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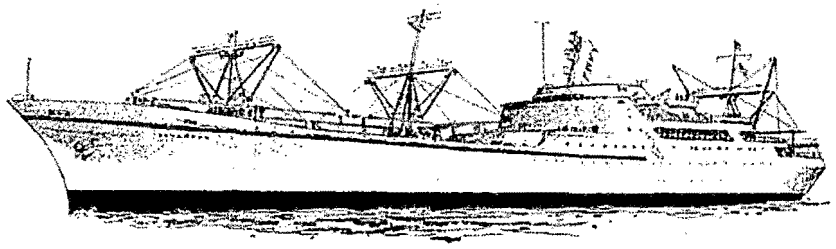
U.S. Department of Transportation
Maritime Administration

N.S. *SAVANNAH* TECHNICAL STAFF

STS-005-020

OFFSITE DOSE CALCULATION MANUAL (ODCM)

Level of Use: Reference



REVISION 1

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Approved: E. W. Koehler 08/13/2019
Senior Technical Advisor **Date**

RECORD OF REVISIONS

Revision	Summary of Revisions
0. 11/09/2018	Original Issue
1.	Corrected duration of sampling time unit to hours in Section 4.4.2.a

TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES

Page No.	Rev. No.	Page No.	Rev. No.	Page No.	Rev. No.
1-18	1				

1.0 INTRODUCTION

1.1 Implementation and Cancellation

This procedure is effective upon approval by the Senior Technical Advisor (STA), but with delayed implementation. It remains in effect until cancelled or superseded.

Implementation of the Offsite Dose Calculation Manual (ODCM) requires a license amendment to revise the Technical Specifications. Implementation will be effective thirty (30) days after approval of LAR 2018-002, "Technical Specification Changes to Revise Section 2.0 Radioactive Releases."

Changes to the ODCM shall be administratively controlled to ensure continued compliance with regulatory requirements.

1.2 Purpose

The NSS ODCM establishes the Radioactive Effluent Controls Program (RECP), described in Section E.9 of STS-005-001, Radiation Protection Plan. The purpose of the RECP is to control radioactive effluents and maintain doses, to members of the public, from such effluents to as low as reasonability achievable.

The NSS ODCM is a supporting technical basis document establishing the programmatic requirements for controlling and assessing radioactive effluents. This ODCM establishes the programmatic controls and methodologies for demonstrating compliance with Technical Specifications for radioactive effluents. It provides the acceptable methods for assessment of potential radiological impact and potential doses in the environment from an effluent release. The assessment and calculational methods of the ODCM provide assurance that releases of effluents from the NSS into unrestricted areas shall not exceed effluent concentrations as listed in 10 CFR 20, Appendix B, Table 2, Columns 1 [gaseous] and 2 [liquids] when averaged over a year.

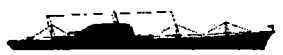
The ODCM contains the requirements and actions for liquid and radioactive gaseous waste and effluents. In addition, the ODCM describes the methodology and parameters to be used in the calculation of off-site doses from radioactive liquid and gaseous effluents.

Radioactive liquid waste controls are defined and conditions for release to the environment are established. For potential gaseous effluents, work area controls and use of ventilation exhaust treatment system for controlling and assessing potential doses are addressed.

The ODCM also is used to define the requirements for the NSS Radiological Environmental Monitoring Program (REMP) and contains the type monitoring, sampling, analysis, and reporting requirements required to conform to 10CFR50 Appendix I.

1.3 Scope/Applicability

1.3.1 The ODCM follows the methodology and models of NUREG-0133 and NUREG-1301, with limited scope as appropriate to reflect the limited decommissioning status of the NSS. The scope reflects:



- Radionuclides that have been included in the analysis for 1) effluents, 2) release limits and 3) dose assessments are those that have been identified by the previous radiological characterization, specifically the Updated Final Safety Analysis Report, STS-004-002.

- Because of 1) the limited residual radioactive liquid waste inventory, 2) limited activities generating additional liquid waste, and 3) controls established on releases to the environment, there is no on-line liquid effluent monitoring instrumentation.

- The only potential for airborne radioactivity and potential release to the environment would be during work activities on contaminated components, during which air sampling and follow-up particulate filter radiochemical analysis shall be performed. Therefore, continuous gaseous or particulate radioactive effluent monitoring is only required during work activities on contaminated or potentially contaminated components.

- Release concentrations to the environment and dose limits to members of the Public have been established at the 10 CFR 20 limits, in keeping with the principal of "as low as reasonably achievable" (ALARA).

- The scope of the environmental monitoring program is limited, reflecting the current radiological conditions and potential for releases to the environment.

2.0 REFERENCES

2.1 Developmental References

2.1.1 NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants"

2.1.2 Generic Letter 89-01, "Guidance for the Implementation of Programmatic Controls for RETS in The Administrative Controls Section of Technical Specifications and the Relocation of Procedural Details of Current RETS to the Offsite Dose Calculation Manual or Process Control Program"

2.1.3 NUREG- 1301 "Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors"

2.1.4 NRC Regulatory Guide 1.109, Rev. 1

2.1.5 NUREG-0172 "Age-Specific Radiation Dose Commitment Factors for a One-year Chronic Intake"

2.1.6 STS-005-018, Radiological Environmental Monitoring and Sampling

2.2 Performance References

2.2.1 STS-004-002, Updated Final Safety Analysis Report

2.2.2 10 CFR 20 Appendix B, Table 2, Column 2

2.2.3 STS-005-001, Radiation Protection Plan

2.2.4 STS-005-022, Radioactive Waste Process Control Plan

3.0 DEFINITIONS

Batch Release: The process by which a discrete liquid volume is releases from the ship to the unrestricted area.

Channel: An arrangement of interconnected components within a system that initiates a single output. A channel loses its identity where single output signals are combined with signals from other channels, e.g., from a monitoring channel, or a safety actuation channel.

Channel Calibration: The adjustment, as necessary, of the channel output such that it responds with necessary range and accuracy to known values of the parameter which the channel monitors. The channel calibration shall include the sensor and any associated alarm and/or trip functions.

Channel Check: 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 Function Test: The injection of a simulated signal into the channel sensor to verify operability including alarm and/or trip functions.

Composite Sample: A combination of individual samples obtained at regular intervals over a time period. Either the volume of each individual sample is proportional to the low rate discharge at the time of sampling or the number of equal volume samples is proportional to the time period used to produce the composite.

Continuous Release: The discharge of fluid waste of a non-discrete volume, e.g., from a volume or system that has an input flow during the continuous release.

Frequency Notation: Notation specified for the performance of Surveillance Requirements shall correspond to the intervals defined in Table 3.1. All Requirements shall be performed within the specified time interval with a maximum allowable extension not to exceed 25% of the surveillance interval.

TABLE 3.1, Frequency Notation

NOTATION	FREQUENCY
S – Once per shift	At least once per 12 hours.
D – Daily	At least once per 24 hours.
W – Weekly	At least once per 7 days.
M – Monthly	At least once per 31 days.
Q – Quarterly	At least once per 92 days.
SA - Semi-Annually	At least once per 184 days.
A – Annually	At least once per 365 days.
P – Prior to release	Completed prior to each release.
NA – Not applicable	Not applicable.
DR – During release	At least once during a release.

Grab Sample: An individual sample collected that is representative of the media/source being sampled.

Lower Limit of Detection (LLD): The smallest concentration of radioactive material in a sample that will yield a net count (above system background) that can be detected with 95 percent probability with only five percent probability of falsely, concluding that a blank observation represents a "real" signal.

Members of the Public: All persons who are not occupationally associated with the NSS and who are not authorized to receive an occupational dose from the NSS. This category does not include employees of the licensee, its contractors, or vendors. Also excluded from this category are persons who enter the NSS or associated pier to service equipment or to make deliveries. This category does include persons who use portions of the NSS pier for recreational, occupational, or other purposes not associated with the NSS.

Operability: A system, subsystem, train, component or device shall be operable or have operability when it is capable of performing its specified function(s). Implicit in this definition shall be the assumption that all necessary attendant instrumentation, controls, electrical power sources, cooling or seal water, lubrication or 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).

Purge/Purging: Any 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.

Restricted Area: An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Source Check: The qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity.

Unrestricted Area: An offsite area, access to which is neither limited nor controlled by the licensee (10 CFR 20 definition). As used in this ODCM, an unrestricted area shall be any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.

Venting: 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.

Ventilation Exhaust Treatment System: Any system designed and installed to reduce radioactive material in particulate form in effluent by passing ventilation or vent exhaust gases through HEPA filters for the purpose of removing particulates from the gaseous effluent prior to its release to the environment.

4.0 RADIOACTIVE EFFLUENT CONTROL PROGRAM

4.1 Radioactive Liquid Effluent Control

4.1.1 Radioactive Liquid Waste Management

The goal of NSS radioactive liquid waste management is to provide for the control of radioactive liquid effluents and maintain the doses to members of the public from radioactive effluents as low as reasonably achievable.

NSS radioactive liquid waste management program minimizes the generation of radioactively contaminated liquids during all maintenance and decommissioning activities. Activities having the potential to generate or cause radioactively contaminated liquids shall be evaluated for waste minimization and appropriate controls.

Liquid waste may be shipped in liquid form as specified by a waste processing vendor. The liquid waste may be solidified or immobilized in a form suitable for transport and disposal as a solid radioactive waste that meets the specific burial site disposal criteria. Approved processes for the solidification, transport and disposal of radioactive waste are described in STS-005-022, Radioactive Waste Process Control Plan.

Release as a liquid effluent into the receiving water body shall only be conducted where deemed necessary and appropriate, in accordance with Section 2.0 Technical Specifications. Currently, there are no functioning, originally installed, systems capable of discharging liquids off of the ship. All hull penetrations are covered by welded blank flanges.

a. Requirements

1. All radioactive liquids shall be controlled so as to prevent leakage or spills to the unrestricted area (offsite) of the NSS.

2. Liquid release shall be by batch release. Prior to release, all sources of input shall be isolated or terminated prior to sampling and analysis as specified in Section 4.1.3.

3. A release permit is generated controlling the concentrations in any single release to less than the effluent concentrations of 10 CFR 20, Appendix B, Table 2, Column 2, using the method as specified in Section 4.2.

4. Liquid effluent concentrations averaged over a calendar year shall not exceed effluent concentrations of 10 CFR 20, Appendix B, Table 2, Column 2.

5. A dose assessment shall be performed using the method specified in Section 4.2, documenting that the potential doses to a maximum exposed individual is maintained below the dose limit to a member of the public. In keeping with the principle of "as low as reasonably achievable" (ALARA), an administrative dose limit from liquid effluents has been established at 1 mrem, total body and 3 mrem, maximum organ, collectively for all releases during a calendar year.

b. Actions

1. With radioactive liquid waste identified in an unrestricted area, take immediate actions to control and prevent release to the environment.

2. With releases to an unrestricted area exceeding the effluent concentrations listed in 10 CFR 20, Appendix B, Table 2, Column 2, or the cumulative annual doses exceeding one-half of the annual administrative limit (i.e., 0.5 mrem/year total body or 1.5 mrem/year maximum organ, immediately suspend any further release until allowed conditions are reestablished.

3. If an unauthorized release to the environment occurs:

   a) Initiate sampling of the source and the environment (water sample) in the immediate release area.

   b) Perform analyses to quantify the activity levels; perform a dose assessment using the methodology of Section 4.2.

   c) Notify the RSO.

4.1.2 Radioactive Liquid Effluent Instrumentation

a. Requirements

There is no Radioactive Liquid Effluent Instrumentation in service for the NSS. All liquids are controlled on a batch basis; no online liquid effluent monitoring is required.

b. Actions

None

4.1.3 Sampling and Analysis

a. Requirements

1. Prior to sampling, all sources of input shall be isolated or terminated.

2. Content of the source shall be well mixed prior to sampling. This can be accomplished by recirculating a minimum of two waste volumes or by turbulent mixing.

3. A representative grab sample shall be collected and analyzed for principal gamma emitters and H-3 with a lower limit of detection as specified in Table 4.1.

b. Action

1. If sampling is not being conducted as required, then terminate release and assess potential for any unmonitored release.

Table 4.1, Radioactive Liquid Waste Sampling

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (μCi/ml)[a]
Batch Liquid Release	P (prior to release) Each Batch	P (prior to release) Each Batch	Principal Gamma Emitters[b]	5×10^{-7}
			H-3	1×10^{-5}
		Quarterly Composite (if Co-60 identified)	Fe-55 Ni-59 Ni-63	1×10^{-6}

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

[b] Principal gamma emitters, for which the LLD specification exclusively applies, are Co-60 and Cs-137. This 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. If not detected, a "less than" the nuclide's LLD value shall be recorded for the release. The "less than" values shall not be used in the dose calculations.

4.2 Liquid Effluent Release Limits and Dose Assessments Method

4.2.1 Release Concentration Limit

a. Requirements

The concentration in liquid effluent for any single release shall not exceed the concentrations of 10 CFR 20, Appendix B, Table 2, Column 2. The cumulative concentration shall be evaluated using the following equation:

$$\sum_i \frac{C_i}{EC_i} \leq 1.00$$

Where:

Ci = concentration of radionuclide "i" in the BATCH release (μCi/ml)

ECi = effluent concentration limit for radionuclide "i" from 10 CFR 20, Appendix B, Table 2, Column 2 (μCi/ml)

The average concentration in all liquid releases shall not exceed effluent concentrations listed in 10 CFR 20, Appendix B, Table 2, Column 2.

b. Action

1. With releases being conducted without an assessment or in excess of the 10 CFR 20, Appendix B, Table 2, Column 2, immediately terminate the release and perform a follow-up assessment.

2. Suspend further releases until the cause for the release has been identified and corrected.

4.2.2 Dose Assessment

The 10 CFR 20 effluent concentration values are based on drinking water. However, there is no drinking water pathway applicable for the NSS. Liquid pathways for the NSS include consumption of fish and invertebrates.

a. Requirements

1. To demonstrate compliance with the limitations of Section 4.1.1, a dose assessment for a release to the receiving water body, an unrestricted area, shall be performed prior to any batch release.

2. A conservative assessment may be performed using the methodology presented below. Methodology is based on NRC Regulatory Guide 1.109, Rev. 1, and NUREG-0133.

3. The doses, as calculated for any single release, shall be added to previous release doses during the current calendar year to determine the cumulative dose for the year.

4.2.3 Dose Assessment Method for Total Body

$$D_{TB} = 1.67E-02 * Vol * \Sigma_i \, (A_{i\,TB} * \, C_i)$$

4.2.4 Dose Assessment Method for Maximum Organ

$$D_o = \frac{1.67E-02 * \, Vol}{RR} * \Sigma_i \, (A_{i\,o} * \, C_i)$$

Where:

D_{TB} = dose to total body of an individual (adult) from the batch release

D_o = dose to the individual organ "o" from the batch release

$A_{i\,TB}$ = the site-specific ingestion dose conversion factor to the adult total body for each identified radionuclide i (mrem/hr per μCi/ml, from Table 4.2)

$A_{i\,o}$ = the site-specific ingestion dose conversion factor for organ "o" of an adult from the ingestion of fish and invertebrate (mrem/hr per μCi/ml, from Table 4.2)

C_i = concentration of each identified radionuclide i in the release (μCi/ml)

Vol = total volume released (gallons)

RR = release rate (gallons per minute)

1.67E-02 = conversion factor (hr/min)

a. The maximum organ dose is determined by calculating the individual organ doses using the above equation and the organ dose conversion factors from Table 4.2.

b. The dose calculations assume an adult consumes fish and shellfish harvested from the immediate area of the discharge for the duration of the

release period. No additional dilution is assumed in the receiving water body, which yields a very conservative, bounding dose assessment. It should not be assumed that this calculated dose represents an actual dose to a real person. Its use is solely for a conservative assessment for limiting liquid releases to the receiving water body, assuring any actual dose will be a very small fraction of the NRC's annual dose limit to a member of the public.

4.2.5 Site Specific Dose Conversion Factors

The site-specific dose conversion factors ($A_{i\,TB}$ and $A_{i\,o}$) are presented in Table 4.2 and were calculated using the following equation:

$$A_{i\,TB} = 1.14\text{E}+05\ (U_F * BF_i + U_I * BF_i)\ DF_{i\,TB}$$

and

$$A_{i\,o} = 1.14\text{E}+05\ (U_F * BF_i + U_I * BF_i)\ DF_{i\,o}$$

Where:

1.14E+05 = conversion factor (pCi/μCi x ml/kg ÷ hr/yr)

U_F = adult fish consumption (21 kg/yr, from RG 1.109)

BF_i = Bioaccumulation factor for radionuclide I in saltwater fish (liters/kg, from RG 1.109, Table A-1)

U_i = adult shellfish consumption (5 kg/yr, from RG 1.109)

BI_i = Bioaccumulation factor for radionuclide "i" in saltwater invertebrate (liters/kg, from RG 1.109, Table A-1)

$DF_{i\,TB}$ = dose conversion factor for radionuclide "i" for adults total body, from Table E-11 of Regulatory Guide 1.109 and NUREG 0172 (mrem/pCi)

$DF_{i\,o}$ = dose conversion factor for nuclide "i" for adults in pre-selected organ "o" from Table E-11 of Regulatory Guide 1.109 and NUREG 0172 (mrem/pCi)

4.2.6 Presence of Fe-55, Ni-59, and Ni-63

Actual presence for Fe-55, Ni-59, and Ni-63 shall be based on radiochemistry analysis of composite sample, as required. Otherwise, potential presence shall be based on scaling factor using a correlation to measured Co-60. Correlation may be based on the measurement data as summarized in the Updated Final Safety Analysis Report, STS-004-002 or additional, updated measurements as available.

Note
Note: The aquatic food pathway for adults provides the most conservative dose estimates.

Table 4.2, Site-Specific Liquid Pathway Dose Conversion Factors

Nuclide	Composite Dose Conversion Factors Total Body ($A_{i\,TB}$) and Organ ($A_{i\,o}$) (mrem/hr per μCi/ml)						
	Total Body	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
H-3	2.80E-01	0.00E+00	2.80E-01	2.80E-01	2.80E-01	2.80E-01	2.80E-01
Co-60	8.23E+03	5.11E+04	3.53E+04	0.00E+00	0.00E+00	1.97E+04	2.03E+04
Fe-55	3.82E+03	0.00E+00	1.73E+03	0.00E+00	0.00E+00	0.00E+00	3.25E+04
Ni-59	6.22E+02	3.73E+03	1.28E+03	0.00E+00	0.00E+00	0.00E+00	2.64E+02
Ni-63	1.67E+03	4.96E+04	3.44E+03	0.00E+00	0.00E+00	0.00E+00	7.18E+02
Cs-137	7.85E+03	8.77E+03	1.20E+04	0.00E+00	4.07E+03	1.35E+03	2.32E+02

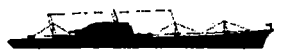
4.3 Radioactive Gaseous Effluent Control

4.3.1 Radioactive Gaseous Waste Management

The goal of NSS radioactive gaseous waste management is to provide for the control of radioactive gaseous effluents and maintain the doses to members of the public from radioactive effluents as low as reasonably achievable.

NSS radioactive gaseous waste management program minimizes the generation of airborne radioactively levels during all maintenance and decommissioning activities. The Reactor Compartment (RC) frames 99 -126 and the Reactor Support Systems in Engine Room Lower Level are the only areas on the NSS that are controlled for purposes of radiation protection. Within the RC, there are areas that pose a potential for airborne radioactivity during maintenance or decommissioning activities:

- Containment Vessel (CV), which houses the NSS's reactor plant and primary cooling system; and,
- Reactor Compartment support areas:
  - Cold Water Chemistry Lab;
  - Radiation Monitoring Room;
  - Gas Absorber Equipment Room;
  - Radiation Sampling Room;
  - Port and Starboard Charging Rooms;
  - Port Stabilizer Room; and,
  - Reactor Compartment Lower Level (RCLL).



a. Requirements

1. Activities performed within any radiologically controlled areas that have the potential to generate or create airborne radioactivity shall be evaluated; work practices shall be used for minimizing airborne levels and releases to the unrestricted area.

2. Releases from any radiation protection areas during work activities that have the potential for generating airborne radioactivity shall be sampled with a continuous particulate air sampler during the work activities.

3. Release of gaseous effluent from any radiation protection areas to unrestricted areas may be performed under the following conditions:

   a) A release permit is generated; a post release analysis shall be performed verifying that the release to concentrations not exceeding the concentrations of 10 CFR 20, Appendix B, Table 2, Column 1, using the method as specified in Section 4.4.

   b) A dose assessment shall be performed using the method specified in Section 4.4, documenting that the potential doses to a maximum exposed individual is less than 1 mrem, effective dose equivalent per year collectively for gaseous releases during a calendar year.

b. Actions

1. Work activities being conducted that have the potential for generating airborne radioactivity without an appropriate air sampler shall be immediately terminated. If feasible, ventilation to/from the area shall be isolated; an air sample shall be collected from the work area for quantifying airborne levels and determining potential releases to the unrestricted area.

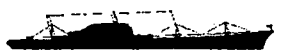
2. Perform analyses to quantify the activity levels; perform a dose assessment using the methodology of Section 4.4.

3. With releases to an unrestricted area exceeding the effluent concentrations of 10 CFR 20, Appendix B, Table 2, Column 1 or the cumulative annual doses exceeding the limits specified above, immediately suspend further releases until the cause for the elevated airborne levels has been identified and corrected.

4.3.2 Radioactive Gaseous Effluent Monitoring Instrumentation

a. Requirements

1. During work activities having the potential for generating airborne radioactivity, discharges to the unrestricted area from CV or the RCLL



shall be through a ventilation system with a HEPA filter and a radiation monitor providing isolation upon alarm.

2. The radioactive gaseous effluent monitoring instrumentation shall be operable with its alarm/trip setpoints established to provide indication of abnormally elevated levels of particulate radioactive effluents. The setpoint shall be established following a period of baseline operation with no activities on-going that could cause elevated airborne radioactivity levels and a review of this data on the detector's response and background levels.

b. Actions

1. With the radioactive gaseous effluent monitoring instrumentation alarm/trip setpoint less conservative than required, immediately suspend the release of radioactive effluent monitored by the affected channel or declare the channel inoperable.

2. With the radioactive gaseous process or effluent monitoring instrumentation inoperable, releases may continue provided:

a) Prior to initiation of the release an air particulate sample is collected and analyzed with a verification that the release shall not exceed the concentrations of 10 CFR 20, Appendix B, Table 2, Column 1 EC concentrations at the discharge point to the unrestricted area.

b) An air sample is collected from the work area continuously during operation of the ventilation system for the release to the unrestricted area.

4.3.3 Sampling and Analysis

a. Requirement

During work activities that have the potential to generate airborne radioactivity, sampling and analysis shall be performed as specified in Table 4.3.

b. Action

1. If sampling is not being conducted as required then:

a) Terminate release;

b) Collect an air sample from the work area;

c) Perform analysis as specified in Table 4.3; and,

d) Assess release rate and dose using methods of Section 4.4.

Table 4.3, Radioactive Gaseous Effluent Sampling and Analysis

Ventilation	Sample Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD)[a] (μCi/ml)
Ventilation Releases from CV or RCLL to UNRESTRICTED AREAS	Particulate Filter	During operation of the ventilation system	Upon completion of work activity (and isolation of ventilation system), not to exceed W (weekly) intervals	Principal Gamma Emitters[b] on particulate filter	1×10^{-11}
			Quarterly composite if Co-60 identified	Fe-55 Ni-59 Ni-63	$1X10^{-11}$

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

[b] Principal gamma emitters, for which the LLD specification exclusively applies, are Co-60 and Cs-137. This 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. If not detected, a "less than" the nuclide's LLD value shall be recorded for the release. The "less than" values shall not be used in the dose calculations.

4.4 Gaseous Effluent Release Limits and Dose Assessments

4.4.1 Release Concentration Evaluation

1. Requirements

Using the analysis of the particulate air sample, verify that for any measured radionuclide of NSS origin that the concentration as released to the unrestricted area did not exceed the concentrations of 10 CFR 20, Appendix B, Table 2, Column 1 using the following equation:

$$\sum_i {}^{C_i}/_{EC_i} \leq 1.00$$

and

$$C_i = {}^{A_i}/_{(FR * t)}$$

Where:

C_i = concentration for radionuclide "i" in the effluent release (μCi/ml)

EC_i = Effluent concentration value for radionuclide "i" from 10 CFR 20, Appendix B, Table 2, Column 1 (μCi/ml)

A_i = activity for radionuclide "i" as measured on the particulate filter for the release(s) (μCi)

FR = sampler flow rate during the sampling period (cubic centimeters/minute)

t= duration of sampling (release) period (minutes).

2. Action

With releases to an unrestricted area exceeding the effluent concentrations of 10 CFR 20, Appendix B, Table 2, Column 1, immediately suspend further releases until the cause for the elevated airborne levels has been identified and corrected.

4.4.2 Gaseous Dose Assessment

a. Requirements

Using the analysis of the particulate air sample, perform a dose analysis for any measurable radionuclides of NSS origin, using the following equation:

$$D_{eff} = 5.7x10^{-3} * t \sum_{i} {}^{C_i}/_{EC_i}$$

Where:

D_{eff} = Effective dose equivalent to a Member of the Public assumed to be exposed to the effluent release for the duration of the release (mrem)

C_i = concentration for radionuclide "i" in the effluent release (μCi/ml)

t = duration of sampling (release) period (hours)

EC_i = Effluent concentration value for radionuclide "i" from 10 CFR 20, Appendix B, Table 2, Column 1 (μCi/ml)

$5.7x10^{-3}$ = conversion factor (50 mrem effective dose [EC_i value for 1-year exposure] divided by 8760 hours per year)

b. Cumulative Release to an Unrestricted Area

With cumulative releases to an unrestricted area exceeding 1 mrem per year, immediately suspend further releases until the cause for the elevated airborne levels has been identified and corrected.

c. Dose Calculation Assumptions

The dose calculations assume an individual is exposed to the effluent concentration for the duration of the release period. Exposure is via the inhalation pathway; no other pathways, such as food products are considered due to the location and the surrounding environment. No additional dispersion is assumed, which yields a very conservative, bounding dose assessment. It should not be assumed that this calculated dose represents an actual dose to a real person. Its use is solely for a conservative assessment for limiting gaseous releases to the receiving areas, assuring any actual dose will be a very small fraction of the NRC's annual dose limit to a member of the public.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)

5.1 Program Scope

A Radiological Environmental Monitoring Program (REMP) shall be conducted to provide a verification of the adequacy of the programs and procedures in-place for limiting and controlling radioactive effluents and doses in unrestricted areas. Measurements of elevated levels of radioactivity in the environment are to be evaluated by the RSO.

5.2 Sampling Program

The REMP shall include the sampling and analysis of environmental media and pathways of exposure that are considered important, considering the scope of activities being performed. Additionally, the direct radiation component should be measured at selected locations in and around the ship, at locations suitable for assessing exposures to Members of the Public from on-ship activities.

5.2.1 Direct Radiation Measuring Devices

Direct radiation measuring devices, such as thermoluminescent dosimeters (TLDs), optically stimulated luminescent dosimeters (OSL) or equivalent monitoring devices, shall be placed at strategic locations throughout the vessel to monitor the radiation from reactor generated materials. MARAD shall determine these locations on the vessel and shall require dosimeter readings at least semi-annually.

5.2.2 Water and Sediment Samples

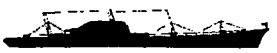
Semi-annually, water samples and bottom sediment shall be taken adjacent to the ship and analyzed for principal gamma emitting radionuclides.

5.3 Quality Assurance / Interlaboratory Comparison

The performance of the REMP shall be in accordance with approved procedures and conducted under the requirements of the NSS Decommissioning Quality Assurance Plan. All sample radiochemistry analyses are performed by contracted vendor(s). For radioanalytical analysis, the contracted vendor shall participate in an interlaboratory comparison program. The vendor for the direct radiation measuring devices (TLDs or OSLs) shall be in keeping with the guidance of ANSI N 13.37.

5.4 Pathway Assessment

If the NSS is relocated, a pathway evaluation shall be performed for the new location. This evaluation shall examine the site environment and identify any pathways of exposure that may exist. The methods for dose analysis and REMP sampling media and locations shall be revised, as needed, to reflect any additional, potentially significant pathways of exposure.



6.0 RECORDS AND REPORTING REQUIREMENTS

Records documenting the performance of the ODCM, including the REMP, shall be maintained. For effluents, records of the sample, analysis, release rate and dose assessment shall be maintained for all releases of radioactive effluents to the unrestricted area.

For the REMP, records of the sampling and analysis and direct dosimetry results (TLDs or OSLs) shall be reviewed and approved by the RSO. A summary of results shall be included in the Annual Radiological Environmental Monitoring Report and the Annual Radioactive Effluent Release Report. The summary of results shall include number and type of samples and measurements, minimum detectable levels, and all detected radionuclides, except for naturally occurring radionuclides. Additionally, the Annual Radioactive Effluent Release Report shall include quantities of solid waste released from the NSS. Unavailable, missing, and lost samples and plans to prevent recurrence and comments shall be reported.

The implementation of the ODCM shall be reviewed annually. Any changes shall be reviewed by the Safety Review Committee and approved by the Senior Technical Advisor, U. S. Maritime Administration. Changes, with an accompanying criteria and justification for the changes, shall be reported to the NRC as part of the Annual Monitoring Report for the period in which the changes occurred.