABILITY: At all times

ACTION:

a. With dose rate(s) exceeding the above limits, immediately decrease the release rate to within the above limit(s).

SURVEILLANCE REQUIREMENTS

SR 2.1.1.1 DELETED

SR 2.1.1.2 The dose rate due to Tritium and radioactive materials in particulate form in gaseous effluents shall be determined to be within the above limits in accordance with Section 2.7 by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 2-1.

TABLE 2-1

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS PROGRAM

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
Continuous (Containment Ventilation and Tent Ventilation Systems)	*	*	Tritium	$1x10^{-6}$
	Continuous[f] Sampler	W Particulate Sample	Principal Gamma Emitters[g]	$1x10^{-11}$
	Continuous[f] Sampler	M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
	Continuous[f] Sampler	Q Composite Particulate Sample	Sr-90 Ni-63	$1x10^{-11}$ $1x10^{-11}$
Open Air Demolition Monitoring (OAD)	Continuous Sampling during active OAD work[h]	W Particulate Sample	Principal Gamma Emitters[g]	$1x10^{-11}$
		M Composite Particulate Sample	Gross Alpha	$1x10^{-11}$
		Q Composite Particulate Sample	Sr-90 Ni-63	$1x10^{-11}$ $1x10^{-11}$

*Sampling frequencies for Tritium are:

Containment Ventilation : Monthly Grab
Tent Ventilation : N/A
OAD : N/A

TABLE 2-1 (Continued)

TABLE NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66S_b}{E * V * 2.22 \times 10^6 * Y * e^{-\lambda \Delta t}}$$

where:

LLD	=	"a priori" lower limit of detection as defined above (as microcurie per unit mass or volume),
S_b	=	standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),
E	=	counting efficiency (as counts per transformation),
V	=	sample size (in units of mass or volume),
2.22×10^6	=	number of transformations per minute per microcurie,
Y	=	fractional radiochemical yield (when applicable),
λ	=	radioactive decay constant for the particular radionuclide, and
Δt	=	elapsed time between midpoint of sample collection and time of counting (for plant effluents, not environmental samples).

The value of S_b used in the calculation of the LLD for a particular measurement system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance.

Typical values of E, V, Y and Δt should be used in the calculation.

It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of the measurement system and not as a posteriori (after the fact) limit for a particular measurement.**

**For a more complete discussion of the LLD, and other detection limits, see the following:

(1) HASL Procedures Manual, HASL-300 (revised annually).

(2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry" Anal. Chem. 40, 586-93 (1968).

(3) Hartwell, J. K., "Detection Limits for Radioisotopic Counting Techniques," Atlantic Richfield Hanford Company Report ARH-2537 (June 22, 1972).

TABLE 2-1 (Continued)

TABLE NOTATION (Continued)

f. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Specifications 2.1.1, 2.3.1.

g. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Co-58, Co-60, Zn-65, Cs-134, Cs-137, and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported.

h. Continuous air sampling is required in four opposing directions during active Open Air Demolition work with potential for loose contamination to become airborne. The sampler locations should be established based on work being covered and prevailing wind directions.

2.0 **GASEOUS EFFLUENTS** (Continued)

2.2 DOSE – NOBLE GASES – **DELETED**

2.3 DOSE - RADIOACTIVE MATERIALS IN PARTICULATE FORM AND TRITIUM

SPECIFICATION

2.3.1 The dose to an individual from Tritium and radioactive materials in particulate form in gaseous effluents released, from each reactor unit, from the Site (see Figure 2-2) shall be limited to the following:

a. During any calendar quarter: Less than or equal to 7.5 mrem to any organ, and

b. During any calendar year: Less than or equal to 15 mrem to any organ.

APPLICABILITY: At all times

ACTION:

a. With the calculated dose from the release of Tritium and radioactive materials in particulate form, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions taken to reduce releases and the proposed actions to be taken to assure that subsequent releases will be in compliance with Specification 2.3.1.

SURVEILLANCE REQUIREMENT

SR 2.3.1.1 Dose Calculations Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined in accordance with Section 2.8 at least once per 31 days.

SR 2.3.1.2 Doses due to gaseous releases from the facility to areas at and beyond the SITE BOUNDARY shall be projected at least once per 31 days in accordance with the methodology and parameters in the ODCM pursuant to LCS 5.5.2.3.e.

2.4 GASEOUS RADWASTE TREATMENT – **DELETED**

2.5 TOTAL DOSE (Moved to Section 3) – **DELETED**

2.6 METHODS OF CALCULATION FOR GASEOUS EFFLUENT MONITOR SETPOINTS – **DELETED**

SAN ONOFRE NUCLEAR GENERATING STATION
SITE BOUNDARY FOR GASEOUS EFFLUENTS
Figure 2-2

SO123-ODCM
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2.0 **GASEOUS EFFLUENTS** (Continued)

2.7 GASEOUS EFFLUENT DOSE RATE

The methodology used for the purpose of implementation of Specification 2.1.1 for the dose rate above background to an individual in an unrestricted area is calculated by using the following expressions:

2.7.1 For Noble Gas – **DELETED**

2.7.2 For Tritium and for Radioactive Materials in Particulate Form:

$$\dot{D}_o = \overline{W} \sum_i P_i \dot{Q}_i \quad \textbf{(2-1)}$$

where:

$\dot{D}_O$ = maximum organ dose rate in unrestricted areas due to radioactive materials released in gaseous effluents, mrem/yr

$\dot{Q}_i$ = measured or calculated release rate of radionuclide, i, µCi/sec

P_i = dose parameter for radionuclide, i, from Table 2-5 for the inhalation pathway in mrem/yr per µCi/m^3. The dose factors are based on the critical individual organ from all age groups.

$\overline{W}$ = highest calculated historical annual average dispersion $(\overline{X/Q})$ factor for estimating the dose to an individual at or beyond the unrestricted area boundary for the inhalation pathway from ODCM Appendix A.

= $(\overline{X/Q})$, 2.00E-3 sec/m^3 for Units 2/3 for the SSW Site Boundary inhalation pathway.

Table 2-5
Dose Parameter P_i
All Age Groups
Inhalation Pathway

Radionuclide	Inhalation Pathway (mrem/yr per µCi/m^3)	Age Group	Organ
H-3	7.2E+02	Teen	Total Body
Mn-54	2.0E+06	Teen	Lung
Co-58	1.3E+06	Teen	Lung
Co-60	8.7E+06	Teen	Lung
Ni-63	8.2E+05	Child	Bone
Zn-65	1.2E+06	Teen	Lung
Sr-90	3.8E+07	Child	Bone
Cs-134	1.1E+06	Teen	Liver
Cs-137	9.1E+05	Child	Bone
Ce-144	1.3E+07	Teen	Lung

2.0 **GASEOUS EFFLUENTS** (Continued)

2.7 GASEOUS EFFLUENT DOSE RATE (Continued)

2.7.3 Calculation of P_i

Dose rate factors used for determining compliance with airborne radioactivity dose limits are based on the P_i formula from NUREG-0133 5.2.1.1. This formula is essentially identical to the R_{iaT} factor for inhalation provided in Section 2.8.3.1, with the exception that P_i considers only the critical age and organ for each nuclide. P_i factors are tabulated for the current source term in Table 2-5.

$$P_i = K' * (BR) * DFA_i \tag{2-2}$$

where:

P_i = critical organ dose parameter for the inhalation pathway in mrem/yr per μCi/m^3

K' = a constant of unit conversion, 10^6 pCi/μCi.

BR = the breathing rate of receptor, in m^3/yr, from Table E-5 of RG-1.109.

Age Group	Breathing Rate (m^3/yr)
Adult	8,000
Teen	8,000
Child	3,700
Infant	1,400

DFA_i = maximum organ inhalation dose factor for the [receptor] age group for the ith radionuclide, in mrem/pCi from Tables E-7 through E-10 of RG-1.109, Rev 1 Appendix-E, as amended by NUREG/CR-4653.

NUREG-1301 specifies that P_i is calculated only for the child inhalation pathway and limits child thyroid dose rate to <1500 mrem/year. Consistent with NUREG-1301 bases, P_i includes only the inhalation pathway; however, because radioiodines are no longer a significant consideration for SONGS, all receptors and organs have been considered.

2.0 **GASEOUS EFFLUENTS** (Continued)

2.8 GASEOUS EFFLUENT DOSE CALCULATION

2.8.1 Dose from Noble Gas In Gaseous Effluents – **DELETED**

2.8.2 Dose from Tritium and Radioactive Materials in Particulate Form in Gaseous Effluents

Total doses due to gaseous effluents are calculated for purposes of monthly dose calculation and also for annual dose reporting in the ARERR. Routine dose calculations are performed using Controlling Location Factors (CLFs) based on a composite of critical organs, age groups, locations, and dose pathways. These routine calculations are bounding and demonstrate compliance with dose limitations from Appendix I to 10 CFR 50; however, they do not provide a specific organ or whole body dose for a receptor.

Annual calculations are performed using $R_{iak\tau}$ factors specific to each organ, age group, and pathway with dispersion parameters (W_k) specified for the location of a real receptor. These doses are used to demonstrate compliance with annual dose limits from the ODCM including 10 CFR 50, Appendix I and 40 CFR 190 limits.

The dose to an individual from Tritium and radioactive materials in particulate form in gaseous effluents released to unrestricted areas is calculated using the following expressions:

$$D_{a\tau}(gaseous) = 3.17 \times 10^{-8} \sum_i [Q_i * \sum_k (R_{ika\tau} W_k)] \quad \textbf{(2-3)}$$

where:

$D_{a\tau}$ (gaseous)	=	total dose from gaseous effluents to an individual, mrem
3.17×10^{-8}	=	year/second
Q_i	=	amount of each radionuclide, i, (Tritium, radioactive material in particulate form), released in gaseous effluents, µCi
$\Sigma_k R_{ika\tau} W_k$	=	sum of all pathways, k, for radionuclide, i, of the R_i W product, in mrem/yr per µCi/sec. The $\Sigma_k R_{ik} W_k$ value for each radionuclide, i, is given in Table 2-6 for Units 2/3. The value given is the maximum $\Sigma_k R_{ik} W_k$ for all locations based on the most restrictive age groups and is used to demonstrate compliance in routine release permits. Occupancy and usage factors may be used, as identified in the Land Use Census.
$R_{ika\tau}$	=	dose factor for each identified radionuclide, i, for pathway k, age group, a, and organ τ (for the inhalation pathway in mrem/yr per µCi/m³ and for the food and ground plane pathways in m²-mrem/yr per µCi/sec), at the controlling location. The R_{ik}'s for each age group and organ are given in Appendix A. Data in these tables are derived using the NRC code GASPAR.
W_k	=	annual average dispersion $(\overline{X/Q})$ or deposition $(\overline{D/Q})$ factor for estimating the dose to an individual at the controlling location for pathway k from Appendix A.
	=	$(\overline{X/Q})$ for the inhalation pathway and tritium food pathway sec/m³.
	=	$(\overline{D/Q})$ for the food and ground plane pathways for all particulates in m⁻².

2.0 **GASEOUS EFFLUENTS** (Continued)

2.8 GASEOUS EFFLUENT DOSE CALCULATION (Continued)

2.8.3 Calculation of $R^{k}_{ai\tau}$

The following formulas are based on NUREG-0133 methodology with minor changes based on plant-specific needs. NUREG-0133 specifies R_i to be calculated for only the highest organ for each nuclide to demonstrate compliance with 10 CFR 50, Appendix I; however, demonstration of compliance with 40 CFR 190 requires the ability to calculate doses to each organ and the whole body. Therefore, SONGS uses a combined approach of applying maximum organ doses in calculation of routine doses due to gaseous effluents to demonstrate compliance, but a full set of dose factors for each age, organ, pathway and nuclide have been compiled for use in demonstrating compliance for the whole body and individual organs for annual reporting purposes. Formulas are included for Inhalation, Ground Plane, Vegetable, and Meat pathways (superscript I, G, V, and M, respectively), based results from the Land Use Census. Other pathways may be developed based on RG-1.109 and/or NUREG-0133 methodology if needed in the future.

2.8.3.1 Inhalation Pathway Factor, $R^{I}_{ai\tau}$

$$R^{I}_{ai\tau}\left[\frac{\chi}{Q}\right] = K' * (BR)_a * (DFA_i)_{a\tau} \qquad \textbf{(2-4)}$$

where:

$R^{I}_{ai\tau}\left[\frac{\chi}{Q}\right]$ = inhalation pathway dose factor in mrem/yr per µCi/m^3

K' = a constant of unit conversion, 10^6 pCi/µCi.

$(BR)_a$ = the breathing rate of the receptor of age group (a), in m^3/yr, from Table E-5 of RG-1.109. Previously defined in 2.7.3.

$(DFA_i)_{a\tau}$ = the dose factor for receptor of age group (a), organ (τ), for the ith radionuclide in mrem/pCi from Tables E-7 through E-10 of RG-1.109 as amended by NUREG/CR-4653. The total body is considered an organ in this model.

2.0 **GASEOUS EFFLUENTS** (Continued)

2.8 GASEOUS EFFLUENT DOSE CALCULATION (Continued)

2.8.3 Calculation of $R_{ai\tau}^{k}$ (Continued)

2.8.3.2 Ground Plane Pathway Factor, $R_{i\tau}^{G}\left[\frac{D}{Q}\right]$

$$R_{i\tau}^{G}\left[\frac{D}{Q}\right] = K'K'' * (SF) * (DFG_i)_\tau * \left[\frac{(1-e^{-\lambda_i t})}{\lambda_i}\right] \quad \textbf{(2-5)}$$

where:

$R_{i\tau}^{G}\left[\frac{D}{Q}\right]$	= Ground Plane pathway dose factor in mrem/yr per µCi/sec
K"	= a constant of unit conversion, 8760 hr/yr.
λ_i	= the decay constant for the ith radionuclide (units of sec^{-1}).
t	= period of long-term buildup for activity in soil (4.73×10^8 sec, 15 years, based on RG-1.109 Table E-15).
$DFG_{i\tau}$	= the ground plane dose conversion factor for the ith radionuclide (mrem/hr per pCi/m^2) from Table E-6 of RG-1.109. Ground plane dose factors are provided for total body (which also applies to each other organ) and skin.
SF	= the shielding factor (dimensionless). SF is set to 0.7 based on RG-1.109, Table E-15.

Ground plane dose factors are not provided for tritium, carbon-14, or nuclides that emit only beta radiations.

2.8 GASEOUS EFFLUENT DOSE CALCULATION (Continued)

2.8.3 Calculation of $R^k_{ai\tau}$ (Continued)

2.8.3.3 Vegetation Pathway Factor $R^V_{ia\tau}$

For nuclides other than tritium, $R^V_{ia\tau}$ is formulated using the deposition parameter (D/Q)

$$R^V_{ia\tau}\left[\frac{D}{Q}\right] = K'\left[\frac{r}{Y_V(\lambda_i+\lambda_w)}\right](DFL_i)_{a\tau}\left[U^L_a f_L e^{-\lambda_i t_L} + U^S_a f_g e^{-\lambda_i t_h}\right] \quad \textbf{(2-6)}$$

where:

$R^V_{ia\tau}\left[\frac{D}{Q}\right]$ = vegetation pathway dose factor for all nuclides except tritium in mrem/yr per µCi/sec.

r = the fraction of deposited activity retained on the leaves (dimensionless). Taken to be 0.2 for all particulates (RG-1.109, Table E-15).

Y_v = the agricultural yield for the vegetable. Taken to be 2.0 kg/m^2 for both stored and fresh leafy vegetables (RG-1.109, Table E-15).

λ_w = the weathering decay constant for removal from plant surfaces (5.7E-7 sec^{-1}, based on 14-day weathering half-time shown in Table E-15 of RG-1.109).

$(DFL_i)_{a\tau}$ = dose conversion factor for ingestion pathways, radionuclide (i), age group (a), and organ (τ), in mrem/pCi from Tables E-11 through E-13 of RG-1.109 as updated by NUREG-0172.

U^L_a = the consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr.

Age	U^L_a Value (kg/yr) from RG-1.109, Table E-5
Adult	64
Teen	42
Child	26
Infant	0

U^S_a = the consumption rate of stored vegetation by the receptor in age group (a), in kg/yr.

Age	U^S_a Value (kg/yr) from RG-1.109, Table E-5
Adult	520
Teen	630
Child	520
Infant	0

f_L = the fraction of the annual intake of fresh leafy vegetation grown locally. (Default of 1.0 based on RG-1.109 Table E-15)

f_g = the fraction of the annual intake of stored vegetation grown locally. (Default of 0.76 based on RG-1.109 Table E-15)

t_L = the average time between harvest of leafy vegetation and consumption, in seconds. (8.64E+4 sec, based on RG-1.109 Table E-15)

t_h = the average time between harvest of stored vegetation and consumption, in seconds. (1.21E+6 sec, based on NUREG/CR-4653 Table C.1. entry for PART Line 441)

2.8.3.3 Vegetation Pathway Factor $R^V_{ia\tau}$ (Continued)

The tritium concentration in vegetables is based on the airborne tritium concentration rather than deposition. Therefore, $R^V_{aj\,H-3}$ is based on [χ/Q], rather than [D/Q]:

$$R^V_{a\tau\,H-3}\left[\frac{\chi}{Q}\right] = K'K'''\left[U^L_a f_L + U^S_a f_g\right](DFL_{H-3})_{a\tau}\left[0.75\left(\frac{0.5}{H}\right)\right] \quad \textbf{(2-7)}$$

where:

$R^V_{a\tau\,H-3}\left[\frac{\chi}{Q}\right]$	= vegetation pathway dose factor for tritium in mrem/yr per µCi/m^3
K'''	= a constant of unit conversion, 10^3 gm/kg.
H	= absolute humidity of the atmosphere, in gm/m^3.
	= 10.6 g/m^3 (ORNL-DWG-79-12316R from ORNL/TM-6990, Tritium – An Analysis of Key Environmental and Dosimetric Questions)
0.75	= the fraction of the vegetation that is water.
0.5	= the ratio of the specific activity of the vegetation water to atmospheric water.

2.8.3.4 Vegetation-Animal-Meat Pathway Factor, $R^M_{i\alpha\tau}$

The NUREG-0133 formula for Vegetation-Animal-Meat dose factors has been modified based on the assumption that the wild deer consume only foraged material, no stored feed. Additional discussions in Bases Section 6.3.6.

For nuclides other than tritium, $R^M_{i\alpha\tau}$ formulated using the deposition parameter (D/Q):

$$R^M_{ia\tau}\left[\frac{D}{Q}\right] = K' \frac{Q_F(U_{ap})}{\lambda_i+\lambda_w} F_f(r)(DFL_i)_{a\tau} \frac{e^{-\lambda_i t_f}}{Y_p} \quad \textbf{(2-8)}$$

where:

$R^M_{ia\tau}\left[\frac{D}{Q}\right]$ = Vegetation-Animal-Meat dose factor for all nuclides except tritium in mrem/yr per µCi/sec.

Q_F = the animal's forage consumption rate, in kg/d (wet weight). Taken to be 50 kg/day based on cow feed ingestion from Table E-3 of RG-1.109 and consistent with the use of cow meat transfer factors.

U_{ap} = the receptor's meat consumption rate for age (a), in kg/yr.

Age	U_{ap} Value (kg/yr) from RG-1.109, Table E-5
Adult	110
Teen	65
Child	41
Infant	0

F_f = the stable element transfer coefficient to meat, in days/kg, from NUREG/CR-4653 Table 3.3 (which provides updated values from RG-1.109).

Y_p = the agricultural yield for pasture. Taken to be 0.7 kg/m^2 (RG-1.109, Table E-15).

t_f = time from harvest of animal to consumption of meat, in seconds (1.73×10^6 sec, based on RG-1.109, Table E-15).

The tritium concentration in meat is based on the airborne tritium concentration rather than deposition. Therefore, $R^M_{a\tau\,H-3}$ is based on [χ/Q], rather than [D/Q]:

$$R^M_{a\tau\,H-3}\left[\frac{\chi}{Q}\right] = K'K'''F_f Q_F\left(U_{ap}\right)(DFL_{H-3})_{a\tau}\ \left[0.75\frac{0.5}{H}\right] \quad \textbf{(2-9)}$$

where:

$R^M_{a\tau\,H-3}\left[\frac{\chi}{Q}\right]$ = Vegetation-Animal-Meat pathway dose factor for tritium in mrem/yr per µCi/m^3.

All other terms have been previously defined.

TABLE 2-6

UNITS 2&3 CONTROLLING LOCATION FACTORS[1]

Nuclide	$\Sigma_k R_{ik} W_k$ mrem/yr per µCi/sec	Age	Sector	Location
H-3	1.74E-03	Teen	P	San Onofre Recreational Beach (SORB, R-P3)
Mn-54	1.45E+01	Teen	Q	San Onofre Recreational Beach (SORB, R-Q5)
Co-58	5.50E+00	Teen	Q	San Onofre Recreational Beach (SORB, R-Q5)
Co-60	1.84E+02	Teen	Q	San Onofre Recreational Beach (SORB, R-Q5)
Ni-63	1.63E+01	Child	P	Cotton Point Gardens (G-P1)
Zn-65	8.16E+00	Teen	Q	San Onofre Recreational Beach (SORB, R-Q5)
Sr-90	7.76E+02	Child	P	Cotton Point Gardens (G-P1)
Cs-134	5.53E+01	Teen	Q	San Onofre Recreational Beach (SORB, R-Q5)
Cs-137	8.21E+01	Child	Q	San Onofre Recreational Beach (SORB, R-Q5)
Ce-144	3.23E+01	Teen	P	San Onofre Recreational Beach (SORB, R-P3)

These values to be used in manual calculations are the maximum $\Sigma_k R_{ik} W_k$ for all locations based on the most restrictive age group.

3.0 **PROJECTED DOSES**

3.1 LIQUID DOSE PROJECTION

The methodology used for projecting a liquid dose over 31 days for Specification 1.3.1 is as follows:

3.1.1 Determine the monthly total body and organ doses resulting from releases during the previous 12 months.

3.1.2 Projected dose = Previous 12 months' dose divided by 12 for the total body and each organ.

3.2 GASEOUS DOSE PROJECTION

The methodology used for projecting a gaseous dose over 31 days for Specification 2.3.1 is as follows:

3.2.1 Determine the monthly organ dose resulting from releases during the previous 12 months.

3.2.2 Projected dose = Previous 12 months' dose divided by 12 for the organ dose.

3.0 **<u>PROJECTED DOSES</u>** (Continued)

3.3 TOTAL DOSE

SPECIFICATION

3.3.1 The dose or dose commitment to any member of the public, due to releases of radioactivity and radiation, from Uranium fuel cycle sources shall be limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which shall be limited to less than or equal to 75 mrem) over any calendar year.

APPLICABILITY: At all times

ACTION:

a. With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Specifications 1.2.1a, 1.2.1b, 2.1.1a, 2.1.1b, 2.3.1a, or 2.3.1b, prepare and submit a Special Report to the Nuclear Regulatory Commission, within 30 days, which defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding the limits of Specification 3.3.1. This Special Report shall include an analysis which estimates the radiation exposure (dose) to a member of the public from Uranium fuel cycle sources (including all effluent pathways and direct radiation) for a 12 consecutive month period that includes the release(s) covered by this report. If the estimated dose(s) exceeds the limits of Specification 3.3.1, and if the release condition resulting in violation of 40 CFR 190 has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR 190 and including the specified information of paragraph 190.11(b). Submittal of the report is considered a timely request, and a variance is granted until staff action on the request is complete. The variance only relates to the limits of 40 CFR 190 and does not apply in any way to the requirements for dose limitation of 10 CFR Part 20, as addressed elsewhere in this ODCM.

SURVEILLANCE REQUIREMENT

SR 3.3.1.1 Dose Calculations Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Surveillances SR 1.2.1.1 and SR 2.3.1.1.

3.0 **PROJECTED DOSES** (Continued)

3.4 TOTAL DOSE CALCULATIONS

3.4.1 Total Dose to the Likely Most-Exposed Member of the Public

The total annual dose or total dose commitment to any member of the public, due to releases of radioactivity and to radiation, from Uranium fuel cycle sources within 5 miles of the Site is calculated using the following expressions. This methodology is used to meet the annual dose limitations of 40 CFR 190. The transportation of radioactive material is excluded from the dose calculations.

The Annual Total Dose is determined for maximum organ, whole body, and thyroid to verify the Site total is less than or equal to 25 mrem, 25 mrem, and 75 mrem respectively. Total doses include those due to gaseous and liquid effluent releases, and due to direct radiation dose detected using REMP TLDs.

3.4.1.1 Annual Total Organ Dose

$$D_{tot,a,\tau}(Organ) = D_{a\tau}(Liquid) + D_{a\tau}(Gaseous) + D(Direct) \qquad \textbf{(3-1)}$$

where:

$D_{a\tau}(Liquid)$ = Annual Organ Dose for all radioactive liquid releases during the year using Equation (1-7) for age group, a, and organ, τ.

$D_{a\tau}(Gaseous)$ = Annual Organ Dose for all radioactive gaseous releases during the year using Equation (2-3) for age group, a, and organ, τ.

D(Direct) = Annual Direct Radiation Dose to a Member of the Public. Determined using methodology described in ANSI/HPS N13.37-2014 and as reported in the AREOR. Occupancy adjusted, as appropriate. See Section 3.4.1.3, below.

3.4.1.2 Annual Total Whole Body Dose

$$D_{tot,a}(WB) = D_{a,WB}(Liquid) + D_{a,WB}(Gaseous) + D(U1) + D(Direct) \qquad \textbf{(3-2)}$$

where:

$D_{a,WB}(Liquid)$ = Annual Whole Body Dose for all radioactive liquid releases during the year using Equation (1-7) for age group, a.

$D_{a,WB}(Gaseous)$ = Annual Whole Body Dose for all radioactive gaseous releases during the year using Equation (2-3) for age group, a.

D(U1) = 7.96E-2 mrem/yr, Total Effective Dose Equivalent from the offshore portion of the Unit 1 Circulating Water System.

Reference: Safety Evaluation related to Amendment No. 165 to Facility Operating License No. DPR-13, SCE, SONGS Unit 1

Effluent/ODCM Evaluation SDS-CH2-EVA-0008, Removal of Dose Related to Recreational Diver in the Unit 1 Circulating Water System

3.4.1.3 Annual Direct Radiation Dose

Dose due to direct radiation is determined using the methodology specified in ANSI/HPS N13.37-2014.

TLD results are received from the vendor normalized to 91-day exposure period and accounting for transit dose. Quarterly and Annual Baseline Background Doses (B_Q and B_A) have been determined for each station (except that assumed baseline background doses were used for those stations within the site boundary where plant influence did not allow determination of an accurate background). Minimum Differential Doses (MDD_Q and MDD_A) were determined based on variation of the overall system.

Facility-Related Dose may be detected on either a Quarterly or Annual basis:

$$\begin{cases} If\ M_Q > (B_Q + MDD_Q)\ then\ F_Q = M_Q - B_Q \\ If\ M_Q \leq (B_Q + MDD_Q)\ then\ F_Q = not\ detected \end{cases} \quad \textbf{(3-3)}$$

$$\begin{cases} If\ M_A > (B_A + MDD_A)\ then\ F_A = M_A - B_A \\ If\ M_A \leq (B_A + MDD_A)\ then\ F_A = not\ detected \end{cases} \quad \textbf{(3-4)}$$

where:

M_Q = Quarterly field measurement result normalized to 91 days

B_Q = Quarterly Baseline Background Dose associated with the location

MDD_Q = Quarterly Minimum Differential Dose for the dosimetry system

F_Q = Quarterly Facility-Related Dose

M_A = Annual field measurement result (i.e. sum of four normalized quarters)

B_A = Annual Baseline Background Dose associated with the location

MDD_A = Annual Minimum Differential Dose for the dosimetry system

F_A = Annual Facility-Related Dose

3.0 **PROJECTED DOSES** (Continued)

3.4 TOTAL DOSE CALCULATIONS (Continued)

3.4.1 Total Dose to the Likely Most-Exposed Member of the Public (Continued)

3.4.1.3 Annual Direct Radiation Dose (Continued)

A quality check is performed before assigning facility-related dose at that location. Dose to a Member of the Public is determined from Facility-Related Dose by applying occupancy factor corrections; doses may also be extrapolated to more distant locations using the inverse square law, if appropriate. If the adjusted dose is less than 1 mrem, then D(Direct) is reported as Not Detected (ND).

$$\begin{cases} If\ F_Q > 0\ then\ \ D(Direct) = F_Q * Occupancy\ Factor \\ If\ F_A > 0\ then\ \ D(Direct) = F_A * Occupancy\ Factor \\ If\ D(Direct) < 1.0\ mrem, then\ report\ as\ D(Direct) = Not\ Detected \end{cases} \qquad \textbf{(3-5)}$$

Occupancy Factors are provided in E.M. Goldin Memorandum for File, "Occupancy Factors at San Onofre Owner Controlled Area Boundaries," dated October 1, 1991. Example occupancy times are:

Location	Occupancy (hrs./yr.)	Occupancy Factor (unitless, =Occupancy/8760 hrs./yr.)
Beach (West Boundary, seawall)	300	0.0342
East and North Boundaries	20	0.00228
South Boundary and West fence (top of bluff)	8	0.00091

4.0 EQUIPMENT

4.1 RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

SPECIFICATION

4.1.1 The radioactive liquid effluent monitoring instrumentation channels shown in Table 4-1 shall be FUNCTIONAL with their alarm/trip setpoints set to ensure the limits of Specification 1.1.1 are not exceeded. The alarm/trip setpoints of these channels shall be determined in accordance with Section 1.4.

APPLICABILITY: At all times

ACTION:

a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than required by the above specification, immediately suspend the release of radioactive liquid effluents monitored by the affected channel or declare the channel non-FUNCTIONAL.

b. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels FUNCTIONAL, take the ACTION shown in Table 4-1. Exert best efforts to return the instrument to FUNCTIONAL status within 30 days and, additionally, if the non-FUNCTIONAL instrument(s) remain non-FUNCTIONAL for greater than 30 days, explain in the next Annual Radioactive Effluent Release Report why the non-FUNCTIONALITY was not corrected in a timely manner.

c. With less than the minimum number of radioactive liquid effluent monitoring instrumentation channels FUNCTIONAL and either the appropriate ACTION items in Table 4-1 not taken or the necessary surveillances not performed at the specified frequency prescribed in Table 4-2, perform an evaluation based on the significance of the event in accordance with the site Corrective Action Program.

SURVEILLANCE REQUIREMENTS

SR 4.1.1.1 Each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4-2.

SR 4.1.1.2 At least once per 12 hours and within 1 hour after a change in pump operation that affects dilution flow has been completed, all pumps required to be providing dilution to meet the site radioactive effluent concentration limits of Specification 1.1.1 shall be determined to be operating and providing dilution to the discharge structure.

TABLE 4-1

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT*	MINIMUM CHANNELS FUNCTIONAL	ACTION
1. GROSS RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE		
a. Liquid Radwaste Effluent Line - 2/3RT-7813*	1	28
b. NIA Yard Drain Sump - 2/3RT-2101*	1	44
2. PROCESS FLOW RATE MEASUREMENT DEVICES		
a. Liquid Radwaste Effluent Line – FE7643	1	31
b. Minor Liquid Pathway Effluent Line	1	31
c. NIA Yard Drain Sump Effluent Line – 2/3FQI-6095	1	31
3. ISFSI COMMAND DATA ACQUISITION SYSTEM (CDAS) (RE-2101 EFFLUENT MONITOR ALARMS)	1	32

TABLE 4-1 (Continued)

TABLE NOTATION

* Monitor Recorders are not required for the FUNCTIONALITY of the monitor, providing the non-FUNCTIONAL recorder does not cause the monitor to become non-FUNCTIONAL (i.e., feedback signal). As long as the monitor has indication, alarm capability (if applicable), proper response (based on surveillance requirements) and isolation function (if applicable), the loss of the recorder does not render the monitor non-FUNCTIONAL.

ACTION 28 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirements, effluent releases may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Specification 1.1.1 and

b. At least two technically qualified members of the Facility Staff independently verify the release rate calculation and discharge line valving;

Otherwise, suspend release of radioactive effluents via this pathway.

If the remote alarm monitoring function is not available for 2/3RT-7813 but the monitor is FUNCTIONAL, effluent releases via this pathway may continue provided the monitor is verified FUNCTIONAL by performing a Channel Check once per 4 hours during actual releases.

ACTION 31 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided the process flow rate is estimated at least once per 12 hours during actual releases. In addition, a new flow estimate shall be made within 1 hour after a change that affects process flow has been completed. Pump curves may be used to estimate process flow.

Loss of process flow instrument(s) results in the associated gross activity monitor becoming non-FUNCTIONAL. Perform the compensatory action for the non-FUNCTIONAL gross activity monitor in addition to this compensatory action. [2/3RT-7813]

ACTION 32 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided the monitor is verified FUNCTIONAL by performing a channel check at least once per 4 hours during actual releases.

ACTION 44 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided that, at least once per 24 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) at a lower limit of detection of no more than 10^{-7} microcurie/ml.

TABLE 4-2

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

NOTE: Frequency notations are found in Table 6-2, Frequency Notation.

	INSTRUMENT**	CHANNEL CHECK	SOURCE CHECK	CHANNEL CALIBRATION	CHANNEL FUNCTIONAL TEST
1.	GROSS BETA OR GAMMA RADIOACTIVITY MONITORS PROVIDING ALARM AND AUTOMATIC TERMINATION OF RELEASE				
a.	Liquid Radwaste Effluents Line - 2/3RT-7813	D	P(6)	R(2)	Q(1)
b.	NIA Yard Drain Sump Effluent Line - 2/3RT-2101	D	M(6)	R(2)	Q(1)
2.	PROCESS FLOW RATE MEASUREMENT DEVICES				
a.	Liquid Radwaste Effluent Line – FE7643	D(3)	N/A	R	Q
b.	Minor Liquid Pathway Effluent Line	D(3)	N/A	A	N/A
c.	NIA Yard Drain Sump Effluent Line – 2/3FQI-6095	D(3)	N/A	R	Q
3.	ISFSI CDAS (RE-2101 EFFLUENT MONITOR ALARMS)	D	N/A	N/A(4)	Q

TABLE 4-2 (Continued)

TABLE NOTATION

** Monitor Recorders are not required for the FUNCTIONALITY of the monitor, providing the non-FUNCTIONAL recorder does not cause the monitor to become non-FUNCTIONAL (i.e., feedback signal). As long as the monitor has indication, alarm capability (if applicable), proper response (based on surveillance requirements) and isolation function (if applicable), the loss of the recorder does not render the monitor non-FUNCTIONAL.

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate verification of effluent path isolation actuation signal, automatic pathway isolation, and alarm annunciation (including local and remote alarm functions, as applicable) if any of the following conditions exist:

 1. Instrument indicates measured levels above the alarm/trip setpoint.
 2. Circuit failure.

 Down scale failure testing is bounded by administrative limitation on monitor setpoint which ensure monitor alarm and release termination occur prior to reaching the level of monitor saturation.

 If the instrument controls are not in the operate mode, procedures shall require that the channel be declared non-FUNCTIONAL.

(2) The initial CHANNEL CALIBRATION shall be performed using one or more of the reference standards certified by the National Institute of Standards and Technology or using standards that have been obtained from suppliers that participate in measurement assurance activities with NIST. These standards shall permit calibrating the system over its intended range of energy and measurement range. For subsequent CHANNEL CALIBRATIONs, sources that have been related to the initial calibration shall be used.

(3) CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days on which continuous, periodic, or batch releases are made.

(4) The ISFSI Command Data Acquisition System (CDAS) software and hardware do not require CHANNEL CALIBRATION. The ISFSI CDAS software is quality affecting and controlled by the site Software Modification Request process under procedures ENG-10, Software Development and Maintenance. The ISFSI CDAS hardware that is not associated with spent fuel temperature monitoring is installed plant equipment and controlled by the site design change process using procedure SDS-EN1-PCD-0001.

(5) DELETED

(6) MGPI monitors have automatic and continuous source check to meet this requirement.

4.0 **EQUIPMENT** (Continued)

4.2 RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

SPECIFICATION

4.2.1 The radioactive gaseous effluent sampling instrumentation channels shown in Table 4-3 shall be FUNCTIONAL with their alarm function to ensure isokinetic sample flow is continuously monitored.

APPLICABILITY: At all times

ACTION:

a. **DELETED**

b. With less than the minimum number of radioactive gaseous effluent sampling instrumentation channels FUNCTIONAL, take the ACTION shown in Table 4-3. Exert best efforts to return the instrument to FUNCTIONAL status within 30 days and, additionally, if the non-FUNCTIONAL instrument(s) remain non-FUNCTIONAL for greater than 30 days, explain in the next Annual Radioactive Effluent Release Report why the non-FUNCTIONALITY was not corrected in a timely manner.

c. With less than the minimum number of radioactive gaseous effluent sampling instrumentation channels FUNCTIONAL and either the appropriate ACTION items in Table 4-3 not taken or the necessary surveillances not performed at the specified frequency prescribed in Table 4-4, perform an evaluation based on the significance of the event in accordance with the site Corrective Action Program.

SURVEILLANCE REQUIREMENT

SR 4.2.1.1 Each radioactive gaseous effluent sampling instrumentation channel shall be demonstrated FUNCTIONAL by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL CALIBRATION and CHANNEL FUNCTIONAL TEST operations at the frequencies shown in Table 4-4.

TABLE 4-3
RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

INSTRUMENT	MINIMUM CHANNELS FUNCTIONAL	APPLICABILITY	ACTION
1. CONTAINMENT VENTILATION			
a. Particulate Sampler	1	*	40
b. Associated Sample Flow Measuring Device	1	*	36b
c. Process Flow Rate Monitoring Device (1)	1	*	36a
2. TENT VENTILATION SYSTEMS			
a. Particulate Sampler	1	**	40
b. Associated Sample Flow Measuring Device	1	**	36b
c. Process Flow Rate Monitoring Device (1)	1	**	36a
3. OPEN AIR DEMOLITION (OAD) SAMPLERS			
a. Particulate Sampler	4	***	41
b. Associated Sample Flow Measuring Device	4	***	42

TABLE 4-3 (Continued)

TABLE NOTATION

* At all times.

** Tent ventilation system requirements apply when there is a credible mechanism for release of airborne radioactivity (e.g. when work with radioactive material is being performed within the tent). When the tents are not actively used and do not include detectable loose contamination, then ventilation is not required.

*** Open Air Demolition samplers are required to be in operation during active Open Air Demolition work with a potential to generate airborne activity. Sampler locations should be established in opposing directions from the work being covered and prevailing wind directions.

(1) Functionality of process and sample flow monitoring for the CDV and Tent Ventilation systems means that the remote alarm functions are working to monitor out-of-spec conditions.

ACTION 36 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via this pathway may continue provided:

a. The process flow rate is estimated at least once per 12 hours during actual releases. In addition, a new flow estimate shall be made within 1 hour after a change that affects process flow has been completed. System design characteristics may be used to estimate process flow.

b. The particulate sample flow rate is estimated or verified at least once per 12 hours during actual releases.

ACTION 40 - With the number of channels FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, effluent releases via the effected pathway may continue provided samples are continuously collected with auxiliary sampling equipment as required in Table 2-1.

ACTION 41 - With the number of OAD samplers FUNCTIONAL less than required by the Minimum Channels FUNCTIONAL requirement, OAD activities may continue if alternate air particulate sampling is established to maintain sampling in the required directions.

ACTION 42 - If an OAD sample flow meter is unavailable, OAD activities may continue if sample flow rate is measured at the start and end of the sample period using a calibrated sample flow meter.

TABLE 4-4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

NOTE: Frequency notations are found in Table 6-2, Frequency Notation.

INSTRUMENT	CHANNEL CHECK	SOURCE CHECK	CHANNELS CALIBRATION	CHANNEL FUNCTIONAL TEST	APPLICABILITY
1. CONTAINMENT VENTILATION					
a. Particulate Sampler	W	NA	NA	NA	*
b. Associated Sample Flow Measuring Device	D	NA	A	Q(2)	*
c. Process Flow Rate Monitoring Device(1)	D	NA	R	Q	*
2. TENT VENTILATION SYSTEMS (MHF and DIE Tents)					
a. Particulate Sampler	W	NA	NA	NA	**
b. Associated Sample Flow Measuring Device	D	NA	A	Q(2)	**
c. Process Flow Rate Monitoring Device(1)	D	NA	R	Q	**
3. OPEN AIR DEMOLITION (OAD) SAMPLERS					
a. Particulate Sampler	W	NA	NA	NA	***
b. Associated Sample Flow Measuring Device	W	NA	A	NA	***

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TABLE 4-4 (Continued)

TABLE NOTATION

* At all times.

** Tent Ventilation System requirements apply when there is a credible mechanism for release of airborne radioactivity (e.g. when work with radioactive material is being performed within the tent). When the tents are not actively used and do not include detectable loose contamination, then ventilation system functionality and monitoring is not required.

*** Open Air Demolition sampler surveillance requirements apply at all times during active Open Air Demolition work with a potential to generate airborne activity.

(1) Process flow rate monitoring for CDV and Tent Ventilation systems uses pressures transmitters to verify that the process flow rate remains within a range specified in the system design. Process flow rate measurement is not required for these systems because they use bounding system flow rate for estimating releases. Calibrations and functional testing of the process flow rate monitoring system will include calibrating the pressure transmitters and verifying associated alarm functions.

(2) CDV and Tent Ventilation samplers include a non-transmitting sample flow meter and a remote alarm function based on loss of vacuum. Functional testing in this context is to verify that the alarm is received when sample flow is stopped due to loss of power to the pump.

4.0 **EQUIPMENT** (Continued)

4.3 FUNCTIONALITY OF RADIOACTIVE WASTE EQUIPMENT

The flow diagrams defining the treatment paths and the components of the radioactive liquid, gaseous, and solid waste management systems are shown in Figures 4-5 thru 4-7.

SONGS RADIOACTIVE LIQUID WASTE EFFLUENT SYSTEMS
Figure 4-5

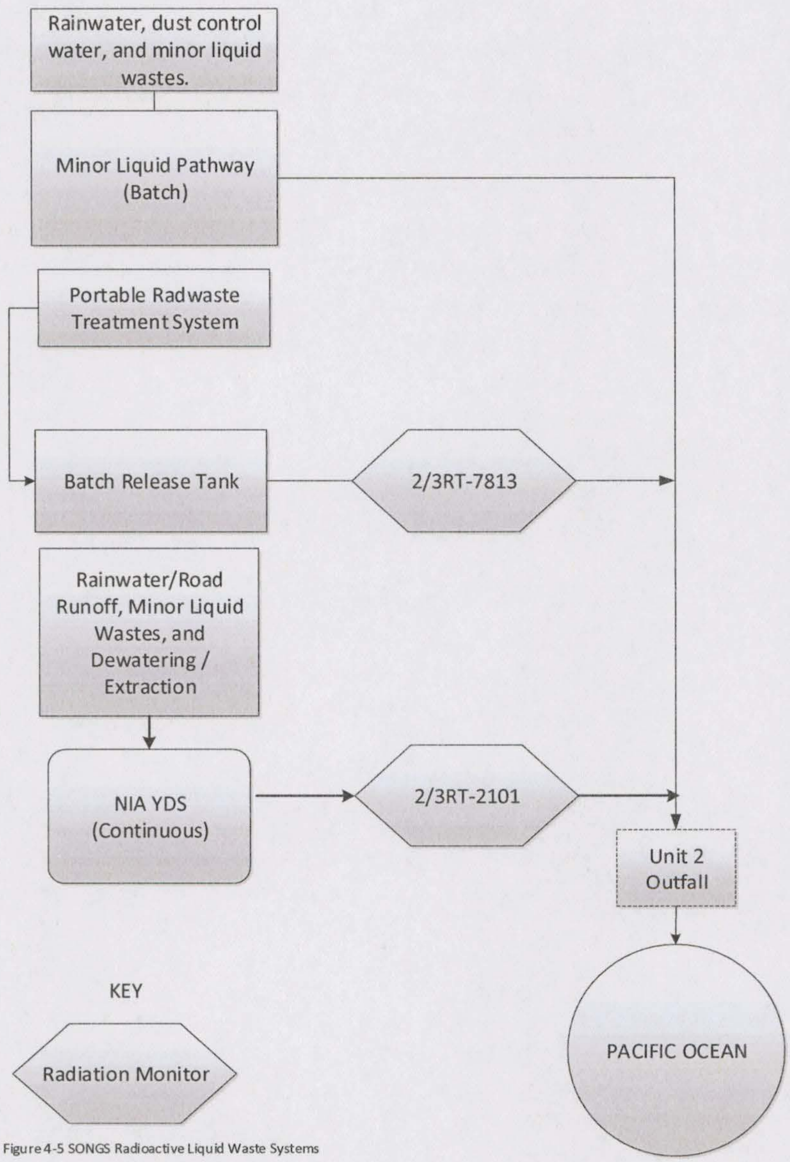


Figure 4-5 SONGS Radioactive Liquid Waste Systems

SONGS RADIOACTIVE GASEOUS WASTE EFFLUENT SYSTEMS

Figure 4-6

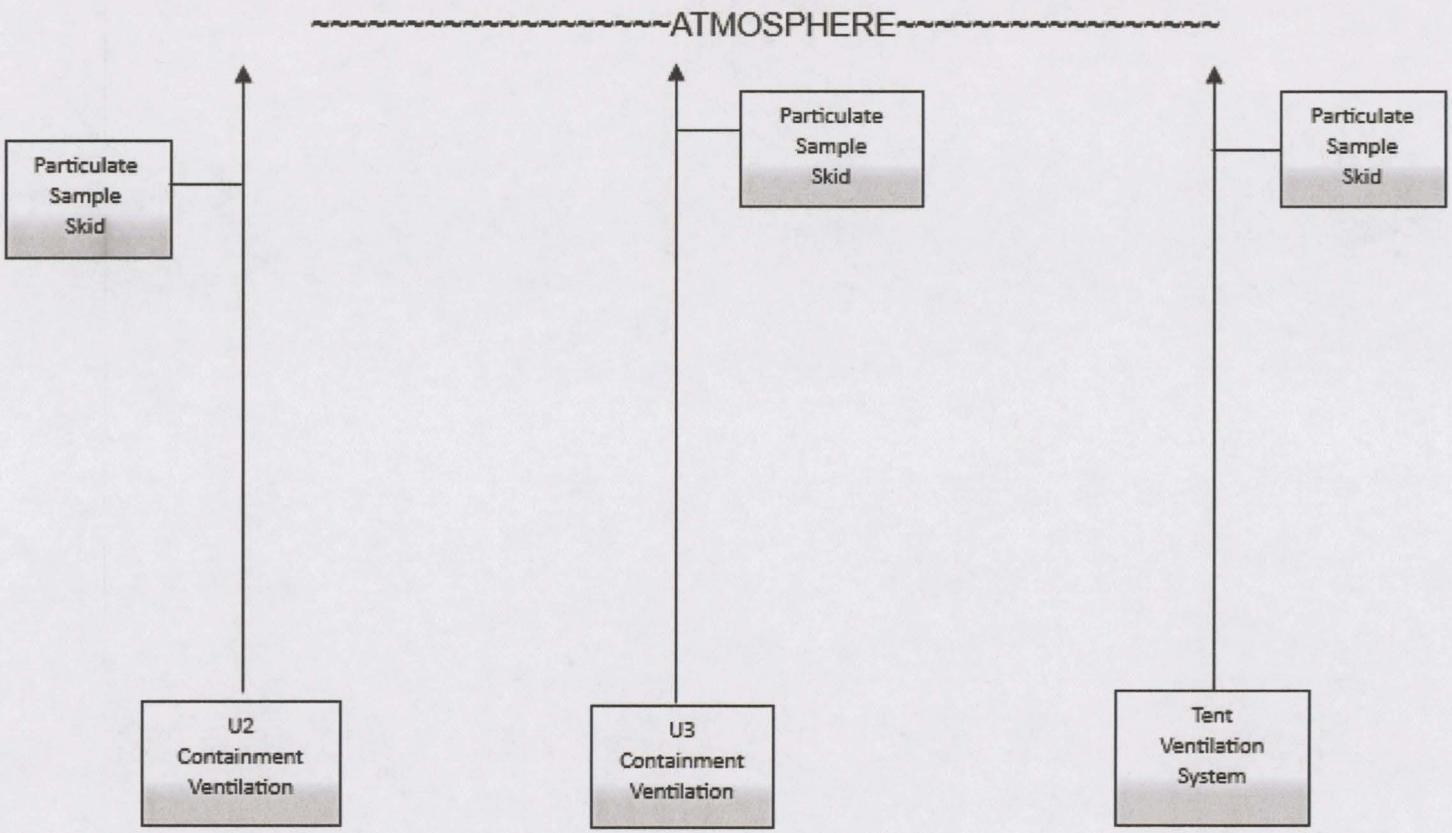
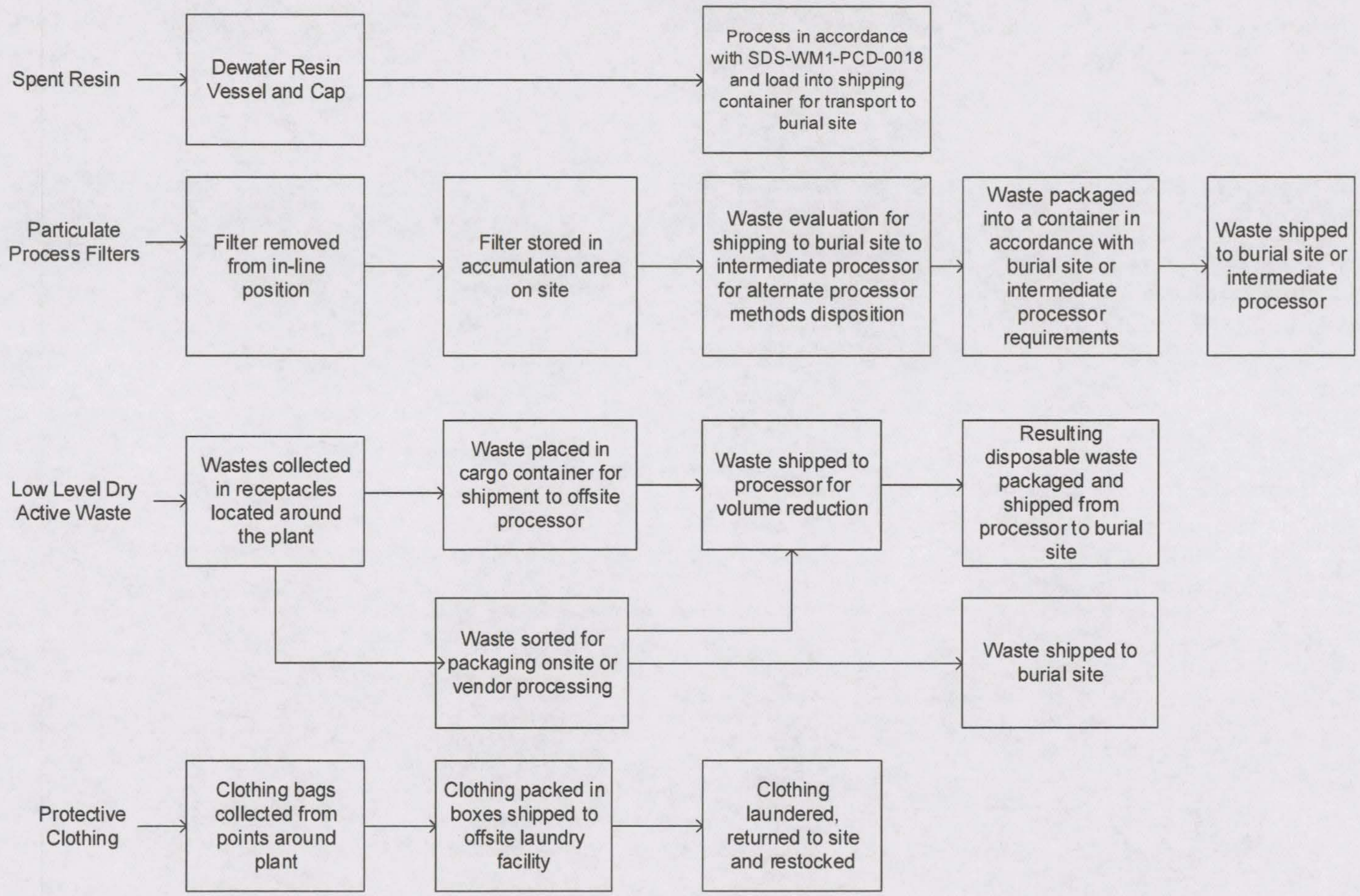


Figure 4-6 SONGS Radioactive Gaseous Waste Treatment Systems

SOLID WASTE HANDLING
Figure 4-7



5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING

5.1 MONITORING PROGRAM

SPECIFICATION

5.1.1 The radiological environmental monitoring program shall be conducted as specified in Table 5-1.

APPLICABILITY: At all times

ACTION:

a. Should the radiological environmental monitoring program not be conducted as specified in Table 5-1, prepare and submit to the Commission, in the Annual Radiological Environmental Operating Report (see Section 5.4), a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. Should the level of radioactivity in an environmental sampling medium exceed the reporting levels of Table 5-2 when averaged over any calendar quarter, prepare and submit to the Commission, within 30 days from the end of the affected calendar quarter a Report pursuant to 10 CFR 50.73. When more than one of the radionuclides in Table 5-2 are detected in the sampling medium, this report shall be submitted if:

$$\frac{\text{concentration (1)}}{\text{limit level (1)}} + \frac{\text{concentration (2)}}{\text{limit level (2)}} + \ldots \geq 1.0$$

c. When radionuclides other than those in Table 5-2 are detected and are the result of plant effluents, this report shall be submitted if the potential annual dose to an individual is equal to or greater than the calendar year limits of Specification(s) 1.2.1 or 2.3.1, as appropriate. This report is not required if the measured level of radioactivity was not the result of plant effluents; however, in such an event, the condition shall be reported and described in the Annual Radiological Environmental Operating Report (see Section 5.4).

5.0 **RADIOLOGICAL ENVIRONMENTAL MONITORING** (Continued)

5.1 MONITORING PROGRAM (Continued)

ACTION: (Continued)

d. With fresh leafy vegetable samples or fleshy vegetable samples unavailable from one or more of the sample locations required by Table 5-1, identify specific locations for obtaining replacement samples and add them within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The specific locations from which samples were unavailable may then be deleted from the monitoring program. Pursuant to Licensee Controlled Specifications 5.7.1, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table for the ODCM reflecting the new location(s) with supporting information identifying the cause of the unavailability of samples and justifying the selection of the new location(s) for obtaining samples.

SURVEILLANCE REQUIREMENT

SR 5.1.1.1 The radiological environmental monitoring samples shall be collected pursuant to Table 5-1 from the locations given in Table 5-4 and Figures 5-1 through 5-5 and shall be analyzed pursuant to the requirements of Tables 5-1 and 5-3.

TABLE 5-1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[a]	Type and Frequency of Analyses
1. AIRBORNE Particulates	Samples from at least 5 locations: 3 samples from close to the three site boundary locations (in different sectors) of the highest calculated annual average ground level D/Q. 1 sample from the vicinity of a community having the highest calculated annual average ground-level D/Q. 1 sample from a control location 15-30 km (10-20 miles) distant and in the least prevalent wind direction[c].	Continuous operation of sampler with sample collection as required by dust loading, but at least once per 7 days.	Particulate sampler. Analyze for gross beta radioactivity > 24 hours following filter change. Perform gamma isotopic[b] analysis on each sample when gross beta activity is > 10 times the yearly mean of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 92 days.
2. DIRECT RADIATION[e]	At least 30 locations including an inner ring of stations in the general area of the site boundary and an outer ring approximately in the 4 to 5 mile range from the site with a station in each landward sector of each ring. The balance of the stations is in special interest areas such as population centers, nearby residences, schools, and along the State Beach walking path.	At least once per 92 days.	Gamma dose. At least once per 92 days.

TABLE 5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[a]	Type and Frequency of Analyses
3. WATERBORNE			
a. Ocean	4 locations	At least once per month.	Gamma isotopic[b] and tritium analysis of each monthly sample.
b. Sediment	4 locations from Shoreline	At least once per 184 days.	Gamma isotopic[b] analysis of each sample.
c. Ocean	5 locations Bottom Sediments	At least once per 184 days.	Gamma isotopic[b] analysis of each sample.

TABLE 5-1 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Sample Locations[a]	Sampling and Collection Frequency[a]	Type and Frequency of Analyses
4. INGESTION			
a. Animals Nonmigratory Marine	3 locations	One sample in season, or at least once per 184 days if not seasonal. One sample of each of the following species: 1. Fish-2 adult species such as perch or sheephead. 2. Crustaceae-such as crab or lobster. 3. Mollusks-such as limpets, seahares or clams.	Gamma isotopic[b] analysis on edible portions.
b. Local Crops	2 locations	Representative vegetables, normally 1 leafy and 1 fleshy collected at harvest time. At least 2 vegetables collected semiannually from each location.	Gamma isotopic[b] analysis on edible portions semiannually.

TABLE 5-1 (Continued)

TABLE NOTATION

a. Sample locations are indicated on Figures 5-1 through 5-5. Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability, and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report.

b. Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

c. The purpose of this sample is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites which provide valid background data may be substituted.

e. One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermoluminescent dosimeter may be considered to be one phosphor and two or more phosphors in a packet may be considered as two or more dosimeters. Film badges should not be used for measuring direct radiation.

TABLE 5-2

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Reporting Levels

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Marine Animals (pCi/kg, wet)	Local Crops (pCi/kg, wet)
H-3*	3×10^4			
Mn-54	1×10^3		3×10^4	
Co-58	1×10^3		3×10^4	
Co-60	3×10^2		1×10^4	
Zn-65	3×10^2		2×10^4	
Cs-134	30	10	1×10^3	1×10^3
Cs-137	50	20	2×10^3	2×10^3

*Reporting Level value of 30,000 pCi/l selected for H-3 based on NUREG-1301 guidance for plants where no drinking water pathway exists.

TABLE 5-3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS[c]

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	Water (pCi/l)	Airborne Particulate or Gases (pCi/m^3)	Marine Animals (pCi/kg, wet)	Local Crops (pCi/kg, wet)	Sediment (pCi/kg, dry)
gross beta		1×10^{-2}			
H-3*	3000				
Mn-54	15		130		
Co-58, 60	15		130		
Zn-65	30		260		
Cs-134	15	5×10^{-2}	130	60	150
Cs-137	18	6×10^{-2}	150	80	180

*Maximum LLD value of 3000 pCi/l selected for H-3 based on NUREG-1301 guidance for plants where no drinking water pathway exists.

TABLE 5-3 (Continued)

TABLE NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66S_b}{E * V * 2.22 * Y * e^{-\lambda \Delta t}}$$

where:

LLD = "a priori" lower limit of detection as defined above (as microcurie per unit mass or volume)

S_b = standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

E = counting efficiency (as counts per transformation)

V = sample size (in units of mass or volume)

2.22 = number of transformations per minute per picoCurie

Y = fractional radiochemical yield (when applicable)

λ = radioactive decay constant for the particular radionuclide

Δt = elapsed time between sample collection or end of the collection period and time of counting (for environmental samples, not plant effluents)

The value of S_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples (e.g., Potassium-40 in milk samples). Typical values of E, V, Y and Δt shall be used in the calculations.

It should be recognized that the LLD is defined as an <u>a priori</u> (before the fact) limit representing the capability of the measurement system and not as <u>a posteriori</u> (after the fact) limit for a particular measurement.*

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* For a more complete discussion of the LLD, and other detection limits, see the following:

(1) HASL Procedures Manual, <u>HASL-300</u> (revised annually).

(2) Currie, L. A., "Limits for Qualitative Detection and Quantitative Determination - Application to Radiochemistry" <u>Anal. Chem. 40</u>, 586-93 (1968).

TABLE 5-3 (Continued)

TABLE NOTATION (Continued)

c. Other peaks which are measurable and identifiable, together with the radionuclides in Table 5-3, shall be identified and reported.

5.2 LAND USE CENSUS

SPECIFICATION

5.2.1 A Land Use Census shall be conducted and shall identify the location of the nearest milk animal, the nearest residence and the nearest garden* of greater than 500 square feet producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of five miles.

APPLICABILITY: At all times

ACTION:

a. With the Land Use Census identifying a location(s) that yields a calculated dose or dose commitment greater than the values currently being calculated in Specification 2.3.1, pursuant to Licensee Controlled Specifications Section 5.7.1, identify the new locations in the next Annual Radioactive Effluent Release Report.

b. With the Land Use Census identifying a location(s) that yields a calculated dose or dose commitment (via the same exposure pathway) 20 percent greater than at a location from which samples are currently being obtained in accordance with Specification 5.1.1, add the new location within 30 days to the Radiological Environmental Monitoring Program given in the ODCM. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment(s) via the same exposure pathway, may be deleted from this monitoring program after October 31, of the year in which this Land Use Census was conducted. Pursuant to Licensee Controlled Specifications Section 5.7.1, submit in the next Annual Radioactive Effluent Release Report documentation for a change in the ODCM including a revised figure(s) and table(s) for the ODCM reflecting the new location(s) with information supporting the change in sampling locations.

SURVEILLANCE REQUIREMENT

SR 5.2.1.1 The Land Use Census shall be conducted at least once per 12 months between the dates of June 1 and October 1 using that information which will provide the best results, such as by a door-to-door survey, aerial survey, or by consulting local agriculture authorities. The results of the Land Use Census shall be included in the Annual Radiological Environmental Operating Report pursuant to Specification 5.4.1.

*Broad leaf vegetation sampling may be performed at the site boundary in the direction sector with the highest D/Q in lieu of the garden census.

5.3 INTERLABORATORY COMPARISON PROGRAM

SPECIFICATION

5.3.1 Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program that complies with RG-4.15.

APPLICABILITY: At all times

ACTION:

a. With analyses not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report.

SURVEILLANCE REQUIREMENT

SR 5.3.1.1 A summary of the results obtained as part of the above required Interlaboratory Comparison Program and in accordance with Section 5.4.1 of this document shall be included in the Annual Radiological Environmental Operating Report (see Section 5.4).

5.4 ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT*

5.4.1 Per LCS 5.7.1.2: "The Annual Radiological Environmental Operating Report covering the operation of the unit during the previous calendar year shall be submitted by May 15 of each year. The report shall include summaries, interpretations, and analyses of trends of the results of the Radiological Environmental Monitoring Program for the reporting period. The material provided shall be consistent with the objectives outlined in the Offsite Dose Calculation Manual (ODCM), and in 10 CFR 50, Appendix I, Sections IV.B.2, IV.B.3, and IV.C.

The Annual Radiological Environmental Operating Report shall include the results of analyses of all radiological environmental samples and of all environmental radiation measurements taken during the period pursuant to the locations specified in the table and figures in the ODCM, as well as summarized and tabulated results of these analyses and measurements in the format of the table in the Radiological Assessment Branch Technical Position, Revision 1, November 1979. The report shall identify the thermoluminescent dosimeter (TLD) results that represent collocated dosimeters in relation to the NRC TLD program and the exposure period associated with each result. In the event that some individual results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted in a supplementary report as soon as possible."

* A single submittal may be made for a multiple unit station.

5.0 **RADIOLOGICAL ENVIRONMENTAL MONITORING** (Continued)

5.5 SAMPLE LOCATIONS

The Radiological Environmental Monitoring Sample Locations are identified in Figures 5-1 through 5-6. These sample locations are described in Table 5-4 and indicate the distance in miles and the direction, determined from degrees true north, from the center of the Units 2 and 3 building complex. Table 5-6 gives the sector and direction designation for the Radiological Environmental Monitoring Sample Location on Map, Figures 5-1 through 5-6.

TABLE 5-4

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

TYPE OF SAMPLE AND SAMPLING LOCATION		DISTANCE* (miles)	DIRECTION*	TLD Designation[b]
Direct Radiation				
1[a]	City of San Clemente (Former SDG&E Offices)	5.7	NW	SI
2[a]	Camp San Mateo (MCB, Camp Pendleton)	3.6	N	OR
3[a]	Camp San Onofre (MCB, Camp Pendleton)	2.8	NE	SI
4	Camp Horno (MCB, Camp Pendleton)	4.4	E	OR
6[a]	Old El Camino Real (AKA Old Route 101)	3.0	ESE	OR
8	Noncommissioned Officers' Beach Club	1.4	NW	SI
10[a]	Bluff (Adjacent to Former PIC #1)	0.7	WNW	IR
11	Former Visitors' Center	0.4	NW	IR
12	South Edge of Switchyard	0.2**	E	SI
15	Southeast Site Boundary	0.1**	SSE	SI
16[a]	East Southeast Site Boundary	0.4**	ESE	SI
19	San Clemente Highlands	4.9	NNW	OR
22[a]	Former U.S. Coast Guard Station – San Mateo Point	2.7	WNW	OR
34[a]	San Onofre School (MCB, Camp Pendleton)	1.9	NW	SI
35	Range 312 (MCB, Camp Pendleton)	4.8	NNE	OR
36	Range 208C (MCB, Camp Pendleton)	4.1	NE	OR
40	SONGS Garden - Mesa (Adjacent to Former PIC #3)	0.7	NNW	IR
41	Old Route 101 - East	0.3	E	SI
46	San Onofre State Beach Park	1.0	SE	IR

TABLE 5-4 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

TYPE OF SAMPLE AND SAMPLING LOCATION		DISTANCE* (miles)	DIRECTION*	TLD Designation[b]
Direct Radiation (Continued)				
50[a]	Oceanside Fire Station (CONTROL)	15.6	SE	SI
55	San Onofre State Beach (Unit 1, West)	0.2**	WNW	SI
56	San Onofre State Beach (Unit 1, West)	0.2**	W	SI
57	San Onofre State Beach (Unit 2)	0.1**	SW	SI
58	San Onofre State Beach (Unit 3)	0.1**	S	SI
61	Mesa - East Boundary (Adjacent to Former PIC #4)	0.7	N	IR
62	MCB - Camp Pendleton (Adjacent to Former PIC #5)	0.7	NNE	IR
63	MCB - Camp Pendleton (Adjacent to Former PIC #6)	0.6	NE	IR
64	MCB - Camp Pendleton (Adjacent to Former PIC #7)	0.6	ENE	IR
65	MCB - Camp Pendleton (Adjacent to Former PIC #8)	0.7	E	IR
66	San Onofre State Beach Park (Adjacent to Former PIC #9)	0.6	ESE	IR
68	Range 210C (MCB, Camp Pendleton)	4.4	ENE	OR
73	South Yard Facility	0.4**	ESE	SI
75	Gate 25 MCB	4.6	SE	OR
76	Former El Camino Real Mobil Station	4.6	NW	OR

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

** Distances are within the Units 2 and 3 Site Boundary and not required by Regulatory Guidance.

a Collocated with California Department of Public Health TLD.

b TLD Designations are: Inner Ring (IR), Outer Ring (OR), Special Interest (SI)

TABLE 5-4 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

TYPE OF SAMPLE AND SAMPLING LOCATION		DISTANCE* (miles)	DIRECTION*
Airborne			
1	City of San Clemente (City Hall)	5.1	NW
9	State Beach Park	0.6	ESE
10	Bluff	0.7	WNW#
12	Former SONGS Evaporation Pond	0.6	NW
13	Marine Corps Base (Camp Pendleton East)	0.7	E
16	San Luis Rey Substation (CONTROL)	16.7	SE
20	E Site Boundary (Alt for AS-13)	0.2	E
21	ESE Site Boundary (Alt for AS-9)	0.4	ESE
Ocean Water			
A	Station Discharge Outfall - Unit 1	0.6	SW
B	Outfall - Unit 2	1.5	SW
C	Outfall - Unit 3	1.2	SSW
D	Newport Beach (CONTROL)	30.0	NW

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

\# Air Sampler #10 is not required per REMP bases but has been maintained due to being collocated with a CDPH sampler.

TABLE 5-4 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

TYPE OF SAMPLE AND SAMPLING LOCATION		DISTANCE* (miles)	DIRECTION*
Shoreline Sediment (Beach Sand)			
1	San Onofre State Beach (Southeast)	0.6	SE
2	San Onofre Surfing Beach	0.8	WNW
3	San Onofre State Beach (Southeast)	3.5	SE
4	Newport Beach (North End) (CONTROL)	29.2	NW
Local Crops			
2	Vista/Oceanside (CONTROL)**	15 to 25	SE to ESE
6	SONGS Garden***	0.7	NNW

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

** Control location should be in Sector G or F, 15 to 25 miles from site. The control location will be selected based on sample availability. The exact location shall be noted in the Annual Radiological Environmental Operating Report.

*** The SONGS Garden, location 6, for local crops, was relocated 0.1 miles west and 0.3 miles north to remain on controlled property with irrigation adjacent to former PIC #3 on September 2015. Prior to September 2015, SONGS Garden, location 6, was just inside the east border of Sector R, 0.4 miles out from the E-50 building.

TABLE 5-4 (Continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING SAMPLE LOCATIONS

TYPE OF SAMPLE AND SAMPLING LOCATION		DISTANCE* (miles)	DIRECTION*
Non-Migratory Marine Animals			
A	Unit 1 Outfall	0.9	WSW
B	Units 2 and 3 Outfall	1.5	SSW
C	Laguna Beach (CONTROL)**	15 to 20	WNW to NW
Ocean Bottom Sediments			
B	Unit 1 Outfall	0.8	SSW
C	Unit 2 Outfall	1.6	SW
D	Unit 3 Outfall	1.2	SSW
E	Laguna Beach (CONTROL)	15 to 20	NW
F	SONGS Upcoast	0.9	WSW

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

** A location more distant from SONGS in the WNW to NW direction may be used as the CONTROL location.

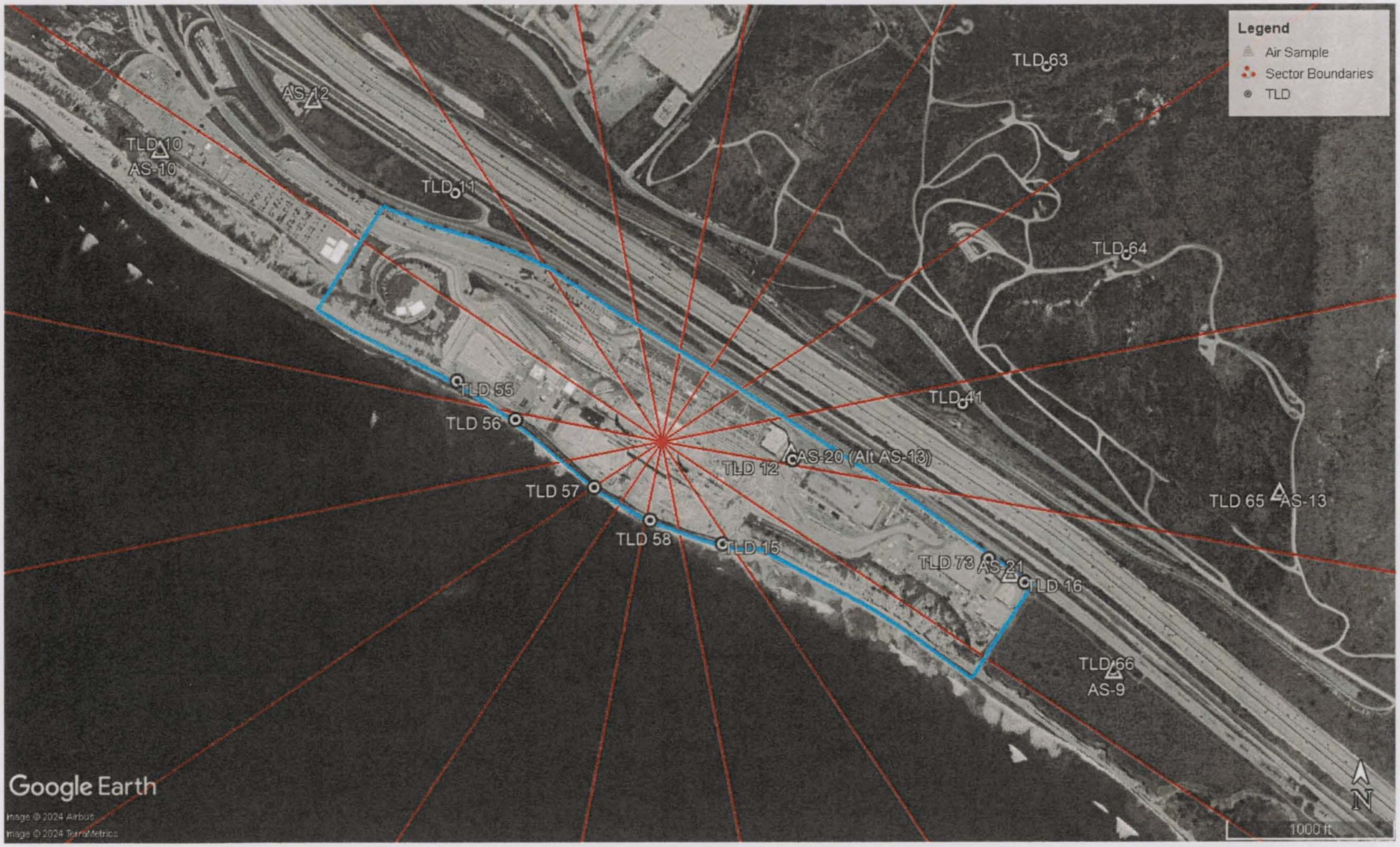
TABLE 5-6

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	281.25	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.

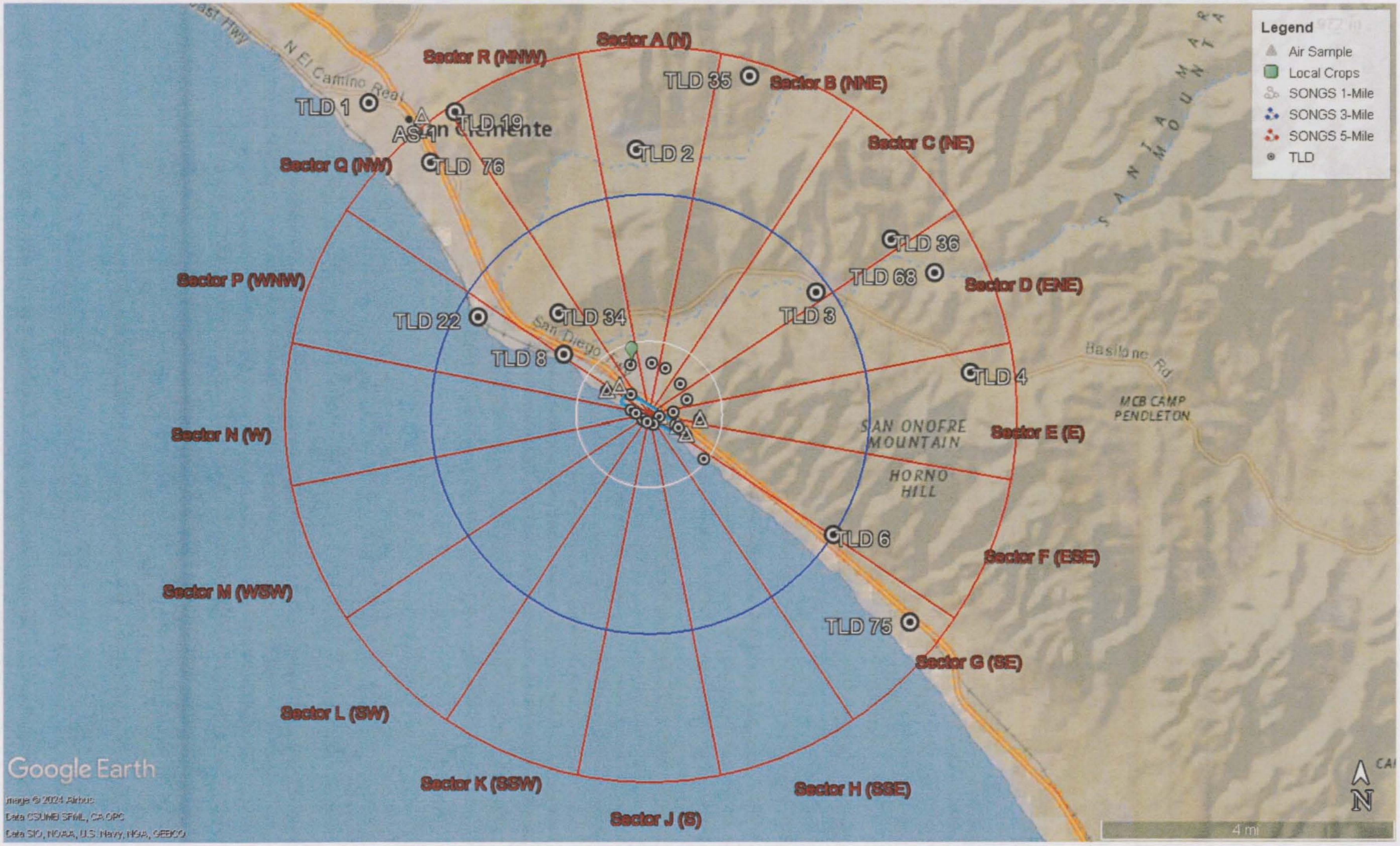
SONGS Nearby Terrestrial Locations, Aerial Image
Figure 5-1



SO123-ODCM
Revision 20
08/2024

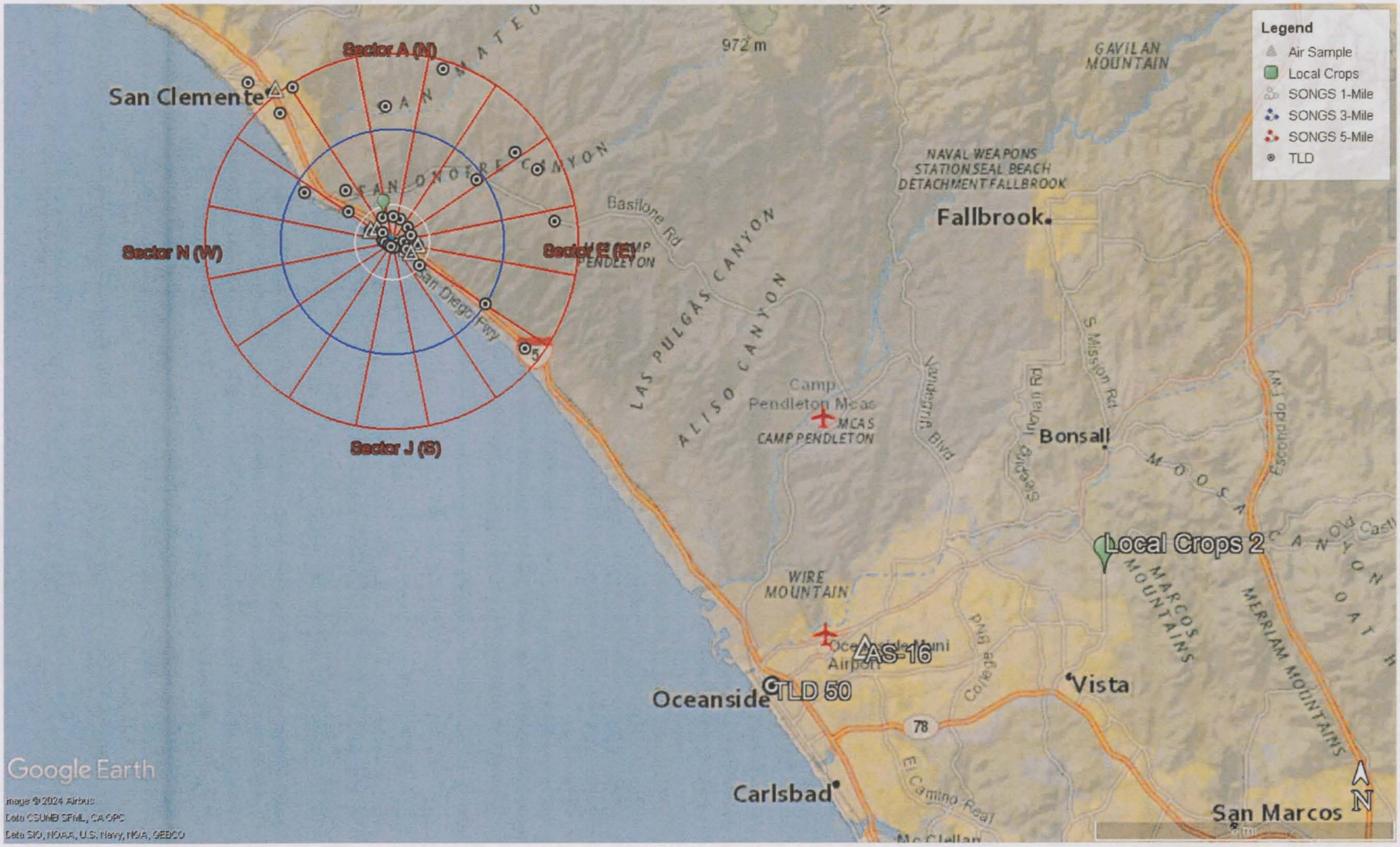
SONGS Terrestrial Samples, 1-Mile
Figure 5-2

SONGS Terrestrial Samples, 5-Miles
Figure 5-3



SO123-ODCM
Revision 20
08/2024

SONGS Terrestrial Samples, Control
Figure 5-4



SO123-ODCM
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SONGS Marine Samples, Near
Figure 5-5

SO123-ODCM
Revision 17
04/2022

SONGS Marine Samples, Far
Figure 5-6

SO123-ODCM
Revision 17
04/2022

6.0 **ADMINISTRATIVE**

6.1 DEFINITIONS

The defined terms of this section appear in capitalized type and are applicable through these Specifications.

ACTION

6.1.1 ACTION shall be that part of a specification which prescribes remedial measures required under designated conditions.

CHANNEL CALIBRATION

6.1.2 A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel, including the sensor and alarm and/or trip functions. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

6.1.3 A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

CHANNEL FUNCTIONAL TEST

6.1.4 A CHANNEL FUNCTIONAL TEST shall be:

a. Analog channels – the injection of a simulated signal into channel as close to the sensor as practicable to verify FUNCTIONALITY of alarm, interlock, and/or trip functions. The ANALOG CHANNEL FUNCTIONAL TEST shall include adjustments, as necessary, of the alarm, interlock, and/or trip setpoints such that the setpoints are within the required range and accuracy.

b. Bistable channels - the injection of a simulated signal into the sensor to verify FUNCTIONALITY, including alarm and/or trip functions.

c. Digital computer channels - the exercising of the digital computer hardware using diagnostic programs and the injection of simulated process data into the channel to verify FUNCTIONALITY.

6.0 **ADMINISTRATIVE** (Continued)

6.1 DEFINITIONS (Continued)

FREQUENCY NOTATION

6.1.5 The FREQUENCY NOTATION specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 6.2.

FUNCTIONAL - FUNCTIONALITY

6.1.6 A system, subsystem, train, component or device shall be FUNCTIONAL or have FUNCTIONALITY when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, normal or emergency electrical power, cooling and seal water, lubrication and other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its function(s) are also capable of performing their related support function(s).

MEMBERS OF THE PUBLIC

6.1.7 MEMBER(S) OF THE PUBLIC shall include all individuals who by virtue of their occupational status have no formal association with the plant. This category complies with the requirements of 10 CFR 50 and shall include non-employees of the licensee who are permitted to use portions of the site for recreational, occupational, or purposes not associated with plant functions. This category shall not include non-employees such as vending machine servicemen or postmen who, as part of their formal job function, occasionally enter an area that is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.

PURGE - PURGING

6.1.8 PURGE or PURGING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is required to purify the confinement.

SITE BOUNDARY

6.1.9 The SITE BOUNDARY shall be that line beyond which the land is not owned, leased, or otherwise controlled by the licensee.

SOLIDIFICATION

6.1.10 SOLIDIFICATION shall be the conversion of radioactive wastes from liquid systems to a homogeneous (uniformly distributed), monolithic, immobilized solid with definite volume and shape, bounded by a stable surface of distinct outline on all sides (free-standing).

6.0 **ADMINISTRATIVE** (Continued)

6.1 DEFINITIONS (Continued)

SOURCE CHECK

6.1.11 For MGPI monitors a SOURCE CHECK shall be the verification of proper computer response to the continuous internal detector, monitor calibration and electrical checks. [2/3RT-7813, 2/3RT-2101]

SURVEILLANCE REQUIREMENT: MEETING SPECIFIED FREQUENCY

6.1.12 The Specified Frequency for each SR is met if the Surveillance is performed within 1.25 times the interval specified in the Frequency, as measured from the previous performance or as measured from the time a specified condition of the Frequency is met.

For Frequencies specified as “once,” the above interval extension does not apply.

If a Completion Time requires periodic performance on a “once per ...” basis, the above Frequency extension applies to each performance after the initial performance.

This provision is not intended to be used repeatedly as a convenient means to extend surveillance intervals beyond those specified. This guidance also applies to Action requirements with a “once per…” frequency.

UNRESTRICTED AREA

6.1.13 An UNRESTRICTED AREA shall be any area at or beyond the SITE BOUNDARY access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, or any area within the SITE BOUNDARY used for residential quarters or for industrial, and/or recreational purposes.

VENTILATION EXHAUST TREATMENT SYSTEM

6.1.14 A VENTILATION EXHAUST TREATMENT SYSTEM is any system designed and installed to reduce gaseous radioactive material in particulate form in effluents by passing ventilation or vent exhaust gases through HEPA filters for the purpose of removing particulates from the gaseous exhaust stream prior to the release to the environment.

NOTE: Local mobile ventilation exhaust treatment system will be used on an as needed bases when outdoor activities have the potential for gaseous effluent releases.

6.0 **ADMINISTRATIVE** (Continued)

6.1 DEFINITIONS (Continued)

VENTING

6.1.15 VENTING is the controlled process of discharging air or gas from a confinement to maintain temperature, pressure, humidity, concentration or other operating condition, in such a manner that replacement air or gas is not provided or required during VENTING. Vent used in system names does not imply a VENTING process.

TABLE 6-2

FREQUENCY NOTATION

NOTATION	FREQUENCY
S	At least once per 12 hours
D	At least once per 24 hours
W	At least once per 7 days
M	At least once per 31 days
Q	At least once per 92 days
SA	At least once per 184 days
A	At least once per 12 months*
R	At least once per 18 months*
P	Completed prior to each release
N.A.	Not applicable
3 x W	At least once per 72 hours 3 times per week (usually M, W, F).

*A month is defined as a 31-day period.

6.0 **ADMINISTRATIVE** (Continued)

6.2 ADMINISTRATIVE CONTROLS

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT*

6.2.1 Per LCS 5.7.1.3: "The Radioactive Effluent Release Report covering the operation of the facility during the previous calendar year shall be submitted before May 1 of each year. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents released from the facility. The report shall also include a summary of the quantities of solid radioactive waste shipped from the facility directly to the disposal site and quantities of solid radioactive waste shipped from the facility's intermediary processor to the disposal site. The material provided shall be consistent with the objectives outlined in the ODCM and Process Control Program (PCP) and in conformance with 10 CFR 50.36a and 10 CFR 50, Appendix I, Section IV.B.1."

6.2.2 The radioactive effluent release reports shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the facility as outlined in RG-1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants, Revision 1, June 1974, with data summarized on a quarterly basis following the format of Appendix B thereof.

6.2.3 The radioactive effluent release report shall include an assessment of the radiation doses due to the radioactive liquid and gaseous effluents released from the facility during the previous calendar year. This same report shall also include an assessment of the radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY (Figure 1-2 and 2-2) during the report period. All assumptions used in making these assessments (i.e., specific activity, exposure time and location) shall be included in these reports. The assessment of radiation doses shall be performed in accordance with the OFFSITE DOSE CALCULATION MANUAL (ODCM).

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* A single submittal may be made for a multiple unit station. The submittal should combine those sections that are common to all units at the Station; however, for units with separate radwaste systems, the submittal shall specify the releases of radioactive material from each unit.

6.2.4 The radioactive effluent release report shall also include an assessment of radiation doses to the likely most exposed MEMBER OF THE PUBLIC from reactor releases and other nearby Uranium fuel cycle sources (including doses from primary effluent pathways and direct radiation) for the calendar year to show conformance with 40 CFR 190, Environmental Radiation Protection Standards for Nuclear Power Operation. Acceptable methods for calculating the dose contribution from liquid and gaseous effluents are given in the ODCM.

6.2.5 The radioactive effluents release shall include the following information for each type of solid waste shipped offsite during the report period:

a. Container volume;

b. Total curie quantity (specify whether determined by measurement or estimate);

c. Principal radionuclides (specify whether determined by measurement or estimate);

d. Type of waste (e.g., spent resin, compacted dry waste, evaporator bottoms);

e. Type of container (e.g., LSA, Type A, Type B, Large Quantity); and

f. Solidification Agent (e.g., cement, urea formaldehyde).

6.2.6 The radioactive effluent release report shall include unplanned releases from the site to unrestricted areas of radioactive materials in gaseous and liquid effluents made during the reporting period.

6.2.7 The radioactive effluent release reports shall include any changes to the ODCM, and the PROCESS CONTROL PROGRAM (PCP) made during the reporting period.

6.2.8 The report shall also include description of any occurrences where required radioactive effluent monitoring instrumentation channels remain non-functional for > 30 days along with an explanation of why the non-functionality was not corrected in a timely manner (in accordance with ODCM Actions 4.1.1.b and 4.2.1.b.).

6.0 **ADMINISTRATIVE** (Continued)

6.2 ADMINISTRATIVE CONTROLS (Continued)

6.2.9 Report any changes or modifications affecting any portion of the gaseous radioactive waste treatment system, the ventilation exhaust treatment system, or the liquid radioactive waste treatment system.

6.0 **ADMINISTRATIVE** (Continued)

6.3 BASES

LIQUID EFFLUENTS

CONCENTRATION (1.1)

6.3.1 This specification is provided to ensure that the concentration of radioactive materials released in liquid waste effluents from the site will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table II, Column 2. This limitation provides additional assurance that the levels of radioactive materials in bodies of water outside the site will result in exposures within (1) the Section II.A design objectives of Appendix I, 10 CFR 50, to an individual, and (2) the limits of 10 CFR 20.106(e) to the population.

DOSE (1.2)

6.3.2 This specification is provided to implement the requirements of Section II.A, III.A ,and IV.A of Appendix I, 10 CFR Part 50. The specification implements the guides set forth in Section II.A of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable." The dose calculations in the ODCM implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents are consistent with the methodology provided in RG-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, October 1977 and RG-1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

This specification applies to the release of liquid effluents from each unit at the site. For units with shared radwaste treatment systems, the liquid effluents from the shared system are proportioned among the units sharing that system.

6.0 **ADMINISTRATIVE** (Continued)

6.3 BASES (Continued)

LIQUID WASTE TREATMENT (1.3)

6.3.3 The FUNCTIONALITY of the liquid radwaste treatment system ensures that this system will be available for use whenever liquid effluents require treatment prior to release to the environment. The requirement that the appropriate portions of this system be used when specified provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable." This specification implements the requirements of 10 CFR Part 50.36a, General Design Criterion 60 of Appendix A to 10 CFR Part 50 and the design objective given in Section II.D of Appendix I to 10 CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10 CFR Part 50, for liquid effluents.

GASEOUS EFFLUENTS

DOSE RATE (2.1)

6.3.4 This specification is provided to ensure that the dose at any time at the site boundary from gaseous effluents from all units on the site will be within the annual dose limits of 10 CFR Part 20 for unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table II, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual in an unrestricted area, either within or outside the site boundary, to annual average concentrations exceeding the limits specified in Appendix B, Table II of 10 CFR Part 20 [10 CFR Part 20.106(b)]. For individuals who may at times be within the site boundary, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the site boundary. These release rate limits also restrict, at all times, the corresponding maximum organ dose rate above background to a member of the public via the inhalation pathway to less than or equal to 1500 mrem/year.

This specification applies to the release of gaseous effluents from all units at the site.

DOSE - RADIOACTIVE MATERIALS IN PARTICULATE FORM AND TRITIUM (2.3)

6.3.5 This specification is provided to implement the requirements of Sections II.C, III.A, and IV.A of Appendix I, 10 CFR Part 50. The specifications are the guides set forth in Section II.C of Appendix I. The ACTION statements provide the required operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable." The ODCM calculational methods specified in the Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. The ODCM calculational methods for calculating the doses due to the actual release rates of the subject materials are consistent with the methodology provided in RG-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, October 1977 and RG-1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for radioactive materials in particulate form and Tritium are dependent on the existing radionuclide pathways to man, in the unrestricted area. The pathways which were examined in the development of these calculations were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

VEGETATION-ANIMAL-MEAT PATHWAY FACTOR (2.8.3.3)

6.3.6 RG-1.109 and NUREG-0133 use transfer factors (with units of μCi/kg per μCi/day = days/kg) to model the concentration of radionuclides in meat based on activity deposited on vegetation surfaces; despite extensive searching, meat-transfer factors specific to deer and consistent with RG-1.109 methodology were not able to be found. Concentration ratios (CRs, based on the ratio of concentrations in feed to the concentration in meat) or aggregated transfer factors (based on soil concentrations) are more commonly used for wild game. The use of available data for deer generally assumes equilibrium conditions based on root uptake from soil, which is not consistent with RG-1.109 modeling of meat-pathway exposure based on foliar deposits for routine, annual releases. Based on the lack of available guidance/methodology and the understanding that using the default cow-meat model is unlikely to substantially underestimate calculated dose, the NUREG-0133 model for cow meat is used as an analog for deer meat.

The NUREG-0133 formula for Vegetation-Animal-Meat dose factors has been modified based on the assumption that the wild deer consume only foraged material, no stored feed. This simplifies the calculation substantially from that provided in NUREG-0133 and RG-1.109 by eliminating the terms f_p, f_s, and Y_s. It also provides conservatism in use of a smaller assumed agricultural yield (resulting in a larger area of deposition being grazed by the animal, and hence, a greater quantity of deposited activity ingested) and no assumed decay time before consumption of the forage.

6.3 BASES (Continued)

TOTAL DOSE (3.3)

6.3.7 This specification is provided to meet the dose limitations of 40 CFR 190. The specification requires the preparation and submittal of a Special Report whenever the calculated doses from plant radioactive effluents exceed twice the design objective doses of Appendix I. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a member of the public will exceed the dose limits of 40 CFR 190 if the individual reactors remain within the reporting requirement level. The Special Report will describe a course of action which should result in the limitation of dose to a member of the public for any calendar year to within the 40 CFR 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the member of the public from other Uranium fuel cycle sources is negligible, with the exception that dose contributions from other nuclear fuel cycle facilities at the same site or within a radius of 5 miles must be considered. If the dose to any member of the public is estimated to exceed the requirements of 40 CFR 190, the Special Report with a request for a variance in accordance with the provisions of 40 CFR 190.11, is considered to be a timely request and fulfills the requirements of 40 CFR 190 until NRC staff action is completed provided the release conditions resulting in violation of 40 CFR 190 have not already been corrected. An individual is not considered a member of the public during any period in which he/she is engaged in carrying out any operation which is part of the nuclear fuel cycle.

6.0 **ADMINISTRATIVE** (Continued)

6.3 BASES (Continued)

RADIOACTIVE LIQUID EFFLUENT INSTRUMENTATION (4.1)

6.3.8 The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm/trip setpoints for these instruments shall be calculated in accordance with the procedures in the ODCM to ensure the alarm/trip will occur prior to exceeding the limits of 10 CFR Part 20. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

RADIOACTIVE GASEOUS EFFLUENT INSTRUMENTATION (4.2)

6.3.9 The radioactive gaseous effluent instrumentation is provided to monitor, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The FUNCTIONALITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63, and 64 of Appendix A to 10 CFR Part 50.

MONITORING PROGRAM (5.1)

6.3.10 The radiological monitoring program required by this specification provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of individuals resulting from the station operation. This monitoring program thereby supplements the radiological effluent monitoring program by verifying the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The initially specified monitoring program will be effective for at least the first three years of commercial operation. Following this period, program changes may be initiated based on operational experience.

The detection capabilities required by Table 5-1 are state-of-the-art for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as an a priori (before the fact) limit representing the capability of a measurement system and not as a posteriori (after the fact) limit for a particular measurement. Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interfering nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

6.0 **ADMINISTRATIVE** (Continued)

6.3 BASES (Continued)

LAND USE CENSUS (5.2)

6.3.11 This specification is provided to ensure that changes in the use of UNRESTRICTED AREAS are identified and that modifications to the monitoring program are made if required by the results of this census. The best survey information from the door-to-door, aerial or consulting with local agricultural authorities shall be used. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. Restricting the census to gardens of greater than 500 square feet provides assurance that significant exposure pathways via leafy vegetables will be identified and monitored since a garden of this size is the minimum required to produce the quantity (26 kg/year) of leafy vegetables assumed in RG-1.109 for consumption by a child. To determine this minimum garden size, the following assumptions were used:

1) that 20% of the garden was used for growing broad leaf vegetation (i.e., similar to lettuce and cabbage), and

2) a vegetation yield of 2 kg/square meter.

INTERLABORATORY COMPARISON PROGRAM (5.3)

6.3.12 The requirement for participation in an Interlaboratory Comparison Program is provided to ensure independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of the quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid.

Enclosure 3

Offsite Dose Calculation Manual

San Onofre Nuclear Generation Station

SO123-ODCM Appendix A Revision 16, September 2023

OFFSITE DOSE CALCULATION MANUAL
NUCLEAR ORGANIZATION
SAN ONOFRE NUCLEAR GENERATING STATION

APPENDIX A
DOSE FACTOR, DISPERSION, AND DEPOSITION PARAMETER TABLES

Page	Description of Change	Reason
All pages	Complete Revision – No track changes required for complete revisions.	R

List of Tables

1.0 Dose Factors

1.1 Ground Plane Dose Factors

Table 1: Ground Plane Dose Factor - All Age Groups

(R^G_{ir}, mrem/yr per μCi/sec)

NUCLIDE	EFFECTIVE	SKIN
MN-54	1.38E+09	1.62E+09
CO-58	3.79E+08	4.44E+08
CO-60	2.15E+10	2.52E+10
ZN-65	7.44E+08	8.56E+08
CS-134	6.82E+09	7.96E+09
CS-137	1.03E+10	1.20E+10
CE-144	6.95E+07	8.03E+07

1.2 Inhalation Dose Factors

Table 2: Inhalation Dose Factor – Adult

(R^{I}_{air}, mrem/yr per μCi/m^3)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**7.17E+02**	**7.17E+02**		**7.17E+02**	**7.17E+02**	**7.17E+02**	**7.17E+02**	**7.17E+02**
MN-54	6.29E+03	7.72E+04		3.95E+04	9.83E+03		**1.40E+06**	
CO-58	2.07E+03	1.06E+05		1.58E+03			**9.27E+05**	
CO-60	1.48E+04	2.84E+05		1.15E+04			**5.96E+06**	
NI-63	1.45E+04	1.33E+04	**4.31E+05**	3.14E+04			1.78E+05	
ZN-65	4.65E+04	5.34E+04	3.24E+04	1.03E+05	6.89E+04		**8.63E+05**	
SR-90	5.76E+05	7.21E+05	**2.87E+07**				9.59E+06	
CS-134	7.27E+05	1.04E+04	3.72E+05	**8.47E+05**	2.87E+05		9.75E+04	
CS-137	4.27E+05	8.39E+03	4.78E+05	**6.20E+05**	2.22E+05		7.51E+04	
CE-144	1.84E+05	8.15E+05	3.43E+06	1.43E+06	8.47E+05		**7.76E+06**	

Table 3: Inhalation Dose Factor – Teen

(R^{I}_{air}, mrem/yr per μCi/m^3).

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**7.24E+02**	**7.24E+02**		**7.24E+02**	**7.24E+02**	**7.24E+02**	**7.24E+02**	**7.24E+02**
MN-54	8.39E+03	6.67E+04		5.10E+04	1.27E+04		**1.98E+06**	
CO-58	2.77E+03	9.51E+04		2.07E+03			**1.34E+06**	
CO-60	1.98E+04	2.59E+05		1.51E+04			**8.71E+06**	
NI-63	1.97E+04	1.41E+04	**5.79E+05**	4.34E+04			3.07E+05	
ZN-65	6.23E+04	4.66E+04	3.85E+04	1.33E+05	8.63E+04		**1.24E+06**	
SR-90	6.65E+05	7.64E+05	**3.31E+07**				1.65E+07	
CS-134	5.48E+05	9.75E+03	5.02E+05	**1.13E+06**	3.75E+05		1.46E+05	
CS-137	3.11E+05	8.47E+03	6.69E+05	**8.47E+05**	3.04E+05		1.21E+05	
CE-144	2.62E+05	8.63E+05	4.88E+06	2.02E+06	1.21E+06		**1.33E+07**	

Table 4: Inhalation Dose Factor – Child

(R^{I}_{air}, mrem/yr per µCi/m^3)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**6.39E+02**	**6.39E+02**		**6.39E+02**	**6.39E+02**	**6.39E+02**	**6.39E+02**	**6.39E+02**
MN-54	9.50E+03	2.29E+04		4.29E+04	1.00E+04		**1.57E+06**	
CO-58	3.16E+03	3.43E+04		1.77E+03			**1.10E+06**	
CO-60	2.26E+04	9.61E+04		1.31E+04			**7.06E+06**	
NI-63	2.79E+04	6.32E+03	**8.20E+05**	4.62E+04			2.75E+05	
ZN-65	7.02E+04	1.63E+04	4.25E+04	1.13E+05	7.13E+04		**9.94E+05**	
SR-90	7.65E+05	3.43E+05	**3.84E+07**				1.47E+07	
CS-134	2.24E+05	3.84E+03	6.50E+05	**1.01E+06**	3.30E+05		1.21E+05	
CS-137	1.28E+05	3.61E+03	**9.05E+05**	8.24E+05	2.82E+05		1.04E+05	
CE-144	3.61E+05	3.88E+05	6.76E+06	2.11E+06	1.17E+06		**1.19E+07**	

Table 5: Inhalation Dose Factor – Infant

(R^{I}_{air}, mrem/yr per µCi/m^3)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**3.68E+02**	**3.68E+02**		**3.68E+02**	**3.68E+02**	**3.68E+02**	**3.68E+02**	**3.68E+02**
MN-54	4.98E+03	7.05E+03		2.53E+04	4.98E+03		**9.98E+05**	
CO-58	1.82E+03	1.11E+04		1.22E+03			**7.76E+05**	
CO-60	1.18E+04	3.19E+04		8.01E+03			**4.50E+06**	
NI-63	1.16E+04	2.42E+03	**3.38E+05**	2.04E+04			2.08E+05	
ZN-65	3.10E+04	5.13E+04	1.93E+04	6.25E+04	3.24E+04		**6.46E+05**	
SR-90	3.12E+05	1.31E+05	**1.55E+07**				1.12E+07	
CS-134	7.44E+04	1.33E+03	3.96E+05	**7.02E+05**	1.90E+05		7.95E+04	
CS-137	4.54E+04	1.33E+03	5.48E+05	**6.11E+05**	1.72E+05		7.12E+04	
CE-144	1.76E+05	1.48E+05	3.19E+06	1.21E+06	5.37E+05		**9.83E+06**	

1.3 Vegetable Ingestion Dose Factors

Table 6: Vegetable Ingestion Dose Factor – Adult

(R^V_{air}, m^2-mrem/yr per μCi/sec all nuclides except tritium, mrem/yr per μCi/m^3 for tritium)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**9.81E+02**	**9.81E+02**		**9.81E+02**	**9.81E+02**	**9.81E+02**	**9.81E+02**	**9.81E+02**
MN-54	5.96E+07	**9.57E+08**		3.12E+08	9.30E+07			
CO-58	6.89E+07	**6.23E+08**		3.07E+07				
CO-60	3.68E+08	**3.13E+09**		1.67E+08				
NI-63	3.48E+08	1.50E+08	**1.04E+10**	7.20E+08				
ZN-65	4.56E+08	6.35E+08	3.17E+08	**1.01E+09**	6.74E+08			
SR-90	1.39E+10	1.74E+10	**6.94E+11**					
CS-134	9.06E+09	1.94E+08	4.66E+09	**1.11E+10**	3.59E+09		1.19E+09	
CS-137	5.69E+09	1.68E+08	6.35E+09	**8.68E+09**	2.95E+09		9.80E+08	
CE-144	1.76E+06	**1.11E+10**	3.29E+07	1.37E+07	8.15E+06			

Table 7: Vegetable Ingestion Dose Factor – Teen

(R^V_{air}, m^2-mrem/yr per μCi/sec all nuclides except tritium, mrem/yr per μCi/m^3 for tritium)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**1.12E+03**	**1.12E+03**		**1.12E+03**	**1.12E+03**	**1.12E+03**	**1.12E+03**	**1.12E+03**
MN-54	9.00E+07	**9.30E+08**		4.54E+08	1.35E+08			
CO-58	1.01E+08	**6.01E+08**		4.36E+07				
CO-60	5.59E+08	**3.23E+09**		2.48E+08				
NI-63	5.44E+08	1.80E+08	**1.60E+10**	1.13E+09				
ZN-65	6.85E+08	6.22E+08	4.23E+08	**1.47E+09**	9.40E+08			
SR-90	1.84E+10	2.10E+10	**9.21E+11**					
CS-134	7.74E+09	2.07E+08	7.09E+09	**1.67E+10**	5.30E+09		2.02E+09	
CS-137	4.69E+09	1.92E+08	1.01E+10	**1.35E+10**	4.58E+09		1.78E+09	
CE-144	2.83E+06	**1.32E+10**	5.27E+07	2.18E+07	1.30E+07			

Table 8: Vegetable Ingestion Dose Factor – Child

($R^{V}_{air,}$ m^2-mrem/yr per µCi/sec all nuclides except tritium, mrem/yr per µCi/m^3 for tritium)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**1.74E+03**	**1.74E+03**		**1.74E+03**	**1.74E+03**	**1.74E+03**	**1.74E+03**	**1.74E+03**
MN-54	1.77E+08	5.57E+08		**6.64E+08**	1.86E+08			
CO-58	1.97E+08	**3.76E+08**		6.44E+07				
CO-60	1.11E+09	**2.09E+09**		3.78E+08				
NI-63	1.34E+09	1.42E+08	**3.94E+10**	2.11E+09				
ZN-65	1.34E+09	3.80E+08	8.11E+08	**2.16E+09**	1.36E+09			
SR-90	3.76E+10	1.67E+10	**1.87E+12**					
CS-134	5.54E+09	1.42E+08	1.60E+10	**2.63E+10**	8.14E+09		2.92E+09	
CS-137	3.37E+09	1.43E+08	**2.39E+10**	2.29E+10	7.45E+09		2.68E+09	
CE-144	6.77E+06	**1.04E+10**	1.27E+08	3.98E+07	2.20E+07			

1.4 Meat Ingestion Dose Factors

Table 9: Vegetation-Animal-Meat Ingestion Dose Factor – Adult

(R^M_{aiT}, m^2-mrem/yr per μCi/sec all nuclides except tritium, mrem/yr per μCi/m^3 for tritium)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**1.41E+02**	**1.41E+02**		**1.41E+02**	**1.41E+02**	**1.41E+02**	**1.41E+02**	**1.41E+02**
MN-54	1.75E+06	**2.81E+07**		9.17E+06	2.73E+06			
CO-58	4.08E+07	**3.69E+08**		1.82E+07				
CO-60	1.66E+08	**1.41E+09**		7.51E+07				
NI-63	6.32E+07	2.73E+07	**1.89E+09**	1.31E+08				
ZN-65	5.11E+08	7.12E+08	3.55E+08	**1.13E+09**	7.56E+08			
SR-90	2.87E+08	3.59E+08	**1.43E+10**					
CS-134	1.28E+09	2.73E+07	6.57E+08	**1.56E+09**	5.06E+08		1.68E+08	
CS-137	7.80E+08	2.31E+07	8.71E+08	**1.19E+09**	4.04E+08		1.34E+08	
CE-144	7.82E+04	**4.92E+08**	1.46E+06	6.09E+05	3.61E+05			

Table 10: Vegetation-Animal-Meat Ingestion Dose Factor – Teen

(R^M_{aiT}, m^2-mrem/yr per μCi/sec all nuclides except tritium, mrem/yr per μCi/m^3 for tritium)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**8.40E+01**	**8.40E+01**		**8.40E+01**	**8.40E+01**	**8.40E+01**	**8.40E+01**	**8.40E+01**
MN-54	1.39E+06	**1.43E+07**		6.99E+06	2.09E+06			
CO-58	3.24E+07	**1.94E+08**		1.40E+07				
CO-60	1.31E+08	**7.59E+08**		5.83E+07				
NI-63	5.14E+07	1.71E+07	**1.52E+09**	1.07E+08				
ZN-65	4.05E+08	3.67E+08	2.50E+08	**8.67E+08**	5.55E+08			
SR-90	1.98E+08	2.26E+08	**9.88E+09**					
CS-134	5.70E+08	1.53E+07	5.22E+08	**1.23E+09**	3.90E+08		1.49E+08	
CS-137	3.35E+08	1.37E+07	7.23E+08	**9.62E+08**	3.27E+08		1.27E+08	
CE-144	6.59E+04	**3.08E+08**	1.23E+06	5.08E+05	3.03E+05			

Table 11: Vegetation-Animal-Meat Ingestion Dose Factor – Child

(R^{M}_{air}, m^2-mrem/yr per μCi/sec all nuclides except tritium, mrem/yr per μCi/m^3 for tritium)

NUCLIDE	EFFECTIVE	GI-TRACT	BONE	LIVER	KIDNEY	THYROID	LUNG	SKIN
H-3	**1.02E+02**	**1.02E+02**		**1.02E+02**	**1.02E+02**	**1.02E+02**	**1.02E+02**	**1.02E+02**
MN-54	2.13E+06	6.71E+06		**8.00E+06**	2.24E+06			
CO-58	5.02E+07	**9.57E+07**		1.64E+07				
CO-60	2.04E+08	**3.83E+08**		6.92E+07				
NI-63	9.89E+07	1.05E+07	**2.91E+09**	1.56E+08				
ZN-65	6.21E+08	1.75E+08	3.75E+08	**9.99E+08**	6.29E+08			
SR-90	3.15E+08	1.40E+08	**1.56E+10**					
CS-134	3.19E+08	8.14E+06	9.21E+08	**1.51E+09**	4.68E+08		1.68E+08	
CS-137	1.88E+08	7.98E+06	**1.33E+09**	1.27E+09	4.15E+08		1.49E+08	
CE-144	1.23E+05	**1.89E+08**	2.31E+06	7.25E+05	4.01E+05			

2.0 Dispersion and Deposition Parameters

Table 12: Gaseous Site Boundary Dispersion and Deposition Parameters

Description	Direction	Sector	miles	meters	χ/Q (sec/m^3)	D/Q (m^{-2})
Boundary	N	(A)	0.1	161	1.60E-04	5.10E-07
Boundary	NNE	(B)	0.1	161	2.50E-04	5.30E-07
Boundary	NE	(C)	0.1	161	1.70E-04	5.80E-07
Boundary	ENE	(D)	0.11	177	3.90E-04	6.40E-07
Boundary	E	(E)	0.14	225	1.20E-04	5.90E-07
Boundary	ESE	(F)	0.22	354	5.80E-05	2.60E-07
Boundary	SE	(G)	0.13	209	1.30E-04	2.80E-07
Boundary	SSE	(H)	0.1	161	1.90E-04	2.40E-07
Boundary	S	(J)	0.09	145	3.70E-04	3.80E-07
Boundary	SSW	(K)	0.08	129	2.00E-03	2.20E-06
Boundary	SW	(L)	0.08	129	6.20E-04	5.00E-07
Boundary	WSW	(M)	0.09	145	2.40E-04	2.40E-07
Boundary	W	(N)	0.11	177	1.30E-04	1.60E-07
Boundary	WNW	(P)	0.18	290	6.10E-05	9.70E-08
Boundary	NW	(Q)	0.2	322	5.30E-05	1.70E-07
Boundary	NNW	(R)	0.13	209	1.00E-04	3.20E-07

Table 13: LUC Residence Dispersion and Deposition Parameters

(For Recent LUC)

Description	Direction	Sector	miles	meters	χ/Q (sec/m^3)	D/Q (m^{-2})
Residence	N	(A)	3.6	5794	1.10E-07	5.30E-10
Residence	NE	(C)	2.4	3862	2.20E-07	1.40E-09
Residence	NE	(C)	2.6	4184	1.90E-07	1.20E-09
Residence	ENE	(D)	3	4828	4.70E-07	1.10E-09
Residence	E	(E)	4.1	6598	1.10E-07	7.20E-10
Residence	SE	(G)	2.9	4667	2.30E-07	6.40E-10
Residence	WNW	(P)	1	1609	2.40E-06	5.10E-09
Residence	WNW	(P)	2.7	4345	2.50E-07	4.40E-10
Residence	NW	(Q)	1.1	1770	1.90E-06	7.80E-09
Residence	NW	(Q)	1.4	2253	1.10E-06	4.30E-09
Residence	NNW	(R)	1.3	2092	1.10E-06	5.50E-09

Table 14: LUC Garden Dispersion and Deposition Parameters

(For Recent LUC)

Description	Direction	Sector	miles	meters	χ/Q (sec/m^3)	D/Q (m^{-2})
Garden	WNW	(P)	2.8	4506	2.30E-07	4.10E-10
Garden	WNW	(P)	2.9	4667	2.20E-07	3.80E-10
Garden	NW	(Q)	4.1	6598	1.10E-07	3.40E-10
Garden	NW	(Q)	4.4	7081	9.50E-08	2.90E-10
Garden	NW	(Q)	4	6437	1.10E-07	3.60E-10
Garden	NNW	(R)	0.7	1127	5.00E-06	2.50E-08
Garden	NNW	(R)	4.9	7886	6.60E-08	2.50E-10

Table 15: LUC 'Other Use' Dispersion and Deposition Parameters

(For Recent LUC)

Description	Direction	Sector	miles	meters	χ/Q (sec/m^3)	D/Q (m^{-2})
Other Use	N	(A)	3.6	5794	1.10E-07	5.30E-10
Other Use	N	(A)	0.4	644	1.30E-05	6.90E-08
Other Use	NNE	(B)	2.1	3380	5.00E-07	1.80E-09
Other Use	NE	(C)	2.2	3541	2.70E-07	1.80E-09
Other Use	E	(E)	4	6437	1.10E-07	7.60E-10
Other Use	ESE	(F)	0.8	1287	5.40E-06	3.20E-08
Other Use	ESE	(F)	1.9	3058	6.70E-07	3.70E-09
Other Use	SE	(G)	1.8	2897	6.40E-07	2.00E-09
Other Use	ESE	(F)	2.1	3380	5.40E-07	2.90E-09
Other Use	SE	(G)	2.1	3380	4.50E-07	1.40E-09
Other Use	SE	(G)	2.8	4506	2.50E-07	7.00E-10
Other Use	SE	(G)	2	3219	5.00E-07	1.50E-09
Other Use	WNW	(P)	0.5	805	1.00E-05	2.10E-08
Other Use	WNW	(P)	1.8	2897	5.90E-07	1.20E-09
Other Use	WNW	(P)	1	1609	2.40E-06	5.10E-09
Other Use	NW	(Q)	1.1	1770	1.90E-06	7.80E-09
Other Use	NW	(Q)	0.6	966	7.60E-06	3.00E-08
Other Use	NW	(Q)	0.7	1127	5.80E-06	2.40E-08
Other Use	NW	(Q)	1.2	1931	1.60E-06	6.30E-09
Other Use	NW	(Q)	1.3	2092	1.30E-06	5.10E-09

Table 16: LUC Deer Location Dispersion and Deposition Parameters

(For Recent LUC)

Description	Direction	Sector	miles	meters	χ/Q (sec/m^3)	D/Q (m^{-2})
Deer	NNW	(R)	1.8	2897	5.20E-07	2.50E-09
Deer	N	(A)	1.8	2897	4.80E-07	2.70E-09
Deer	NNE	(B)	0.8	1287	5.85E-06	2.37E-08
Deer	NE	(C)	0.8	1287	3.00E-06	2.20E-08
Deer	ENE	(D)	0.8	1287	9.40E-06	2.80E-08
Deer	E	(E)	0.8	1287	4.10E-06	3.80E-08
Deer	ESE	(F)	1.5	2414	1.10E-06	6.50E-09

2.1 Standard Distance Dispersion and Deposition Parameters

Table 17: SONGS χ/Q at Standard Distances from 0.25 - 5 miles (sec/m^3)

DIR.	Sector	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5
S	(J)	5.49E-05	1.60E-05	7.79E-06	3.73E-06	1.41E-06	7.46E-07	4.67E-07	3.24E-07	2.40E-07	1.87E-07	1.51E-07	1.25E-07
SSW	(K)	2.61E-04	7.57E-05	3.65E-05	1.75E-05	6.69E-06	3.56E-06	2.25E-06	1.57E-06	1.17E-06	9.13E-07	7.39E-07	6.15E-07
SW	(L)	8.25E-05	2.40E-05	1.16E-05	5.57E-06	2.12E-06	1.13E-06	7.10E-07	4.94E-07	3.68E-07	2.87E-07	2.32E-07	1.93E-07
WSW	(M)	3.78E-05	1.11E-05	5.37E-06	2.57E-06	9.76E-07	5.17E-07	3.24E-07	2.25E-07	1.67E-07	1.30E-07	1.05E-07	8.70E-08
W	(N)	3.00E-05	8.75E-06	4.27E-06	2.04E-06	7.72E-07	4.08E-07	2.55E-07	1.76E-07	1.31E-07	1.02E-07	8.19E-08	6.78E-08
WNW	(P)	3.49E-05	1.02E-05	4.93E-06	2.36E-06	8.94E-07	4.72E-07	2.95E-07	2.04E-07	1.51E-07	1.18E-07	9.47E-08	7.85E-08
NW	(Q)	3.58E-05	1.04E-05	5.11E-06	2.44E-06	9.12E-07	4.75E-07	2.94E-07	2.01E-07	1.48E-07	1.14E-07	9.11E-08	7.49E-08
NNW	(R)	3.17E-05	9.13E-06	4.47E-06	2.13E-06	7.91E-07	4.10E-07	2.53E-07	1.73E-07	1.26E-07	9.71E-08	7.75E-08	6.36E-08
N	(A)	3.00E-05	8.47E-06	4.10E-06	1.95E-06	7.26E-07	3.77E-07	2.33E-07	1.59E-07	1.17E-07	9.00E-08	7.19E-08	5.92E-08
NNE	(B)	4.31E-05	1.22E-05	5.85E-06	2.78E-06	1.05E-06	5.52E-07	3.44E-07	2.38E-07	1.76E-07	1.36E-07	1.10E-07	9.08E-08
NE	(C)	2.75E-05	7.48E-06	3.56E-06	1.68E-06	6.27E-07	3.27E-07	2.02E-07	1.39E-07	1.02E-07	7.89E-08	6.32E-08	5.21E-08
ENE	(D)	8.30E-05	2.33E-05	1.11E-05	5.31E-06	2.03E-06	1.08E-06	6.77E-07	4.71E-07	3.51E-07	2.74E-07	2.22E-07	1.84E-07
E	(E)	3.87E-05	1.04E-05	4.89E-06	2.31E-06	8.69E-07	4.56E-07	2.84E-07	1.96E-07	1.44E-07	1.12E-07	8.98E-08	7.42E-08
ESE	(F)	4.72E-05	1.32E-05	6.36E-06	3.02E-06	1.14E-06	5.96E-07	3.71E-07	2.55E-07	1.89E-07	1.46E-07	1.17E-07	9.69E-08
SE	(G)	3.82E-05	1.11E-05	5.41E-06	2.58E-06	9.66E-07	5.05E-07	3.13E-07	2.15E-07	1.58E-07	1.22E-07	9.81E-08	8.08E-08
SSE	(H)	3.49E-05	1.02E-05	5.00E-06	2.39E-06	8.98E-07	4.71E-07	2.93E-07	2.02E-07	1.49E-07	1.15E-07	9.23E-08	7.62E-08

Table 18: SONGS D/Q at Standard Distances from 0.25 - 5 miles (m^{-2})

DIR.	Sector	0.25	0.5	0.75	1	1.5	2	2.5	3	3.5	4	4.5	5
S	(J)	8.44E-08	2.86E-08	1.47E-08	6.97E-09	2.50E-09	1.24E-09	7.31E-10	4.79E-10	3.37E-10	2.50E-10	1.92E-10	1.53E-10
SSW	(K)	4.48E-07	1.51E-07	7.77E-08	3.69E-08	1.33E-08	6.58E-09	3.88E-09	2.54E-09	1.79E-09	1.32E-09	1.02E-09	8.10E-10
SW	(L)	1.01E-07	3.41E-08	1.75E-08	8.33E-09	2.99E-09	1.48E-09	8.74E-10	5.72E-10	4.03E-10	2.98E-10	2.30E-10	1.83E-10
WSW	(M)	5.43E-08	1.84E-08	9.43E-09	4.49E-09	1.61E-09	7.99E-10	4.71E-10	3.08E-10	2.17E-10	1.61E-10	1.24E-10	9.83E-11
W	(N)	4.72E-08	1.60E-08	8.20E-09	3.90E-09	1.40E-09	6.94E-10	4.09E-10	2.68E-10	1.88E-10	1.40E-10	1.08E-10	8.55E-11
WNW	(P)	6.12E-08	2.07E-08	1.06E-08	5.05E-09	1.81E-09	9.00E-10	5.30E-10	3.47E-10	2.44E-10	1.81E-10	1.39E-10	1.11E-10
NW	(Q)	1.21E-07	4.10E-08	2.11E-08	1.00E-08	3.60E-09	1.78E-09	1.05E-09	6.88E-10	4.84E-10	3.59E-10	2.76E-10	2.20E-10
NNW	(R)	1.30E-07	4.40E-08	2.26E-08	1.07E-08	3.86E-09	1.91E-09	1.13E-09	7.37E-10	5.19E-10	3.85E-10	2.96E-10	2.35E-10
N	(A)	1.42E-07	4.81E-08	2.47E-08	1.18E-08	4.22E-09	2.09E-09	1.23E-09	8.07E-10	5.68E-10	4.21E-10	3.24E-10	2.58E-10
NNE	(B)	1.37E-07	4.62E-08	2.37E-08	1.13E-08	4.06E-09	2.01E-09	1.18E-09	7.75E-10	5.46E-10	4.04E-10	3.12E-10	2.48E-10
NE	(C)	1.51E-07	5.09E-08	2.61E-08	1.24E-08	4.46E-09	2.21E-09	1.30E-09	8.53E-10	6.00E-10	4.45E-10	3.43E-10	2.72E-10
ENE	(D)	1.93E-07	6.52E-08	3.35E-08	1.59E-08	5.72E-09	2.84E-09	1.67E-09	1.09E-09	7.69E-10	5.70E-10	4.39E-10	3.49E-10
E	(E)	2.57E-07	8.68E-08	4.45E-08	2.12E-08	7.61E-09	3.77E-09	2.22E-09	1.45E-09	1.02E-09	7.58E-10	5.84E-10	4.64E-10
ESE	(F)	2.20E-07	7.44E-08	3.82E-08	1.82E-08	6.52E-09	3.23E-09	1.90E-09	1.25E-09	8.77E-10	6.50E-10	5.01E-10	3.98E-10
SE	(G)	1.05E-07	3.56E-08	1.83E-08	8.68E-09	3.12E-09	1.55E-09	9.11E-10	5.96E-10	4.20E-10	3.11E-10	2.40E-10	1.90E-10
SSE	(H)	6.36E-08	2.15E-08	1.11E-08	5.25E-09	1.89E-09	9.36E-10	5.51E-10	3.61E-10	2.54E-10	1.88E-10	1.45E-10	1.15E-10

Enclosure 4

Offsite Dose Calculation Manual

San Onofre Nuclear Generation Station

SO123-ODCM-Appendix B Revision 11, August 2024

OFFSITE DOSE CALCULATION MANUAL

NUCLEAR ORGANIZATION

SAN ONOFRE NUCLEAR GENERATING STATION (SONGS)

APPENDIX B

SUPPLEMENTAL INFORMATION FOR EFFLUENT CONTROLS

SO123-ODCM-B
Revision 11
08/2024

ODCM APPENDIX B

TABLE OF CONTENTS

Note: Change bars appear in Table of Contents due to deletion of section(s) within the document. No changes were made within the section itself.

Apri1 23, 1993

TO: DARYL DICK, SONGS Effluent Engineering

SUBJECT: RECOMMENDED EFFLUENT CONCENTRATION FROM 10CFR20 APPENDIX B, TABLE 2, FOR SETPOINT CALCULATIONS

Daryl,

I have indicated on the attached table which effluent concentration limits (ECLs) are recommended for use when calculating radiation monitor setpoint values for liquid and airborne radioactive effluent releases from SONGS.

For simplicity's sake, when the station implements the new 10CFR20, ECLs should be used exclusively. In cases where more than one value is listed (based on retention) in Appendix B, Table 2, the most conservative value is recommended for routine calculations. Under conditions which require more flexibility, actual chemical and physical characteristics of the release stream may be considered to allow use of a more representative value. It is recommended that each of these instances be documented. Since no ECLs are provided in Column 2 for dissolved and entrained gases in liquids, per NUREG 1301, ·Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors·, Specification 3.11.1.1, a value of 2E-4 uCi/ml should be used.

If there are any questions, please call me at 50512.

Kathleen Yhip
HPE Engineer

cc: HPE Files

GAS AND LIQUID EFFLUENT CONCENTRATION LIMIT (ECl) VALUES						
	ISOTOPE	GAS ECL	GAS MPC	ISOTOPE	LIQUID ECL	LIQUID MPC
		(ECL)	(MPC)		(ECL)	(MPC)
1	H-3	1E-7	2E-7	H-3	1E-3	3E-3
2	Na-24	7E-9	5E-9	Na-24	5E-5	3E-5
3	Ar-41	1E-8	4E-8	Ar-41		2E-4
4	Sc-46	3E-10	8E-10	Sc-46	1E-5	4E-5
5	Cr-51	6E-8 d 3E-8 w, a	8E-8	Cr-51	5E-4	2E-3
6	Mn-54	1E-9	1E-9	Mn-54	3E-5	1E-4
7	Mn-56	2E-8 d 3E-8 w	2E-8	Mn-56	7E-5	1E-4
8	Fe-55	3E-9 d 6E-9 w	3E-8	Fe-55	1E-4	8E-4
9	Fe-59	5E-10 d 7E-10 w	2E-9	Fe-59	1E-5	5E-5
10	Co-57	4E-9 w 9E-10 a	6E-9	Co-57	6E-5	4E-4
11	Co-58	2E-9 w 1E-9 a	2E-9	Co-58	2E-5	9E-5
12	Co-60	2E-10 w 5E-11 a	3E-10	Co-60	3E-6	3E-5
13	Cu-64	4E-8 d 3E-8 w, a	4E-8	Cu-64	2E-4	2E-4
14	Zn-65	4E-10	2E-9	Zn-65	5E-6	1E-4
15	Br-82	6E-9 d 5E-9 w	6E-9	Br-82	4E-5	4E-5
16	Br-84	8E-8 d 9E-8 w	3E-8	Br-84	4E-4	2E-4
17	Kr-85	7E-7	3E-7	Kr-85		2E-4
18	Kr-85m	1E-7	1E-7	Kr-85m		2E-4
19	Kr-87	2E-8	2E-8	Nr-87		2E-4
20	Kr-88	9E-8	2E-8	Kr-88		2E-4
21	Rb-88	9E-8	2E-4	Rb-88	4E-4	2E-4

GAS AND LIQUID EFFLUENT CONCENTRATION LIMIT (ECI) VALUES						
	ISOTOPE	GAS ECL	GAS MPC	ISOTOPE	LIQUID ECL	LIQUID MPC
		(ECL)	(MPC)		(ECL)	(MPC)
22	Rb-89	2E-7	2E-4	Rb-89	9E-4	2E-4
23	Sr-89	1E-9 d 2E-10 a	3E-10	Sr-89	8E-6	3E-6
24	Sr-90	3E-11 d 6E-12 a	3E-11	Sr-90	5E-7	3E-7
25	Sr-91	8E-9 d 5E-9 a	9E-9	Sr-91	2E-5	5E-5
26	Sr-92	1E-8 d 9E-8 a	1E-8	Sr-92	4E-5	6E-5
27	Y-90	9E10	3E-9	Y-90	7E-6	2E-5
28	Y-91m	3E-7 w 2E-7 a	6E-7	Y-91m	2E-3	3E-3
29	Y-92	1E-8	1E-8	Y-92	4E-5	6E-5
30	Zr-95	4E-10 d, a 5E-10 w	1E-9	Zr-95	2E-5	6E-5
31	Zr-97	3E-9 d 2E-9 w, a	3E-9	Zr-97	9E-6	2E-5
32	Nb-95	2E-9	3E-9	Nb-95	3E-5	1E-4
33	Nb-95m	4E-9 w 3E-9 a	1E-10	Nb-95m	3E-5	3E-6
34	Nb-97	1E-7	2E-7	Nb-97	3E-4	9E-4
35	Mo-99	4E-9 d 2E-9 a	7E-9	Mo-99	2E-5	4E-5
36	Tc-99m	2E-7 d 3E-7 w	5E-7	Tc-99m	1E-3	3E-3
37	Ru-103	2E-9 d 1E-9 w 9E-10 a	3E-9	Ru-103	3E-5	8E-5
38	Ru-106	1E-10 d 8e-11 w 2E-11 a	2E-10	Ru-106	3E-6	1E-5
39	Ag-110m	2E-10 d 3E-10 w 1E-10 a	3E-10	Ag-110m	6E-6	3E-5
40	Sn-113	2E-9 d 8E-10 w	2E-9	Sn-113	3E-5	9E-5

GAS AND LIQUID EFFLUENT CONCENTRATION LIMIT (ECl) VALUES						
	ISOTOPE	GAS ECL	GAS MPC	ISOTOPE	LIQUID ECL	LIQUID MPC
		(ECL)	(MPC)		(ECL)	(MPC)
41	Sn-117m	3E-9 d 2E-9 w	1E-10	Sn-117m	3E-5	3E-6
42	Sb-122	3E-9 d 2E-9 w	5E-9	Sb-122	1E-5	3E-5
43	Sb-124	1E-9 d 3E-10 w	7E-10	Sb-124	7E-6	2E-5
44	Sb-125	3E-9 d 7E-10 w	9E-10	Sb-125	3E-5	1E-4
45	Xe-131m	2E-6	4E-7	Xe-131m		2E-4
46	Xe-133	5E-7	3E-7	Xe-133		2E-4
47	Xe-133m	6E-7	3E-7	Xe-133m		2E-4
48	Xe-135	7E-8	1E-7	Xe135		2E-4
49	Xe-135m	4E-8	3E-8	Xe-135m		2E-4
50	Xe-138	2E-8	3E-8	Xe138		2E-4
51	Te-129m	9E-10 d 3E-10 w	1E-9	Te-129m	7E-6	2E-5
52	Te-132	1E-9 d 9E-10	4E-9	Te-132	9E-6	2E-5
53	I-131	2E-10	1E-10	I-131	1E-6	3E-7
54	I-132	2E-8	3E-9	I-132	1E-4	8E-6
55	I-133	1E-9	4E-10	I-133	7E-6	1E-6
56	I-134	6E-8	6E-9	I-134	4E-4	2E-5
57	I-135	6E-9	1E-9	I-135	3E-5	4E-6
58	Cs-134	2E-10	4E-10	Cs-134	9E-7	9E-6
59	Cs-136	9E-10	6E-9	Cs-136	6E-6	6E-5
60	Cs-137	2E-10	5E-10	Cs-137	1E-6	2E-5
61	Cs-138	8E-8	3E-8	Cs-138	4E-4	2E-4
62	Ba-139	4E-8	3E-8	Ba-139	2E-4	2E-4
63	Ba-140	2E-9	1E-9	Ba-140	8E-6	2E-5
64	La-140	2E-9	4E-9	La-140	9E-6	2E-5
65	Ce-141	1E-9 w 8E-10 a	5E-9	Ce-141	3E-5	9E-5

GAS AND LIQUID EFFLUENT CONCENTRATION LIMIT (ECl) VALUES						
	ISOTOPE	GAS ECL	GAS MPC	ISOTOPE	LIQUID ECL	LIQUID MPC
		(ECL)	(MPC)		(ECL)	(MPC)
66	Ce-143	3E-9 w 2E-9 a	7E-9	Ce-143	2E-5	4E-5
67	Ce-144	4E-11 w 2E-11 a	2E-10	Ce-144	3E-6	1E-5
68	Nd-147	1E-9	8E-9	Nd-147	2E-5	6E-5
69	W-187	1E-8	1E-8	W-187	3E-5	6E-5
70	Np-239	3E-9	2E-8	Np-239	2E-5	1E-4
71	ALPHA	1E-15	2E-14	ALPHA	2E-9	3E-8

June 14, 1993

J. CLARK
P. KNAPP

SUBJECT: Impact of new 10 CFR 20 upon SONGS Effluent Control Limits

INTRODUCTION

The New 10 CFR 20 is mandated to be implemented by all licensees by January 1, 1994. Unit 1 Technical Specification (T5) 6.B.4.f. (2) AND (7) and Units 2 and 3 TS 6.8.4.e. (2) and (7) require programs which set limits on concentrations of liquid and gaseous releases from the site according to 10 CFR 20 Appendix B, Table II. Questions have been asked of licensing regarding the effect of the new regulation upon SONGS Effluent Control Limits, and if it is necessary to revise the TS prior to implementation of the new rule.

EXECUTIVE SUMMARY

Licensing has reviewed the applicable TS and the new 10 CFR 20. As a result of the above, Licensing has concluded that SCE is not required to obtain amendments to the TS as a result of implementation of the revised Part 20. The new Part 20 permits the existing TS cited above to be amended at any time SCE deems appropriate.

The above conclusion is in agreement with the position presented to NRC Staff by NUMARC during a meeting earlier this month. Preliminary comments from the NRC staff indicate their concurrence. The NRC is expected to issue meeting minutes by mid-June, showing their concurrence.

LICENSING ISSUE

Revised Part 20 [20.1008) (b)] generally requires that the license condition and TS references to the old Part 20, Sections 20.1-20.601 should be considered to have been replaced by comparable references to the new Part 20, Sections 20.1001-20.2401. The revised Part 20 [20.1008(c)] requires that any TS that is more restrictive than a requirement in the revised Part 20 remains in force until there is a TS change through a license amendment.

The limit on annually averaged radioactivity concentrations in effluents to unrestricted areas, which is a requirement in the old Part 20 (20.106), has been changed to an optional method [20.1302(b)(2)(i)] of demonstrating compliance with the annual dose limit specified in 20.1301 and is no longer ITSELF a requirement in the revised Part 20.

SONGS TS require that effluent concentrations be maintained below the indicated level at all times. "At all times" is reasonably accepted as meaning that averaging beyond instrument response times is not permitted. The revised Part 20 contains NO comparable "at all times" concentration limit.

The SONGS TS, by not permitting any arbitrary averaging period, are therefore MORE RESTRICTIVE than the revised part 20 limits.

Accordingly, since the SONGS TS are more restrictive than the revised Part 20, the provision of 20.1008(c) applies, with the result that the TS remains in effect, as is, until it is revised, or the license is renewed. With this conclusion, SONGS may exercise any of the following options:

1. NOT request any TS changes, with the result that SONGS must still establish setpoints in accordance with 10 CFR 20, Appendix B, Table II.

2. Request an amendment to section 6.8.4 changing the reference to the "revised" Part 20, Appendix B, Table 2.

3. Request an amendment to the Tech Specs of units 2/3, and NOT of 1, or vice versa.

4. Upon approval by the NRC, implement any of the above Tech Spec changes irrespective of the implementation date of the revised 10 CFR 20.

This memo does not intend to say that any requirements of 10 CFR 20 and 40 CFR 190 are invalid, including those limits pertaining to dose to members of the public, and applicable survey methods to confirm conformance with those limits.

E. S. MEDLING

cc: W. Marsh
D. Dick
S. Hetterick
P. Chang
L. Bray
NLFS
CDM

SONGS REMP Bases

The Radiological Environmental Monitoring Program (REMP) at SONGS is based on the REMP program as originally established for Unit 1 and augmented for operation of Units 2 and 3. The program is largely consistent with current regulatory guidance provided by NUREG-1301. There are deviations from the guidance due to site-specific considerations such as land use and geographic characteristics around SONGS.

The SONGS REMP generally remains consistent with the program that existed during plant operation. As decommissioning has progressed, some changes have been implemented, generally decreasing the sample program to be closer to NUREG-1301 guidance, where appropriate.

Airborne Particulate Sample Location Bases:

Airborne particulate samples are required in ODCM Table 5-1:

> *Samples from at least 5 locations:*
>
> > *3 samples from close to the three site boundary locations (in different sectors) of the highest calculated annual average ground level D/Q.*
> >
> > *1 sample from the vicinity of a community having the highest calculated annual average ground-level D/Q.*
> >
> > *1 sample from a control location 15-30 km (10-20 miles) distant and in the least prevalent wind direction.*

Dispersion and deposition parameters have been updated in ODCM Appendix A Rev 16. It is necessary to evaluate the current REMP Air Particulate sample locations based on the ODCM requirement.

The Indicator requirement is for 3 samples in different sectors of the highest calculated annual average D/Q. Previous REMP bases (September 1997 Memorandum included in ODCM Appendix B Rev 10) have noted that the Indicator locations were located at the #2, #3, and #4 highest D/Q locations because the highest D/Q location in that data set was in the SSW sector, toward the Ocean.

The current offsite sector D/Qs at 0.5-miles and their ranking are provided in Table 1 and the D/Q values are depicted visually in Figure 1. A distance of 0.5 miles was chosen to be consistent with approximate distances to existing air sample locations and to provide equivalent comparison between relative ranking of the sectors.

Table 1: Deposition parameters (D/Q) at 0.5 mi from SONGS with Ranking.

Direction (from SONGS)	D/Q (per m², at 0.5 mi)	Rank
S	2.86E-08	12
SSW	1.51E-07	1
SW	3.41E-08	11
WSW	1.84E-08	15
W	1.60E-08	16
WNW	2.07E-08	14
NW	4.10E-08	9
NNW	4.40E-08	8
N	4.81E-08	6
NNE	4.62E-08	7
NE	5.09E-08	5
ENE	6.52E-08	4
E	8.68E-08	2
ESE	7.44E-08	3
SE	3.56E-08	10
SSE	2.15E-08	13

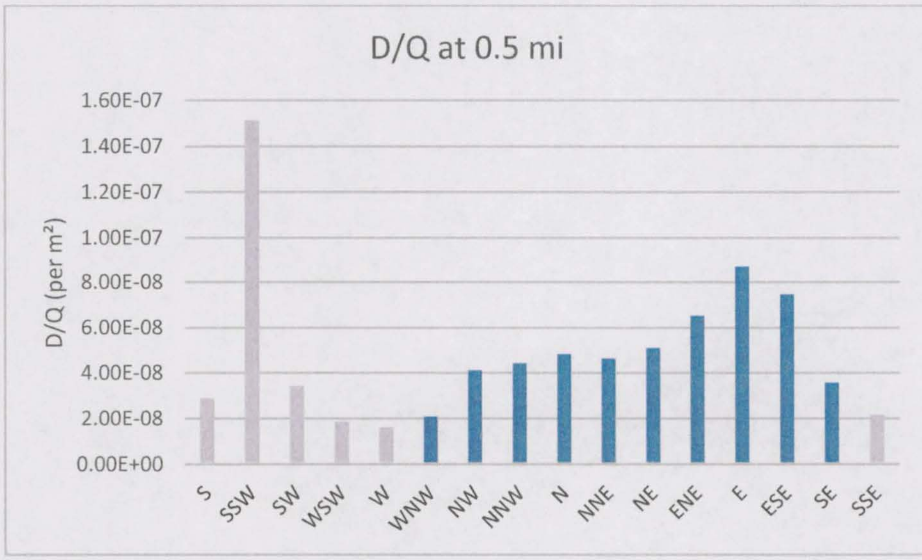

Figure 1: Chart of Deposition parameters for 0.5 mi from SONGS. (Landward sectors shown as dark blue and seaward sectors shown as light blue.)

Similar to the previous REMP bases, the highest D/Q sector is SSW. This is due to the frequent combination of stable atmospheric conditions with offshore wind. There is no significant airborne exposure pathway in the SSW sector, and it is not practical to monitor airborne particulates over the water. Therefore, only landward sectors are considered for monitoring.

The three highest ranked landward sectors in the current (2013-2017) dataset are E, ESE, and ENE (#2, #3, and #4, respectively). Current ODCM air sample locations are NW, E and ESE sectors (AS-12, -13, and -9, respectively). The NW sector was ranked 9th in the current data. However, it can be seen that there is very little difference between ranks five through nine in Figure 1.

An alternative air sample location has been established for the E sector. This new location (AS-21) is within, but as close as practical to, the Site Boundary. It has been established based on what appears to be a permanent loss of power to the AS-9 sample location. Because work is still in progress to reestablish power at AS-9, both locations are maintained. While offsite locations are ideal for REMP sampling, it is very difficult to establish power outside of the fence in the E Sector due to restriction for work within the State Park. Therefore, the only practical alternative is to establish a secure location with reliable electricity as close as practicable to the site boundary.

Basis for maintaining AS-12 as one of highest D/Q sector locations

Air Sampler 12 will be maintained as the 3rd highest D/Q location. The basis for this is that there is little difference between the deposition in the NW sector (currently monitored) vs. the ENE sector that would be indicated. There is significant uncertainty in modeling dispersion and deposition parameters. NCRP Report No. 76 indicates that "the variability of short-term, short-range Gaussian model predictions ranges from factors of approximately 3 to 10. This decreases to factors of 2 to 4 for averaged data." Then a factor of 2 can be assumed to be approximately the highest expected level of precision for calculated dispersion data. Deposition calculations include additional uncertainty due to deposition velocity estimates. The ratio of the 0.5-mile annual average D/Q for NW/ENE is 0.63 (4.10E-8 m^{-2}/6.52E-08 m^{-2}). Thus, when comparing the two sectors in question, there is no statistically significant difference in calculated deposition based on the uncertainty in the dispersion model used.

Further, AS-12 currently monitors nearby receptors in the NW sector at approximately 1.5 miles (D/Q 3.60E-9 m^{-2}). The nearest potential receptor in the ENE sector is Camp Horno located at approximately 3 miles from SONGS and in a valley behind a significant ridge (D/Q 1.09E-9 m^{-2}).

Finally, AS-12 has been used for long-term monitoring of SONGS, providing useful historical data trends. Changing the air sample location from AS-12 to a new location in the ENE sector would result in a discontinuity in data and loss of a baseline. Therefore, AS-12 will be maintained as the third-highest D/Q required air sample location in the SONGS REMP.

Basis for Maintaining AS-13 location

Air sampler 13 is located approximately 0.7 miles in the E sector. The updated Site Boundary for gaseous effluents ranges from about 0.14 mi to 0.25 mi from plant center in the E sector. Closer locations were evaluated for air samplers closer to the new site boundary. There is not a practical offsite location to place an air sampler in this or other sectors along the NE boundary. As can be seen in Figure 2, the new Site Boundary (blue line) is immediately adjacent to Basilone Rd., which is adjacent to the railroad track, which is adjacent to I-5. Then the closest practical offsite location in the E sector would be approximately 0.4-0.5 miles on Camp Pendleton property near Old El Camino Real.

In this case there would be little increased monitoring capability by moving the sampler in, while it would be less desirable for two reasons. Long-term data is available for AS-13 (similar to the consideration for AS-12). Also, the closer location would be much closer to the heavy traffic of I-5, which could substantially alter the baseline and affect particulate loading of samples. Therefore, AS-13 is being maintained as the required monitoring location for the E sector.

An alternate air sample location is being established within the site boundary to act as backup AS-13. This location (AS-20) allows for compensatory sampling if AS-13 is not available. Power availability issues have occurred recently on Camp Pendleton and have been difficult to get resolved quickly. AS-20 will act as a backup, with AS-13 remaining as the preferred location for the reasons specified above.

Figure 2: Aerial image showing locations of the three indicator particulate sample locations (AS-12, -13, and -9), and alternate locations (AS-20 and -21), and the site boundary.

Control Air Sample Location Basis

The Control Air Sample location is specified based on both distance and least prevalent wind direction. The data presented in Figure 3 is based on Wind Direction (from) and it is necessary to invert the directions to determine the least prevalent direction from the site. The six least frequent directions (from) are E, ENE, ESE, NNW, N, and NE are all in directions that do not include a landward location for a Control air sampler (W, WSW, WNW, SSE, S, and SE directions from the site, respectively. The lowest frequency direction toward a landward sector is wind from the NW (blowing to the SE) at 4.5% frequency. AS-16 is located in the SE sector at 16.7 miles, consistent with the distance and direction requirement.

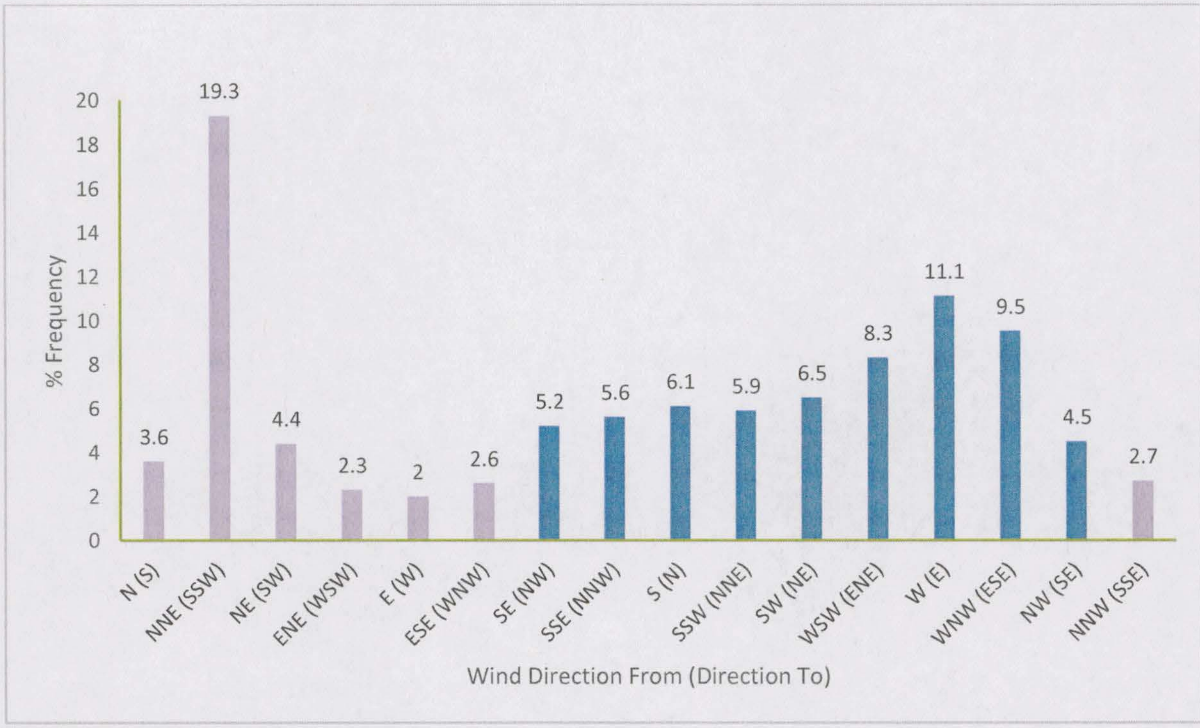

Figure 3: Wind direction frequency 2013-2017 dataset (downwind direction shown in parentheses).

ODCM-Required Air Particulate Sample Locations

Indicator location bases have been discussed above. The two remaining required locations are one sample in the vicinity of a community and one sample from a control location. The community location is being maintained as AS-1, located in San Clemente, approximately 5 miles from plant Center in the NW sector. The Control location is being maintained as AS-16 located near the San Luis Rey substation in Oceanside approximately 17 mi SE.

The REMP Air Sample locations are summarized in Table 2.

Table 2: Required REMP Air Sample Locations. Alternate sample location information in curly braces {}.

Number	Description	Location	Designation
AS-1	City of San Clemente (City Hall)	5.1 mi NW	Community
AS-9 {AS-21}	State Beach Park {ESE Site Boundary}	0.6 mi ESE {0.4 mi ESE}	Indicator
AS-12	Former SONGS Evaporation Pond	0.6 mi NW	Indicator
AS-13 {AS-20}	Marine Corps Base (Camp Pendleton East) {E Site Boundary}	0.7 mi E {0.2 mi ESE}	Indicator
AS-16	San Luis Rey Substation	16.7 mi SE	Control

Direct Radiation (TLD) Sample Location Bases

ODCM Table 5-1 requires:

> *At least 30 locations including an inner ring of stations in the general area of the site boundary and an outer ring approximately in the 4 to 5 mile range from the site with a station in each landward sector of each ring. The balance of the stations is in special interest areas such as population centers, nearby residences, schools, and along the State Beach walking path.*

The TLD locations are maintained consistent with previous REMP Bases, with few exceptions. Several TLD locations were removed from the ODCM in Revision 17. These changes were evaluated under SDS-CH2-EVA-0038, which was used to formulate the discussion below. The SONGS TLD monitoring requirement differs from NURGEG-1301 guidance due to approximately six sectors being located over the Pacific Ocean. Therefore, the requirement was implemented as a minimum of 30 stations, which is justified and provides an equivalent level of monitoring based on site configuration.

The site is using guidance from ANSI/HPS N13.37-2014 which is largely consistent with NUREG-1301 guidance. The guidance in both documents is based on an inner ring in the general area of the site boundary, an outer ring in the 6-8 km range and some special interest locations. TLDs located on Camp Pendleton can cause complications due to the terrain, location on active firing ranges, etc. SONGS does not have outer ring TLDs in six (6) of the 16 sectors due to the Pacific Ocean. Along the beach walking path TLDs are not located in each sector; this is due to proximity to the site, which is about 0.1 mile along the walking path.

TLD results can be significantly altered by relatively small changes in location due to varying levels of natural radioactivity in rocks and formations around the TLD. ANSI/HPS N13.37-2014 uses long-term background dose (termed Baseline Background Dose) values for determining facility-related dose. If stations are added, then evaluation of a large data set (5-10 years of quarterly data) is required to determine the baseline background dose rate for the location; in addition to the amount of background data needed, for TLDs located close to the facility, it is very difficult to determine a good long-term background dose due to potential contributions both from the environment and from the plant.

Therefore, even as the site boundary is reestablished to be closer to the site, the existing inner ring will be maintained for direct radiation monitoring because it will not be possible to just replace these locations with TLDs at the new site boundary. Monitoring is performed close to the site and even onsite. This is particularly the case for TLDs around the ISFSI, where the locations are often well within the site boundary, and it is expected that direct dose will be detected due to proximity to elevated dose rates from the ISFSI. These on-site locations are not, however, considered part of REMP. A generic background dose rate is estimated for these locations based on more distant TLDs; however, this necessarily increases uncertainty in the net dose calculation for any particular TLD.

As a note, TLD 50 remains in the program at Oceanside. This location would not be required based on the ANSI/HPS N13.37-2014 guidance and it does not represent a credible location for monitoring actual direct radiation dose from SONGS. The location was maintained due to being collocated with a CDPH TLD; it is prudent to maintain sampling at any location that the CDPH is monitoring for their program to corroborate measured doses. If the CDPH removes this location from their program, TLD 50 can be considered for removal.

The site deviates from the specified outer ring distances (6-8 km) in some sectors based on location-specific limitations. Due to the topography of the region, there are generally mountains (or at least very large hills) between SONGS and the specified outer ring locations for the TLDs on Camp Pendleton property. TLDs 2, 3, 4, 19, 35 and 36 are examples of this and in most cases this is unavoidable due to the topography, the location distances for the TLDs and accessibility of locations meeting the criteria. TLD 78 was also located in a valley behind a large ridge; rather than maintain TLD 78 (which did meet the outer ring distance criteria but was a poor monitoring location) TLD 6 is being used as the outer ring TLD in the ESE sector.

Basis for Maintaining Beach Walking Path Locations

The TLDs along the beach walking path were previously considered to be within the Site Boundary and therefore, not required. With the Site Boundary moved to the average high tide line, the beach path TLDs are now located near the Site Boundary. The boundary sectors along the beach walking path vary significantly in length, with the narrowest sectors being so close together that TLD placement in each sector becomes impractical and of low added value. Specifically, the closest site boundary distance is approximately 430' at the border of the SW-SSW sectors. This corresponds to a boundary length of approximately 178', or 62 meters. Current TLDs 56, 57, 58, and 15 are located near sector boundaries and a change to locate TLDs in each sector would result in changing the monitoring locations to fit closer to the centers of these short sectors. It also would place more TLDs in locations near the outfall/plant center where doses are likely to remain lower than near the ISFSI.

Instead, the TLD locations along the beach walking path are set up to monitor the ISFSI and plant in a complete manner (see Figure 4). TLD 55 (with a collocated neutron TLD) monitors as close as practicable to the ISFSI, providing a conservative estimate of dose to a Member of the Public on the beach. TLD 56 monitors the area near the edge of the ISFSI and plant boundaries. TLDs 57 and 58 monitor U2 and U3, respectively. TLD 15 monitors the SE-SSE corner of the Restricted area. This network of TLDs provides logical and complete monitoring of the Site Boundary along the seawall and long-term historical data trends that are critical for environmental dosimetry monitoring per ANSI/HPS N13.37-2014.

Figure 4: Near TLD locations.

TLD Classifications

Below are tables indicating the classification of each TLD currently listed in SO123-ODCM Table 5-4. The tables include the identity of collocated TLDs; these are classified for various purposes including CDPH duplicates, neutron monitoring, or QA duplicates. Following each table is discussion of exceptions and notes about the TLD classifications.

Table 3: Inner Ring TLD Locations.

TLD #	Description	Distance (miles)	Sector	Direction	Classification	Co-located TLDs
61	Mesa - East Boundary (Former PIC 4)	0.7	A	N	Inner Ring	
62	MCB - Camp Pendleton (Former PIC 5)	0.7	B	NNE	Inner Ring	
63	MCB - Camp Pendleton (Former PIC 6)	0.6	C	NE	Inner Ring	
64	MCB - Camp Pendleton (Former PIC 7)	0.6	D	ENE	Inner Ring	
65	MCB - Camp Pendleton (Former PIC 8)	0.7	E	E	Inner Ring	
66	San Onofre State Beach Park (Former PIC 9)	0.6	F	ESE	Inner Ring	Qtr. Dup (200)
46	San Onofre State Beach Park	1	G	SE	Inner Ring	
Sectors H-W (SSE-W) are seaward sectors and do not include Inner Ring TLDs.						
10	Bluff (Former PIC 1)	0.7	P	WNW	Inner Ring	CDPH #6
11	Former Visitors' Center	0.4	Q	NW	Inner Ring	Ann. Dup (201)
40	SONGS Garden - Mesa (Former PIC 3)	0.7	R	NNW	Inner Ring	

Inner ring locations in Table 3 were established in the vicinity of the Site Boundary based on the historical EAB. These inner ring locations have generally been maintained based on the need to maintain continuity with historical baseline data. TLD 11 was reclassified to be an Inner Ring location in ODCM rev 17 based on being closer to the plant than TLD 67 that was acting as the inner ring. TLD 41 is closer in the E sector than TLD 65; in this case, both have been maintained, to defer evaluation of which location to maintain as Inner Ring. TLD 46 is located 1.0 miles in the SE sector; this location is near a recreational area and is a long-term monitoring location that has historically been used as the inner ring TLD for this sector.

The Inner Ring includes only landward sectors (WNW-SE). TLDs along the State Beach walking path are considered Special Interest, rather than Inner Ring locations. This classification is consistent with guidance in ANSI/HPS N13.37-2014 Section 7.1 "Monitoring locations should be established based on a 16-sector radial grid ... where geography permits." In this case, the proximity of the site boundary and land area available makes it impractical to establish locations near the center of each radial sector. Further, relocating to the centers of sectors is inconsistent with the Section 7.1 guidance that "long-term integrity of each field monitoring location is vital to maintaining data quality."

Table 4: Outer Ring TLD Locations.

TLD #	Description	Distance (miles)	Sector	Direction	Classification	Co-located TLDs
2	Camp San Mateo (MCB, Camp Pendleton)	3.6	A	N	Outer Ring	CDPH #8
35	Range 312 (MCB, Camp Pendleton)	4.8	B	NNE	Outer Ring	
36	Range 208C (MCB, Camp Pendleton)	4.1	C	NE	Outer Ring	
68	Range 210C (MCB, Camp Pendleton)	4.4	D	ENE	Outer Ring	
4	Camp Horno (MCB, Camp Pendleton)	4.4	E	E	Outer Ring	
6	Old El Camino Real (AKA Old Route 101)	3	F	ESE	Outer Ring	CDPH #10
75	Gate 25 MCB	4.6	G	SE	Outer Ring	
Sectors H-W (SSE-W) are seaward sectors and do not include Inner Ring TLDs.						
22	Former U.S. Coast Guard Station – San Mateo Point	2.7	P	WNW	Outer Ring	CDPH #4
76	Former El Camino Real Mobil Station	4.6	Q	NW	Outer Ring	
19	San Clemente Highlands	4.9	R	NNW	Outer Ring	

Outer Ring TLD locations are established in a band of 6-8 km (about 4-5 mi) from plant center in landward sectors. There are exceptions to this location guidance, as described below. TLD 2 lies just inside of the 4 km line in the North sector and was formerly classified as the outer ring location for U1 but not U2/3; this location also monitors Camp San Mateo and is collocated with CDPH TLD #8 and is preferred over TLD 33 that was previously credited as the outer ring TLD for the N sector at 5.7 miles (outside of the outer ring distance band). TLD 6 is located at 3.0 miles (about 4.8 km) in the ESE sector; this location was preferable to TLD 78 that was located at 4.4 miles but was behind a large ridge from the plant. TLD 22 is located only 2.7 miles in the WNW sector; this location is the farthest practicable location in that sector based on the coastline contour.

Table 5: Special Interest TLD Locations.

TLD #	Description	Distance (miles)	Sector	Direction	Classification	Co-located TLDs
3	Camp San Onofre (MCB, Camp Pendleton)	2.8	C	NE	Special Interest	CDPH #9
12	South Edge of Switchyard	0.2	E	E	Onsite	
41	Old Route 101 - East	0.3	E	E	Special Interest	
16	East Southeast Site Boundary	0.4	F	ESE	Onsite	CDPH #7
73	South Yard Facility	0.4	F	ESE	Onsite	
50	Oceanside Fire Station (CONTROL)	15.6	G	SE	Control	CDPH #13
15	Southeast Site Boundary	0.1	H	SSE	Beach	
58	San Onofre State Beach (Unit 3)	0.1	J	S	Beach	
57	San Onofre State Beach (Unit 2)	0.1	L	SW	Beach	
56	San Onofre State Beach (Unit 1, West)	0.2	N	W	Beach	
55	San Onofre State Beach (Unit 1, West)	0.2	P	WNW	Beach	Neutron 7
8	Noncommissioned Officers' Beach Club	1.4	Q	NW	Special Interest	
34	San Onofre School (MCB, Camp Pendleton)	1.9	Q	NW	Special Interest	CDPH #5
1	City of San Clemente (Former SDG&E Offices)	5.7	Q	NW	Special Interest	CDPH #2

There are several types of 'Special Interest' locations. One classification is Beach TLDs, which are located along the State Beach walking path; these are located near the site boundary, but they are not considered to be part of the Inner Ring due to being very close to the site, which results in complications in siting based on the sector guidance. Three Onsite TLDs are included in the REMP; these locations provide conservative monitoring of dose rates near the site boundary but do not represent actual public doses without further evaluation and correction. One Control TLD is included based on collocation with CDPH TLD 13; there is no requirement to include Control dosimeter locations in current ANSI/HPS N13.37-2014 guidance (though 'Control' dosimeters are used in the standard to account for extraneous dose during transit). TLD 41 has been maintained as "Special Interest" because a decision has not been made whether this location will become an Inner Ring location in the future. The remaining Special Interest locations are maintained near populations of interest including schools, recreational, and residential areas.

Ocean Water Location Bases

Ocean water sample locations have been maintained consistent with previous bases. ODCM Table 5-1 requires samples from four locations. Locations monitored include one location near each Unit Outfall and one control at Newport Beach.

SONGS includes more surface water sample locations than the guidance in NUREG-1301 indicates. The NUREG indicates that "Salt water shall be sampled only when the receiving water is utilized for recreational activities." (Table 3.12-1 Note (5) SONGS is located on San Onofre State Beach which includes recreational surfing and swimming; therefore, monitoring is appropriate. Three sample locations have been maintained for continuity with previous samples and due to variability in near shore current flow. California State Lands Commission Lease No. PRC 6785.1 (referred to as Lease) requires maintenance of current ocean water sample requirements.

Shoreline Sediment Location Bases

Shoreline Sediment sample locations have been maintained consistent with previous bases. Three samples are taken in the vicinity of San Onofre with a fourth sample taken at an appropriate control location (Newport Beach). The indicator locations are located on San Onofre State Beach with one location slightly upcoast (~0.8 miles from Units 2/3 midpoint at the Surf Beach), and two downcoast (~0.6 miles from Units 2/3 midpoint) and (~3.5 miles from Units 2/3 midpoint). The Final Environmental Statement related to SONGS Units 2 and 3 (NUREG-0490) indicates that the near-shore currents near SONGS are highly complex and regularly switch between upcoast and downcoast directions, but with the downcoast direction typically being more predominant (Section 2.3.1). Thus, indicator samples are preferentially taken downcoast. The control is therefore appropriately taken upcoast at a sufficient distance (Newport Beach at ~29 miles).

NUREG-1301 indicates one sample from a downstream area with potential recreational value. Three sample locations have been maintained for shoreline sediment based on the high recreational value of San Onofre State Beach and based on variability in near-shore current flow. The Lease requires maintenance of current Shoreline Sediment sampling requirements.

Ocean Bottom Sediment Location Bases

Ocean Bottom Sediment sample locations have been maintained consistent with previous bases. Ocean bottom sediments are collected at four indicator locations and one control location. Two indicator locations are near the Unit 1 outfall and one each near Unit 2 and Unit 3 outfalls. The control location is at Laguna Beach which is about 18 miles upcoast and sufficiently distant to be unaffected by plant operation.

Ocean bottom sediment samples are not indicated in NUREG-1301. These samples were included in the original REMP because 'ocean bottom sediment could contribute to human exposure through marine plants and animals' (from previous REMP bases in ODCM Appendix B dated 9/10/1997). The Lease requires maintenance of current Ocean Bottom Sediment sampling requirements.

Marine Animal Location Bases

Non-migratory Marine Animal sample locations have been maintained consistent with previous bases. Nonmigratory marine animals are collected at two indicator locations and one control location. The indicator locations are near the Unit 1 outfall and the vicinity of the Units 2 and 3 outfalls. The control location is at Laguna Beach, which is about 18 miles upcoast and sufficiently distant to be unaffected by plant operation. Nonmigratory marine animals provide a potential pathway for human exposure through ingestion.

The types of animals collected are specified in the ODCM (Fish, Crustacea, and Mollusks) and depend on the species available. The actual sample locations include flexibility to ensure the ability to find the appropriate samples during the defined sampling period.

NUREG-1301 guidance is for one sample of each commercially and recreationally important species in the vicinity of the plant discharge area. SONGS includes two adult fish, one crustacean, and one mollusk samples from two indicator locations. This is consistent with monitoring the relatively abundant sea life in the area. It has been noted in recent sample events that lobster have been difficult to obtain. The Lease requires maintenance of current marine animal sample requirements.

Local Crop Location Bases

Representative vegetables, normally one leafy and one fleshy are collected at harvest time at two locations (one indicator and one control). The control has typically been a farm in the Vista/Oceanside area, over 20 miles distant in the downcoast direction. The indicator garden is the SONGS Garden located 0.7 mi NNW on the former SONGS MESA property. This indicator location represents the closest possible garden location for any sector around SONGS and conservatively monitors potential deposition of gaseous particulate releases.

SONGS deviates from NUREG-1301 guidance for sampling milk, broadleaf vegetation and crops due to local land uses. Land use near SONGS severely restricts availability of agricultural products within five miles of the plant; land use is either State Park, Camp Pendleton, or San Clemente city residential. It is not practical for residents to have large gardens in most areas within 5-miles of SONGS and there are generally no agricultural animals. Therefore, only one indicator crop sample location maintained by SONGS is available.

Non-ODCM Samples

Some sample types are obtained as part of the REMP, but not included as ODCM-required samples.

Kelp samples are obtained and analyzed for gamma-emitting nuclides. Kelp samples are not included in NUREG-1301. The sample requirement is maintained in REMP, but not required by the ODCM. Kelp is frequently unavailable due to declining abundance in local kelp beds. The Lease requires Kelp sampling.

NUREG-1301 specifies Groundwater samples from 'one or two sources, only if likely to be affected.' Groundwater samples are not obtained under the REMP because there are no beneficial uses of groundwater downgradient of SONGS. Onsite shallow groundwater is monitored per the Groundwater Protection Program.

SOUTHERN CALIFORNIA EDISON

San Onofre Nuclear Generating Station Carbon-14 Production, Release and Offsite Dose Calculation Methodology

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Reviewed by: Kathy Yhip — 6/18/2012 (Date)

Approved by: James Darnlow — 6-18-2012 (Date)

This paper documents the methodology to estimate carbon-14 (C-14) production and C-14 gaseous waste effluent source terms at San Onofre Nuclear Generating Station (SONGS). The C-14 effluent source terms are used to estimate radiological doses from C-14 in site gaseous waste effluents. These estimates were generated in order to meet NRC requirements to incorporate C-14 in nuclear power plant 2010 Annual Radioactive Effluent Release Reports (ARERRs). The C-14 production and effluent source term estimates were based on EPRI methodology provided in EPRI Report 1021106, "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents," December 2010. This document is applicable for estimating C-14 gaseous release activity and dose components for inclusion in future site ARERRs.

1.0 Scope

This paper documents the methodology for estimating carbon-14 (C-14) production and C-14 gaseous waste effluent source terms at SONGS Unit 2 and Unit 3. C-14 effluent source terms are used to estimate radiological doses from C-14 in site gaseous waste effluents. These estimates are generated in order to meet NRC requirements to incorporate C-14 in nuclear power plant 2010 Annual Radioactive Effluent Release Reports (ARERRs). The C-14 production and effluent source term estimates are based on EPRI methodology provided in EPRI Report 1021106, Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents, December 2010. This paper is applicable for estimating C-14 gaseous release activity and dose components for inclusion in future SONGS ARERRs.

2.0 Background - NRC Updated Guidance on Reporting Routine Releases

NRC regulations establish limits for radionuclides that potentially could be released from a nuclear power plant. There are a limited number of radionuclides that are released in sufficient quantities and concentrations at any site to warrant reporting to the agency. Under guidance issued by the NRC in 1974, nuclear power plants treated all radionuclides as "principal radionuclides" and performed sensitivity analysis to determine the radionuclides that had to be included in their annual reports.

In June 2009, the NRC provided revised guidance in Regulatory Guide 1.21, Measuring, Evaluating and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, (RG 1.21) Revision 2, establishing a risk-informed approach for identifying principal radionuclides. SCE is not committed to implementation of Revision 2 of RG 1.21; SCE is committed to RG 1.21 Revision 1. However, there is new guidance in Revision 2 on the reporting of C-14 releases that is informative and useful in the preparation of the Annual Radioactive Effluent Release Report.

In Section 1.8 of Revision 2 of this document, the NRC revised guidance states, "if adopting a risk-informed perspective, a radionuclide is considered a principal radionuclide if it contributes either (1) greater than 1% of quarterly or yearly dose limits or (2) greater than 1% of the activity of all radionuclides in the type of effluent being considered."

In Section 1.9 of Revision 2t, the NRC states, "Radioactive effluents from commercial nuclear power plants...have decreased to the point that carbon-14 is likely to be a principal radionuclide...in gaseous effluents." In other words, while releases of carbon-14 have not increased, licensees' actions to reduce the quantity of radioactive effluents have been sufficiently successful that the decline in releases of other radionuclides now makes carbon-14 a more significant contributor in relative terms.

The same section goes on to state, "Carbon-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system ...Because the dose contribution of carbon-14 in liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of carbon-14 in liquid radioactive waste is not required." {emphasis added}

Section 1.9 of this report also specifies that, "The quantity of carbon-14 discharged can be estimated by sample measurements or by use of a normalized carbon-14 source term and scaling factors based on power generation..., or estimated by use of the GALE code from NUREG-0017." {emphasis added}

The NRC has clarified to EPRI and NEI that C-14 production estimates may be made using EPRI methodology (provided in EPRI Report 1021106). The EPRI methodology was developed because the GALE code from NUREG-0017 has no provision for C-14 production or release as a function of reactor power. The EPRI methodology estimates full power C-14 production rates for BWRs and PWRs using (1) either two or three unit specific core neutron flux energy groups, (2) "effective" neutron cross sections for the neutron energy groups, and (3) unit specific coolant mass exposed to the core neutron flux. The EPRI report also summarizes distribution of C-14 source terms for gaseous, liquid and solid releases in BWRs and PWRs based on C-14 measurements cited in literature.

3.0 EPRI Methodology for Estimating C-14 Production Rate in PWRs

Equation 1 is used to calculate the maximum annual production rate of C-14, PR_{MAX}, in curies for each unit (operating at full power (FP) for one year) via the $^{17}O(n,\alpha)^{14}C$ and $^{14}N(n,p)^{14}C$ reactions.

$$PR_{MAX} = \frac{N \bullet [\sigma_{th}\bullet\varphi_{th} + \sigma_i\bullet\varphi_i + \sigma_f\bullet\varphi_f] \bullet 1.0E\text{-}24 \bullet \lambda \bullet M \bullet 3.1536E{+}7}{3.7E{+}10}\text{, Ci/yr} \qquad [Eq\ 1]$$

where:

N	=	1.27E+22 atoms ^{17}O/kg H_2O or 4.284E+19 atoms ^{14}N/kg-ppm N
σ_{th}	=	"effective" thermal neutron cross-section (Table 2),
φ_{th}	=	"core average" thermal neutron flux at FP (Table 3), n/cm^2-s
σ_i	=	"effective" intermediate neutron cross-section (Table 2),
φ_i	=	"core average" intermediate neutron flux at FP (Table 3), n/cm^2-sec
σ_f	=	"effective" fast neutron cross-section (Table 2),
φ_f	=	"core average" fast neutron flux at FP (Table 3), n/cm^2-sec
1.0E-24	=	conversion factor, 1.0E-24 cm^2/barn
λ	=	C-14 decay constant, 3.833E-12/sec
M	=	total "active coolant mass" exposed to neutron flux, kg
3.1536E+7	=	conversion factor, 3.1536E+7 sec/yr (365 days/yr).
3.7E+10	=	conversion factor, 3.7E+10 disintegrations/sec-Ci

Table 1. SONGS Active Coolant Mass(a) and 100% Full Power Values

	Active Coolant Volume(a)	Active Coolant Mass(c)	Thermal Power
Unit 2	784 ft^3 (b)	15881.5 kg	3438 MWt
Unit 3	784 ft^3 (b)	15881.5 kg	3438 MWt

(a) Active coolant volume is the portion of reactor coolant exposed to the core neutron flux.
(b) Active coolant volume from N-0220-030 ECN A54033
(c) Active coolant mass = Active coolant volume (ft^3) x density correction at 100% power (20.257 kg/ft^3)

Table 2. "Effective" Neutron Cross-Sections for C-14 Production in PWRs(a)

Unit	Cross-Section(b)	$^{17}O(n,\alpha)^{14}C$ Reaction	$^{14}N(n,p)^{14}C$ Reaction
2 and 3	Thermal	0.121 barns	0.951 barns
	Intermediate	0.0291 barns	0.0379 barns
	Fast	0.1124 barns	0.0436 barns

(a) Values from EPRI Report 1021106 based on EPRI methodology.
(b) Thermal ≤0.625 eV, Intermediate >0.625 eV and < 1 Mev, Fast > 1 Mev

Table 3. "Core Average" Neutron Flux Values

Unit Cycle	Neutron Flux(a)	BOC n/cm^{2}s	MOC n/cm^{2}s	EOC n/cm^{2}s	Average n/cm^{2}s
U2 C17	FP thermal flux	3.482E+13	3.684E+13	4.355E+13	3.840E+13
	FP intermediate flux(b)	2.040E+14	2.094E+14	2.129E+14	2.088E+14
	FP fast flux(c)	7.356E+13	7.550E+13	7.677E+13	7.528E+13
U3 C17	FP thermal flux	3.428E+13	3.645E+13	4.369E+13	3.814E+13
	FP intermediate flux(b)	1.985E+14	2.064E+14	2.099E+14	2.049E+14
	FP fast flux (c)	7.155E+13	7.441E+13	7.568E+13	7.388E+13

(a) Full Power (FP) flux values from Plant Data Tables (M-38097, Unit 2 and M-38097, Unit 3) - Two neutron flux energy groups are listed: thermal (≤0.625 eV) and intermediate + fast (>0.625 eV).
(b) Intermediate = intermediate + fast (I+F) x 0.75
(c) Fast = (I+F) x 0.25

3.1 RCS Nitrogen Calculation

During power operation, coolant ammonia concentrations average between 0.6 and 1 ppm. Equation 2 estimates the C-14 production via the $^{14}N(n,p)^{14}C$ reaction using the yearly average ammonia concentration.

RCS N, ppm = (ppm ammonia) • (14 g N / 17 g NH_3) *[Eq 2]*

3.2 RCS/VCT Nitrogen Calculation

During power operation, coolant nitrogen concentrations are estimated from Volume Control Tank (VCT) overpressure. Equation 3 estimates the C-14 production via the $^{14}N(n,p)^{14}C$ reaction using the yearly average VCT pressure, temperature and percent N^2.

RCS N, ppm = (VCT N_2,mole fraction) • (28.01g N_2/mole) • (1E6 mg/kg) / (18.02 g H_2O/mole) *[Eq 3]*

where:

VCT N_2, mole fraction = (VCT N_2, atm) / [Henry's Constant (N_2), atm- mole N_2 / mole H_2O]

Henry's Constant, N_2 = [-3.6024 • (VCT Temp, deg F)^2 + 1284.6 • VCT Temp, deg F + 9290.5] atm – mole N_2 / mole H_2O

(VCT N_2, atm) = [(VCT N_2, %)/100) • (VCT pressure, psig +14.7) / 14.7

3.3 Calculation Results for Estimating C-14 Production Rates

Using the EPRI methodology described above in equation 1, the annual C-14 production rates in each of the unit are calculated. The results are reported in the ARERR.

For each unit, the cycle-averages of the maximum annual C-14 production rate are used for estimating gaseous pathway C-14 activity releases and dose contributions in the ARERR

The maximum annual C-14 production rate values are calculated using a PWR spreadsheet developed for EPRI by NWT Corporation for utility information purposes.

4.0 Estimating C-14 Gaseous Releases

For PWRs, EPRI Report 1021106 summarized the distribution of C-14 in release pathways as follows: gaseous 90% to 98%, liquid <1% and solid 2% to 10%. The report also states that 5% to 30% of C-14 in PWR gaseous waste effluents exists in the carbon dioxide form, which contributes to population dose via photosynthesis uptake in the food consumption cycle. EPRI Report 105715, Characterization of Carbon-14 Generated by the Nuclear Power Industry, November 1995, cited that the carbon dioxide form of C-14 averaged 20% in effluents from eight US and German PWRs.

For SONGS, C-14 gaseous dose calculations in the ARERRs are made using the following assumptions for each unit: (1) continuous release of the estimated C-14 generated during power operation based the number of effective full power days (EFPDs) for the period, (2) maximum C-14 activity literature values for gaseous releases cited in EPRI Report 11021106 (98%), and (3) average fraction of C-14 as carbon dioxide for gaseous releases referenced in EPRI Report 105715 (20%).

4.1 Equation 4 estimates the C-14 activity released, $A_{C\text{-}14}$, into the gaseous pathway during the time period for each unit.

$$A_{C\text{-}14} = PR_{MAX} \bullet 0.98 \bullet EFPD \,/\, \text{time period, days} \qquad \text{[Eq 4]}$$

where:

PR_{MAX}	=	maximum annual production rate of C-14, *Ci/yr*
0.98	=	fraction C-14 in PWR gaseous pathway releases (maximum literature value in EPRI Report 1021106,
EFPD	=	number of effective full power days for the unit during the time period, e.g. quarterly or yearly, days
Time period	=	number of days during the time period, e.g. quarterly or yearly, days

4.2 Equation 5 estimates the C-14 activity released in carbon dioxide form, $A_{C\text{-}14,\,CO2}$, into the gaseous pathway during the time period for each unit.

$$A_{C\text{-}14,\,CO2} = A_{C\text{-}14} \bullet 0.20, \text{ Ci (for time period)} \qquad \text{[Eq 5]}$$

where:

$A_{C\text{-}14}$	=	C-14 activity released into the gaseous pathway during the time period for each unit, *Ci/yr*
0.20	=	fraction of C-14 as carbon dioxide in PWR gaseous pathway releases (average value in EPRI Report 105715)

5.0 C-14 Gaseous Releases Dose Calculations

5.1 C-14 Inhalation Dose Calculation (Reg. Guide 1.109 Eq. C-3)

$C^{i}_{14}(r,\theta) = 3.17 \times 10^{4} \bullet Qi_{C\text{-}14} \bullet [X/Q](r,\theta)$

where:

$C^{i}_{14}(r,\theta)$	=	annual average ground-level concentration of C-14 in air at location (r,θ), pCi/m^3
$Qi_{C\text{-}14}$	=	release rate of C-14, Ci/yr, (*$A_{C\text{-}14}$, from Eq. 4)*
$[X/Q](r,\theta)$	=	average atmosphere dispersion factor at location (r,θ), sec/m^3 (using concurrent meteorology from RETDAS program), this value is not decayed or depleted since C-14 is released as organic (CH_3, etc) or inorganic (CO_2) and isotope C-14 half-life is greater than 5000 years

5.2 C-14 Food Pathway Dose Calculations

- Per the 2011 Land Use Census, the Milk pathway does not currently exist at SONGS

5.2.1 <u>C-14 Concentration in Vegetation</u> (Reg. Guide 1.109 Eq. C-8)

The concentration of C-14 in vegetation is calculated by assuming that its ratio to the natural carbon in vegetation is the same as the ratio of C-14 to natural carbon in the atmosphere surrounding the vegetation. (Reg Guide 1.109 Eq. C-8)

$C^{v}_{14}(r,\theta) = 3.17 \times 10^{7} \bullet p \bullet Q_{14} \bullet [X/Q](r,\theta) \bullet 0.11 / 0.16$

where:

$C^{v}_{14}(r,\theta)$	=	the concentration of C-14 in vegetation grown at location (r,θ), pCi/kg
p	=	1, fractional equilibrium ratio, (continuous release)
Q_{14}	=	annual release rate of C-14 as CO_2, Ci/yr (*$A_{C\text{-}14,\ CO2}$ from Eq. 5)*
$[X/Q](r,\theta)$	=	average atmosphere dispersion factor at location (r,θ), sec/m^3 (using concurrent meteorology from RETDAS program)
0.11	=	fraction of the total plant mass that is natural carbon
0.16	=	concentration of natural carbon in the atmosphere, g/m^3
3.17×10^{7}	=	1E+12 pCi/Ci • 1E+3 g/kg / 3.15E+7 sec/yr

5.2.2 <u>C-14 Concentration in Milk</u> (Reg. Guide 1.109 Eq. C-10)

$C^{m}_{14}(r,\theta) = F_m \bullet C^{v}_{14}(r,\theta) \bullet Q_f \bullet \exp\text{-}\lambda_i t_f$

where:

$C^{m}_{14}(r,\theta)$	=	the concentration of C-14 in milk at location (r,θ), pCi/liter
$C^{v}_{14}(r,\theta)$	=	the concentration of C-14 in animal feed, for C-14 this is the concentration of C-14 in vegetation grown at location (r,θ), pCi/kg
F_m	=	average fraction of daily intake of C-14 which appears in milk, Reg. Guide 1.109 Table E-1, (carbon = 1.2E-2)
Q_f	=	amount of feed consumed by animal per day, Reg. Guide 1.109 Table E-3, (cow = 50 kg/day)
$\exp\text{-}\lambda_i t_f$	=	1, due to C-14 half-life greater than 5000 years

5.2.3 C-14 Concentration in Meat (Reg. Guide 1.109 Eq. C-12)

$C^F_{14}(r,\theta) = F_f \bullet C^v_{14}(r,\theta) \bullet Q_f \bullet exp\text{-}\lambda_i t_f$

where:

$C^m_{14}(r,\theta)$	=	the concentration of C-14 in animal flesh at location (r,θ), pCi/kg
$C^v_{14}(r,\theta)$	=	the concentration of C-14 in animal feed, for C-14 this is the concentration of C-14 in vegetation grown at location (r,θ), pCi/kg
F_m	=	average fraction of daily intake of C-14 which appears in each, kilogram of flesh, Reg. Guide 1.109 Table E-1 (carbon = 3.1E-2)
Q_f	=	amount of feed consumed by animal per day, Reg. Guide 1.109 Table E-3 (cow = 50 kg/day)
$exp\text{-}\lambda_i t_f$	=	1, due to C-14 half-life greater than 5000 years

5.2.4 Annual C-14 Dose by Food Exposure Pathway (Reg. Guide 1.109 Eq. C-13)

Leafy Vegetables = $DFI_{C\text{-}14ja} \bullet U^v_a \bullet f_g \bullet C^v_{14}(r,\theta)$

Milk = $DFI_{C\text{-}14ja} \bullet U^m_a \bullet C^m_{14}(r,\theta)$

Meat = $DFI_{C\text{-}14ja} \bullet U^F_a \bullet C^F_{14}(r,\theta)$

Non-Leafy Vegetables = $DFI_{C\text{-}14ja} \bullet U^L_a \bullet f_l \bullet C^v_{14}(r,\theta)$

where:

$DFI_{C\text{-}14ja}$ = C-14 dose conversion factor for organ (j) and age group (a) Reg. Guide 1.109 Tables E-11 through E-14

where the following are from Reg. Guide 1.109 Table E-15:

U^v_a	=	ingestion rate of non-leafy vegetables by age group (a), kg/yr
f_g	=	0.76, fraction of non-leafy vegetables ingested grown in garden
U^m_a	=	ingestion rate of milk by age group (a), liters/yr
U^F_a	=	ingestion rate of meat by age group (a), kg/yr
U^L_a	=	ingestion rate of leafy vegetables by age group (a), kg/yr
f_l	=	1.0, fraction of leafy vegetables ingested grown in garden

5.2.5 C-14 Total Dose

The C-14 total dose in mrem at receptor (r,θ) is the sum of the exposure pathways which exist at that location per the Land Use Census. The highest receptor annual dose, age group, critical organ, sector and exposure pathway are reported in the ARERR.

6.0 References

6.1 Regulatory Guide 1.21, Measuring, Evaluating and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste, Revision 2

6.2 Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I, Revision 1

6.3 EPRI Report 1024827, Carbon-14 Dose Calculation Methods at Nuclear Power Plants, April 2012

6.4 EPRI Report 1021106, Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents, December 2010

6.5 EPRI Report 105715, Characterization of Carbon-14 Generated by the Nuclear Power Industry, November 1995

6.6 N-0220-030 Rev. 0 ECN A54033, SONGS Units 2 and 3 Transient Analysis Model (TAM): Reactor Coolant System Volumes

6.7 M-38097 Rev. 39, Plant Physics Data Book Unit 2 Cycle 17

6.8 M-38098 Rev. 29, Plant Physics Data Book Unit 3 Cycle 16

6.9 Radiological and Dose Assessment Software (RETDAS), Version 3.6, Canberra Industries, Inc.

February 2001

SUBJECT: Offsite Dose Calculation Manual Changes
Safety Evaluation for Modifying References to 10 CFR 50.59

INTRODUCTION

In 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," Section 50.59, "Changes, Tests and Experiments," contains requirements for the process by which licensees may make changes to their facilities and procedures as described in the safety analysis report, without prior NRC approval, under certain conditions. The rule was promulgated in 1962 and revised in 1968.

A proposed new rule was published for comment in October 1998. Following consideration of public comments, on October 4, 1999 the NRC issued a final revision to 10 CFR 50.59 that will become effective March 12, 2001. The new program is scheduled for implementation at San Onofre on July 31, 2001.

DISCUSSION

Following publication of the revised rule, the Nuclear Energy Institute (NEI) submitted a guidance document for the implementation of 10 CFR 50.59 and requested NRC endorsement through a regulatory guide. Subsequently, NEI submitted document NEI 96-07 for endorsement.

According to Regulatory Guide 1.187, Revision 1 of NEI 96-07, "Guidelines for 10 CFR 50.59 Evaluations," dated November 2000, provides methods that are acceptable to the NRC staff for complying with the provisions of 10 CFR 50.59.

The new 10 CFR 50.59 (c) (4) states: The provisions in this section do not apply to changes to the facility or procedures when the applicable regulations establish more specific criteria for accomplishing such changes. NEI 96-07 clarifies that statement to include 'Offsite Dose Calculation Manual changes controlled by technical specifications'. San Onofre Licensee Controlled Specification 5.5.2.1.1 provides the specific criteria for accomplishing ODCM changes.

5.5.2.1.1 Licensee-initiated changes to the ODCM:

a. Shall be documented and records of reviews performed shall be retained. This documentation shall contain:
   1. Sufficient information to support the change(s) together with the appropriate analyses or evaluations justifying the change(s);
   2. A determination that the change(s) maintain the levels of radioactive effluent control required by 10 CFR 20.106, 40 CFR 190, 10 CFR 50.36a, and 10 CFR 50, Appendix I, and not adversely impact the accuracy or reliability of effluent, dose, or setpoint calculations.
   3. Documentation of the fact that the change has been reviewed and found acceptable.

b. Shall become effective upon review and approval by the Vice President-Nuclear Generation or his designee.
c. Shall be submitted to the NRC in the form of a complete, legible copy of the entire ODCM as a part of or concurrent with the Radioactive Effluent Release Report for the period of the report in which any change in the ODCM was made. Each change shall be identified by markings in the margin of the affected pages, clearly indicating the area of the page that was changed, and shall indicate the date (i.e. •• month and year) the change was implemented.

February 2001

SUBJECT: Offsite Dose Calculation Manual Changes
Safety Evaluation for Modifying References to 10 CFR 50.59

To reflect the changes in the regulatory guidance, ODCM section 6.3.1.1.a will be changed as follows:

from:
"A summary of the evaluation that led to the determination that the change could be made in accordance **with 10 CFR 50.59**";

to:
"A summary of the evaluation that led to the determination that the change could be made in accordance **with applicable regulations**".

As part of the implementation of the revised 10 CFR 50.59, a separate procedure is being implemented for effluent evaluations. Included in the procedure will be a checklist of related regulations, regulatory guidance, and licensing basis documents to ensure a comprehensive review. The effluent evaluations will be performed by qualified personnel for changes to the ODCM as well as design changes. Other regulatory guidance documents (e.g. NRC Information Bulletin 80-10, NRC Information Circular 80-18, NRC Generic Letter 81-38) also refer to performing a 10 CFR 50.59 evaluation for situations that could affect the control of radioactive effluents. Wherever the regulatory guidance refers to a 10 CFR 50.59 evaluation that addresses the potential for creating or modifying the control of radioactive effluents, an effluent evaluation using the new procedure will be performed instead.

CONCLUSION
The purpose of the ODCM is to ensure compliance with regulations regarding dose and curies released, setpoint calculations, sampling and monitoring of effluent pathways, and control and maintenance of radiation monitors. This new method of change evaluation more directly addresses these issues through a set of review questions developed as a method for evaluating changes to the ODCM. These questions will replace the 50.59 evaluation and will be used to assess the effects related to ODCM changes.

Effluent evaluations will be performed by qualified personnel in accordance with a site procedure to ensure compliance with all applicable regulations and regulatory guidance. As such, there will be no increase in radioactive effluents released to the environment and no increase in dose to a member of the public.

February 2001

SUBJECT: Offsite Dose Calculation Manual Changes
Safety Evaluation for Modifying References to 10 CFR 50.59

1. May the proposed activity increase the probability of occurrence of an accident evaluated previously in the safety analysis report?

No.

The Licensee Controlled Specifications provide the guidance necessary to ensure that ODCM changes reflect the requirements of the specific controlling regulations. The ODCM has no effect on the probability of accidents and therefore this change will not increase the probability of occurrence of any previously evaluated accident.

2. May the proposed activity increase the consequences of an accident evaluated previously in the safety analysis report?

No.

The proposed change is an administrative change that does not affect operation of equipment or the facility. It does not influence any credible accident at Units 2/3 - a release due to leakage or failure of a radioactive waste system (section 15.7.3.2); and the postulated failure of a liquid tank (section 15.7.3.3). As such, this activity cannot increase the consequences of an accident previously evaluated in the UFSAR.

3. May the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the safety analysis report?

No.

The ODCM has no effect on the operability of any equipment. It provides guidance for determining whether some equipment important to safety is operable and in some cases provides compensatory action to mitigate for inoperable equipment used to collect, transfer, treat, or discharge radioactive effluents. Therefore this change has will not increase the probability of occurrence of a malfunction of equipment important to safety.

4. May the proposed activity increase the consequences of a malfunction of equipment important to safety evaluated previously in the safety analysis report?

No.

The ODCM does not alter operation of important to safety equipment nor does it change the frequency of operation of the equipment, it cannot increase the consequence of a malfunction of equipment important to safety evaluated previously in the safety analysis report.

5. May the proposed activity create the possibility of an accident of a different type than any evaluated previously in the safety analysis report?

No.

Operation of plant equipment is not modified by this activity and therefore cannot create the possibility of an accident of a different type than any evaluated previously in the safety analysis report.

**SUBJECT: Offsite Dose Calculation Manual Changes
Safety Evaluation for Modifying References to 10 CFR 50.59**

6. May the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than any evaluated previously in the safety analysis report?

No.

The ODCM does not alter operation of important to safety equipment nor does it change the frequency of operation of the equipment. The proposed change creates a set of screening questions that ensure that ODCM and design changes are reviewed for their effect related to applicable regulations and controlling documents. These questions require review of specific regulations, licenses, and safety analysis reports. Changes to the new method will not create the possibility of a malfunction of equipment important to safety of a different type than any evaluated previously.

7. Does the proposed activity reduce the margin of safety as defined in the basis for technical specification?

No.

The Licensee Controlled Specification currently requires and will continue to require (1) justification for ODCM changes, (2) no adverse impact to effluent controls, and (3) documentation of adequate review for acceptability. Currently, changes to the ODCM are evaluated using the 10 CFR 50.59 process.

The current process ensures that the ODCM provides adequate instruction to ensure that the requirements of applicable regulations are fulfilled. The proposed process will specifically callout each regulation against which changes to the ODCM are to be evaluated. Evaluating ODCM changes against these criteria has been, and will continue to be, the standard. The new method simply will ensure that all applicable requirements are considered. Chemistry procedures changes and review question development are in progress that will ensure the Technical Specification requirements are met and that there is no reduction in the margin of safety. There will be no resultant dose to a member of the public and no reduction in the margin of safety for any licensing specification or in the control of radioactive effluents as required by 10 CFR 20 and 10 CFR 50.

Title: Site Boundary Sample Garden Relocation.

Activity/Document Number/NN: 203063159-084

Brief description of activity: The garden relocation is needed to accommodate changes in the owner controlled area, and the need to provide irrigation for sample viability in drought conditions. The new location remains in the same downwind sector (highest D/Q sector) as the current garden location (Sample collection performed in lieu of milk sampling due to the absence of dairy farms within 30 miles of the station). This new location is in the same sector as the current garden (location #6), but in the middle of sector R (NNW) vs. near the border with sector A (N). However, dispersion modelling assumes a sector average value across the width of the sector at a given distance thereby averaging out small differences in the compass direction within a primary wind sector. The new location is also further out (0.7 miles from the center point between the Unit 2 and Unit 3 vent release points vs 0.4 miles from the current site boundary garden which is necessary to accommodate changes in the owner controlled area). The additional distance does not change this garden as the controlling location for most radionuclides. This new location is adjacent to air sampling station #11 and will be designated location 6'; a location with functional irrigation. This will ensure adequate samples during harvest; a challenge during the 6 year drought with the current garden location 6. This location is also located on SONGS controlled property enclosed with a chain link fence. With the decommissioning and deconstruction of SONGS structures on the MESA, the current garden is no longer on property controlled by SONGS; it is on property returned to the Department of the Navy. The ODCM will note the date of the location switch, and it will be mentioned in the annual AREOR so that any trend shifts/changes in analytical results not otherwise accounted for may be attributed to the increased distance from the plant.

New SONGS Garden Location, 6', at AP sample location 11.

Performed by Qualified Screener: David A. Montt Date: 01/15/2015
Independent Reviewer: Mark Strum Date: 01/19/2015
Approved by Supervisor, Effluent Engineering (or designee)
Carla Cook Date: 07/15/2015

November 4, 2014

B. D. METZ

SUBJECT: Correlation – Effluents and Environmental Data

REFERENCES:

1. Memorandum M Goeders to EM Goldin, February 28, 1994, Documentation of the Correlation Study for 1992
2. Memorandum for File, EM Goldin, February 13, 2004, Compliance with 10 CFR 50, Appendix I, Section IV B, AR 040101459-1
3. SO123-IX-1.10, Review, Analysis and Reporting of Radiological Environmental Monitoring Program (REMP) Data, Rev. 10
4. 2013 Annual Radiological Environmental Operating Report, San Onofre Nuclear Generating Station Units 1, 2, & 3, May 2014

OBJECTIVE: Regulations in 10 CFR 50, Appendix I, Section IV B, Subparagraph 2 requires "data on measurable levels of radiation and radioactive materials in the environment to evaluate the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals . . ." This memorandum reviews the evaluation of the relationship between effluent releases and doses as assayed by the Radiological Environmental Monitoring Program (REMP).

DISCUSSION

In the 1990's, each year an analysis was performed to determine the relationship between effluent releases and environmental sample results. An example of a very rigorous calculation may be found in Reference 1. That level of evaluation was determined to be unnecessary (Reference 2) as long as actions were in place to trigger an evaluation if environmental samples exceeded some predetermined values. This position was developed because:

- Based on an anecdotal industry survey, many nuclear plants in the US do not conduct any specific evaluation on an annual basis (existing REMP and Effluent program controls satisfy the requirement)
- REMP samples rarely indicate any detectable plant-related radioactivity in the plant environs (i.e. there can be no public dose if there is no detectable radioactivity in the immediate environment)
- Many plants trigger an evaluation when REMP samples exceed investigation levels

In order to ensure that a proper evaluation would be completed if necessary, Reference 2 recommended procedure changes to incorporate action levels. That was completed and the following requirements are in place:

Procedure SO123-IX-1.10 (Reference 3) includes the following requirements:

6.2.2.2.4 IF any REMP sample results exceed administrative limits and are verified to be above the detection limit, THEN the Radiological Effluent and Environmental Specialist or designee SHALL either resolve the issue by laboratory recounts or additional sampling, or generate a Notification with a task assigned to the Radiological Effluent and Environmental Specialist or designee to evaluate the data.

6.2.2.2.5 If any REMP sample results exceed the administrative limit(s) and the results are also greater than the detection limits then generate an additional task assigned to Radiation Protection requesting a peer check of the Radiological Effluent and Engineering Specialists' evaluation.

6.2.2.2.6 A summary of the data evaluation shall be included in the Annual Radiological Environmental Operating Report (AREOR).

6.2.2.2.7 The investigation SHALL compare the expected concentration of radionuclides in REMP samples to that actually observed, or provide a basis for explaining why the detection of radionuclides in the REMP sample(s) should be expected at the observed levels.

These procedural requirements adequately implement the regulatory requirements for an evaluation of the relationship, should one ever need to be completed.

SONGS COMPLIANCE FOR 2013

The 2013 Annual Radiological Environmental Operating Report (Reference 4) included the following verbiage (page 29):

L. Correlation of Effluent Concentrations to Concentrations in the Environment

In accordance with 10 CFR 50 Appendix I, IV.b.2 data on measurable levels of radiation and radioactive materials in the environment have been evaluated to determine the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure.

The REMP soil Cs-137 levels in the control and indicator samples are statistically equivalent, leading to the conclusion that Cs-137 in soil is attributable to residual fallout from external anthropogenic factors such as nuclear weapons testing, Chernobyl, and Fukushima Dai-Ichi.

Data from 2013 continue to support the historical conclusion that the measured concentration of I-131 in kelp is not increasing near SONGS, and is not statistically higher around SONGS than it is at the control locations. I-131 in kelp is due to the release of medical administrations to the ocean from sewage treatment facilities. The effluent based correlation calculation indicates that I-131 activity in kelp attributable to the operation of SONGS would be undetectable and the resultant doses to individuals would be negligible.

> The data from air samplers close to SONGS, the data from air samplers further away, and the data from the Oceanside control sampler are statistically equal.

This wording addresses the question regarding the evaluation but not very clearly. Therefore, the following section, applicable to the calendar year 2013, is recommended for future AREORs:

> REMP samples, both terrestrial and marine, indicated no accumulation of plant-related radioactivity in the environs. No samples, as shown in Table B-2, exceeded investigation levels and, in fact, all samples with detectable activity were not statistically different from controls and were therefore attributed to non-plant-related sources – past nuclear weapons fallout, Chernobyl, Fukushima, and medical iodine releases in sewerage. As such, the operations of SONGS did not have any measurable effect on the environment.
>
> The regulatory requirement to evaluate the relationship between quantities of radioactive materials released in effluents and the resultant radiation doses to individuals may be summarized by the following conclusion:
>
> Effluent program releases are evaluated annually to determine the receptor(s) with the highest hypothetical dose. REMP samples collected through the year indicated no significant accumulation of plant-related radioactivity above control locations, therefore providing assurance that the effluent program projections are consistent with radiological environmental measurements. The concentrations of plant-related radioactivity in environmental samples were less than expected based on effluent releases, further demonstrating program conservatism.

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