U.S. DEPARTMENT OF ENERGY

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Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Data Quality Objectives Supporting Radiological Air Emissions Monitoring for the Marine Sciences Laboratory, Sequim Site

JM Barnett
KM Meier
SF Snyder
EJ Antonio
BG Fritz
TM Poston

December 2012

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This document of Data Quality Objectives (DQOs) was prepared based on the U.S. Environmental Protection Agency (EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA, QA/G4, 2/2006 (EPA 2006), as well as several other published DQOs. The intent of this report is to determine the necessary steps required to ensure that radioactive emissions to the air from the Marine Sciences Laboratory (MSL) headquartered at the Pacific Northwest National Laboratory's Sequim Marine Research Operations (Sequim Site) on Washington State's Olympic Peninsula are managed in accordance with regulatory requirements and best practices. The Sequim Site was transitioned in October 2012 from private operation under Battelle Memorial Institute to an exclusive use contract with the U.S. Department of Energy, Office of Science, Pacific Northwest Site Office.

Acronyms and Abbreviations

CAP-88	Clean Air Act Assessment Package–1988
CAP88-PC	Clean Air Act Assessment Package 1988–Personal Computer
cfm	Cubic Feet Per Minute
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-SC	U.S. Department of Energy-Office of Science
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
MDA	Minimum Detectable Activity
MEI	Maximally Exposed Individual
mrem	Millirem
MSL	Marine Sciences Laboratory
NCDC	National Climatic Data Center
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOC	Notice of Construction
NRM	Not Routinely Measured
PNNL	Pacific Northwest National Laboratory
PNSO	(U.S. Department of Energy) Pacific Northwest Site Office
PTE	Potential-to-Emit
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RDL	Required Detection Limit
TEDE	Total Effective Dose Equivalent
WAC	Washington Administrative Code
WDOH	(State of) Washington Department of Health
X/Q	Chi-over-Q

Definitions

Acute Release—A short-duration release of a radioactive air pollutant with a potentially significant dose consequence.

Chi-over-Q (X/Q)—Concentration of a radioactive material in air at a downwind location, normalized by the release rate of the material from the source facility. In this document, Chi-over-Q is expressed in units of sec/m^3 (radioactivity per cubic meter per radioactivity released per second).

Chronic Release—The nearly continuous release of small quantities of radioactive air pollutants from an emission unit over a period of at least 3 months.

Diffuse Source (nonpoint source)—As applied in Washington Administrative Code (WAC) 246-247-030 [18]: "... a location at which radioactive air emissions originate from an area, such as contaminated ground above a near-surface waste disposal unit, whose extent may or may not be well-defined."

Emission Unit—As applied in Washington Administrative Code (WAC) 246-247-030 [10]: "…any single location that emits or has the potential to emit airborne radioactive material. This may be a point source, nonpoint source, or source of fugitive emissions."

Fugitive Emissions—As applied in Washington Administrative Code (WAC) 246-247-030 [12]: "...radioactive air emissions which do not and could not reasonably pass through a stack, vent, or other functionally equivalent structure, and which are not feasible to directly measure and quantify."

Major Emission Unit—An emission unit having the potential to emit radionuclides that could result in a dose to the maximally exposed individual exceeding one percent of the 10 mrem/yr dose standard in 40 CFR Part 61, Subpart H (i.e., greater than 0.1 mrem/yr). Major sources are subject to the continuous monitoring requirements of 40 CFR Section 61.93.

Marine Sciences Laboratory (MSL)—MSL is a sub-region of the Sequim Site. The MSL includes analytical and general purpose laboratories and wet or support laboratories supplied with heated and cooled freshwater and seawater. In addition, the MSL has a state-of-the-art waste seawater treatment system and a dock facility for a 28-foot research vessel and a specialized scientific diving boat.

Maximally Exposed Individual (MEI)—For the purpose of this DQO report, a maximally exposed individual is a hypothetical member of the public residing near the Pacific Northwest National Laboratory's Sequim Marine Research Operations (Sequim Site) who, by virtue of location and living habits, could receive the highest potential radiation dose from radioactive effluents released from MSL during a calendar year. The MEI dose calculation can be either prospective or retrospective in nature. A prospective MEI location is based on maximum potential radionuclide emissions (the "potential-to-emit") and long-term meteorological data. The retrospective MEI location uses actual emissions and meteorological data applicable to the year for which the evaluation is performed. Emissions affecting the MEI may originate from point sources (i.e., actively ventilated stacks and vents) as well as from fugitive and diffuse sources (such as contaminated soil areas or other facilities that are not actively ventilated). Compliance with federal and state dose standards is determined by the retrospective MEI dose for a specific calendar year.

Millirem (mrem)—A unit of radiation total effective dose equivalent (TEDE) based on the potential for impact on human cells.

Minor Emission Unit—An emission unit having the potential to emit radionuclides that would not result in a dose exceeding one percent of the 10 mrem/yr dose standard in 40 CFR Part 61, Subpart H (i.e., less than 0.1 mrem/yr) to a maximally exposed individual. Minor sources may be subject to the periodic confirmatory measurement requirements of 40 CFR Section 61.93.

Notice of Construction (NOC)—As defined in WAC 246-247-030 [19]: "…an application submitted to the [Washington State Department of Health] by an applicant that contains information required by WAC 246-247-060 for proposed construction or modification of a registered emission unit(s), or for modification of an existing, unregistered emission unit(s)."

Potential-to-Emit (PTE)—Radionuclide emissions estimated for purposes of permitting a new or modified emission unit. As defined in WAC 246-247-030 [21]: "…the rate of release of radionuclides from an emission unit based on the actual or potential discharge of the effluent stream that would result if all abatement control equipment did not exist, but operations are otherwise normal."

Sequim Site—The Sequim Site encompasses 150 acres of uplands and tidelands of which about 7.5 acres have been developed for research operations commonly referred to as the MSL. In October 2012, the Sequim Site transitioned from private operation under Battelle Memorial Institute to an exclusive use contract with the U.S. Department of Energy, Office of Science, Pacific Northwest Site Office.

Total effective dose equivalent (TEDE)—The sum of the dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). In this document, TEDE is expressed in units of millirem.

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1.0 Introduction

This Data Quality Objectives (DQOs) report addresses the radiological air quality requirements and environmental monitoring needs for the Pacific Northwest National Laboratory's (PNNL) Sequim Marine Research Operations (Sequim Site) on Washington State's Olympic Peninsula. The Sequim Site (see Figures 1.1 and 1.2) encompasses 150 acres of uplands and tidelands, about 7.5 acres of which has been developed for research operations. The research operations occur at several laboratories and other facilities in an area of the Sequim Site commonly referred to as the Marine Sciences Laboratory (MSL). There are two facilities at the MSL with the potential for low levels of radioactive material emissions. In October 2012, the Sequim Site transitioned from private operation under Battelle Memorial Institute to an exclusive use contract with the U.S. Department of Energy, Office of Science (DOE-SC), Pacific Northwest Site Office (PNSO).

Radiological air emissions are regulated as emission units. These emission units are regulated under different but essentially comparable regulations if privately or federally owned. An emission unit, as defined by Washington Department of Health (WDOH), is any single location that emits or has the potential to emit airborne radioactive material. This may be a point source, nonpoint source, or source of fugitive emissions. Emission units are categorized for regulatory oversight by their potential radiological release impacts as major or minor emission units. Minor indicates the potential for radioactive air emissions resulting in a dose to the MEI that is less than 0.1 mrem/yr.

DOE facilities are required to demonstrate compliance with the Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAP) for radionuclides, as published in the 1989 amendments to Title 40 Code of Federal Regulations (CFR) Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." The U.S. Environmental Protection Agency (EPA) is the federal agency tasked with oversight and implementation of the regulations. EPA has delegated regulatory authority to WDOH for facilities within Washington State. The WDOH establishes regulations for radionuclide air emissions in the Washington Administrative Code (WAC) Chapter 246-247, "Radiation Protection – Air Emissions" and adopts by reference the standards and approved methods specified in 40 CFR Part 61, Subpart H. Additional regulations by the Washington State Department of Ecology are found in WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides." Additional federal and state requirements for environmental monitoring programs applicable to this DQO report are summarized in Section 2.2.

Besides the Sequim Site, one other DOE-SC site under the programmatic oversight of PNSO is located in Washington State. The PNNL Site is located well inland in Richland, Washington (see Figure 1.3). Radiological air emission requirements for each site are the same, but the environmental settings are quite different. The approach used in the development of this DQO is similar to that used in a DQO completed for the PNNL Site (Barnett et al 2010).

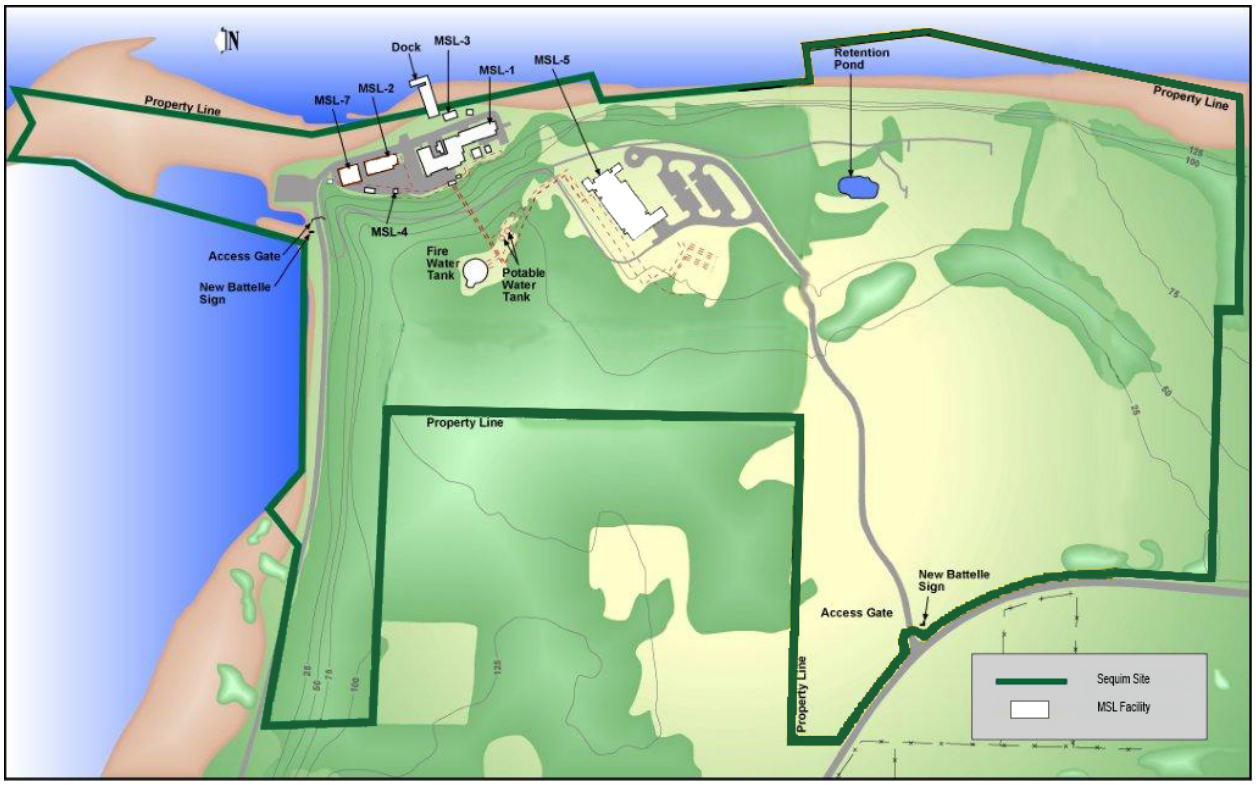

Figure 1.1. Marine Sciences Laboratory, Sequim Site

Figure 1.2. Marine Sciences Laboratory Location

Figure 1.3. Sequim Site and PNNL Site in Washington State

1.1 Location

The Sequim Site on Washington State's Olympic Peninsula is the DOE's only marine research laboratory (see Figure 1.1). The Sequim Site is on the northern portion of the Olympic Peninsula in Clallam County, Washington. It lies on the shores of the Strait of Juan de Fuca and in the rain shadow of the Olympic Mountains. Despite its coastal location, it receives on average less than 15 inches of rainfall annually. Average monthly temperatures range from 31°F to 70°F. Nearby cities are Sequim (population 6,600), Port Angeles (population 19,000), and Port Townsend (population 9,100) (DOC 2011).

2.0 State the Problem

Chapter 2.0 of this DQO report describes the problem (also called the primary study question) and discusses the preliminary data needed to answer the study question. In addition, this chapter discusses the DQO team, available resources, and schedule for completion of the DQO report.

2.1 Background and Scope

This DQO has been prepared to evaluate radioactive air monitoring requirements and inputs, if any, for the Sequim Site. It satisfies input from the WDOH to evaluate the radioactive air emissions characteristics from MSL facilities using the DQO process. Previously, the MSL operated under a private nuclear license (WN-L064-1). With the transition from private operations to an exclusive use contract with the DOE-SC PNSO (i.e., DOE operations), a new rad air emission license was required. Those entering the Sequim Site are there for business purposes; there is no public access.

The Sequim Site has two radioactive air emission units—EP-MSL-1 and EP-MSL-5. Both are nonpoint sources of emissions. Current operations would classify these nonpoint sources with emissions well below the dose limit classification as minor emission units. When these emission units were registered under DOE, potential emissions were maximized to allow more flexibility and timely start-up of any future research projects, but the emission units remain classified as minor emissions units.

2.2 Applicable Regulatory Requirements

Regulatory requirements for determining compliance with the radionuclide air emission standards are specified by EPA in 40 CFR Part 61, Subpart H. In DOE Order 458.1, DOE requires its facilities to comply with this EPA regulation for radioactive air emissions. Similar requirements are identified by the state of Washington in WAC 173-480 and WAC 246-247. The following excerpts from 40 CFR Sections 61.92, 61.93, and 61.94 were deemed most pertinent to this DQO task:

- "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr."

- "Compliance with this standard shall be determined by calculating the highest effective dose equivalent to any member of the public at any offsite point where there is a residence, school, business or office."

- "…radionuclide emissions shall be determined and effective dose equivalent values to members of the public calculated using EPA-approved sampling procedures, computer models Clean Air Act Assessment Package–1988 (CAP-88) or AIRDOS-PC, or other procedures for which EPA has granted prior approval. DOE facilities for which the maximally exposed individual lives within 3 kilometers of all sources of emissions in the facility, may use EPA's COMPLY model and associated procedures for determining dose for purposes of compliance."

Methods to demonstrate compliance with the dose standards were developed for effluents routinely and historically emitted from facilities that may release radionuclides to the atmosphere. Neither the environmental monitoring program nor the methods approved by regulations for estimating atmospheric dispersion and dose consequences were intended to be applied to high-level or acute (short-term) emissions from accidents involving radioactive materials. Therefore, the discussions and conclusions in this document are applicable to routine emissions from facilities that may be characterized as chronic emissions (or occurring at substantially the same rate over time).

2.3 Problem Statement

The objective of this DQO report is to determine what, if any, environmental monitoring must be performed to meet WDOH requirements for routine operations.

2.4 Participants

The DQO planning team includes:

- Radioactive air task lead with background in regulatory compliance, environmental monitoring, and low-level radiation detection. This member is a final decision maker.
- Environmental engineer with experience in sampling and modeling of atmospheric contaminants.
- Senior environmental scientist with Hanford Site environmental monitoring and surveillance experience and preparation of DQO reports.[a]
- Two environmental modeling subject matter experts with the ability to perform atmospheric dispersion and MEI dose calculations by using EPA- and WDOH-approved methods and software.
- Quality assurance (QA) engineer with a background in the DQO process. This member is the DQO facilitator.

2.5 DQO Process and Schedule

The following documents were consulted for the DQO process used in this document:

- Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G4, 2/2006
- Systematic Planning: A Case Study of Particulate Matter Ambient Air Monitoring, EPA QA/CS-2, 3/2007

[a] Retired prior to publication of the final report.

- 100-NR-2 Groundwater Operable Unit Ecological Risk Assessment Data Quality Objectives Summary Report, Fluor Hanford, WMP-23141, Rev 0, 6/2005

- Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project, PNNL, PNNL-12040, Rev 0, 12/1998.

The DQO process was facilitated by the QA engineer. Team formation began in January 2012. The team started in February 2012 and completed an internal draft by April 2012. A final draft was completed and submitted for review and approval in December 2012.

3.0 Goal of the DQO

Chapter 3.0 of the DQO report establishes the principal study question, breaks the study question down into individual questions, and provides a list of actions that might be taken in answering the questions. Which action is selected and what decision is made based on the action will be discussed in the next chapters.

The objective of this DQO report is to determine what, if any, environmental monitoring of radiological air emissions are required to meet WDOH requirements.

The information required to make this decision will include the data and bounding conditions to identify, as necessary, monitoring locations and equipment to demonstrate adequate assessment of Sequim Site radiological air emissions at offsite locations. The following supportive questions must be answered to meet the goals of this DQO report.

3.1 Question #1

What radionuclides-of-concern are expected in the air effluent stream from Sequim Site?

a. State the basis for determining the radionuclides expected to be found.

b. List the method used to determine the radionuclides-of-concern.

c. List the primary radionuclides-of-concern and their form (e.g., particulate, vapor, gas).

Action #1: Use the available isotope information from existing inventory and historical compliance reporting in current regulatory permitting applications to establish a list of radionuclides-of-concern and their chemical and physical forms.

3.2 Question #2

What radionuclide release rates are routinely expected from the Sequim Site's MSL emission unit(s) of interest?

a. List emission points at the Sequim Site.

b. Determine the emission rates of the radionuclides-of-concern from routine operations.

c. Under currently conceived operating conditions, determine if any releases are anticipated under routine operations that would be inadequately modeled as a chronic release.

Action #2: Identify the Sequim Site emission rates for all radionuclides-of-concern, and determine if releases of the radionuclides-of-concern can be adequately and conservatively modeled by air dispersion codes, assuming a uniform emissions rate under routine operations.

3.3 Question #3

Identify the model or process appropriate to predict the offsite location(s) of maximum impact from Sequim Site emission unit(s) of interest (see Question #2)?

a. Establish the criteria for determining the location of the MEI.

Action #3: Determine the most suitable code (CAP88, AIR DOSE PC, or COMPLY) for use at the Sequim Site, to establish the MEI and the MEI location in accordance with the requirements of the selected code.

3.4 Question #4

What monitoring programs currently collect data that would be required for the Sequim Site's MSL radiological air emissions compliance?

a. What data, information, or resources are needed for Sequim Site radioactive air emissions compliance?

b. Considering the answer to (a), which are available from onsite and nearby offsite monitoring programs? Consider the adequacy and availability of the data, information, and resource when answering this question.

c. Which available offsite data, information, or resources could be improved by establishing a Sequim Site radioactive air emissions monitoring program to collect the same type of data?

Action #4: Identify applicable resources needed for air emission compliance. Identify what aspects, if any, of other monitoring programs would be usable by the Sequim Site monitoring program; consider data, procedures, locations, and equipment.

4.0 Inputs

Chapter 4 of this DQO report lists and describes the sources used for answering the questions in chapter 3. Included in this chapter is a description of the type of information needed to meet performance and acceptance criteria, as well as directions for sampling and analysis methods.

4.1 Emission Units

The Sequim Site's MSL has two nonpoint source minor emission units associated with buildings MSL-1 and MSL-5 that are registered with the state of Washington. These emission units are the same units registered with the state when MSL was licensed as a private facility and have radioactive air emissions well below the criteria for classification as a minor emission unit (i.e., potential-to-emit contribution is < 0.1 mrem/yr to the MEI). The air emission registrations prepared for and submitted by DOE indicate the potential dose to the MEI. Information regarding the radionuclides-of-concern, emission rates, and emission unit physical characteristics are described below. The emission units under consideration (see Figure 1.1) for MSL in this DQO include EP-MSL-1 and EP-MSL-5. EP-MSL-1 is located on the tidelands, and EP-MSL-5 is located on the upland.

4.1.1 List of Radionuclides-of-Concern

The registration packages (similar to a Notice of Construction [NOC] application) need to contain the following information (WAC 2011):

1. the indicated annual possession quantity
2. the physical form (solid, particulate solid, liquid, or gas)
3. release rates (potential-to-emit), including both abated emissions (potential releases with effluent controls in place) and unabated emissions (assuming no effluent controls, but that facility operations are otherwise normal).

Since radiological operations at the Sequim Site's MSL will not change significantly under DOE ownership, information from past compliance assessments were used to develop the radionuclides-of-concern list. As in the past, ^{137}Cs is used as a representative beta-/gamma-emitter for beta and gamma-emitting nuclides not otherwise specified. In the same manner, ^{241}Am is used as a representative alpha emitter for alpha-emitting nuclides not otherwise specified. Use of these nuclides allows flexibility in the changing scope of research projects at MSL. However, if future research involves the use of a nuclide *not* bounded by the impacts of the appropriate representative nuclide, the emission unit registration would require revision.

4.1.2 Radionuclide Release Quantities

Based on existing inventory management processes, the low proposed potential-to-emit, and historical inventory, a conservative approach of using worst case radioisotopes for gross alpha and gross beta release quantities is provided (EPA 2002, ANSI 1999). This approach allows for a conservative

determination of overall release quantities based on existing and historical radionuclide inventories, while allowing MSL to adopt the full suite of radionuclides utilized by PNNL (PNSO-directed) research activities. For MSL nonpoint sources, the 40 CFR 61, Appendix D method of determining unabated emissions is utilized. The gross alpha and the gross beta release estimates are summarized and provided in Table 4.1 below.

Table 4.1. Possession Limits and Unabated Release Estimates

	Possession Limit (Ci/yr)	Unabated Release (Ci/yr)
Gross alpha	2.12E-05	2.12E-08
Gross beta	7.85E-02	7.77E-03
Total	**7.9E-02**	**7.8E-03**

4.1.3 Emission Unit Characteristics

The emission unit characteristics are the same for both MSL-1 and MSL-5. These buildings have several locations where radioactive air emissions may originate and exit the building. While they are not fugitive by definition, emissions are fugitive in nature; however, since emission can come from several points within each building, the emission unit is characterized as a nonpoint source (WAC 2011). Emissions from each emission unit are identified as < 0.1 mrem/yr and the associated registration PTEs indicate emission unit characteristic will primarily be particulates with building PTEs < 5 E-04 mrem/yr.

4.2 Meteorological Data

Meteorological data is used to characterize the dispersion of radiological releases from emission point to the actual or hypothetical exposure point. The level of site-specificity for meteorological data depends on the input requirements of the environmental modeling code chosen for compliance determination. As indicated in section 2.2, available codes to use for compliance determination are CAP88-PC, COMPLY, and AIRDOS. During its years as a privately operated facility, COMPLY was used for compliance determination. The requirements for each of the pre-approved codes are provided in Table 4.2.

No meteorological data is currently collected onsite. Weather in this region is affected by both the nearby marine and high mountain effects. The closest National Climatic Data Center (NCDC) locations of historical wind data are at the Port Angeles, Fairchild airport, 33.3 km to the west, and in Dungeness Bay, 10.7 km to the north-by-northwest (see Figure 4.1). Port Townsend, Washington has a meteorological station 21.5 km to the east, but data records are inadequate. Winds at Port Angeles and Dungeness are overwhelmingly from the west, as indicated in Table 4.3. MSL-1 is located eastward and at a lower elevation than MSL-5. Reviewing the available regional wind data, one can assume a much more turbulent wind pattern at MSL-1. This increased turbulence could result in decreased air concentrations at offsite locations.

Table 4.2. Meteorological Data Requirements for Pre-Approved EPA Compliance Codes

Code	Meteorological Data Requirement
CAP88-PC version3	• Data array of wind frequency by direction, speed, and atmospheric stability • Annual average ambient temperature • Lid height • Absolute humidity (important only if tritium released) LIMITATION: MEI must be >0.1km from the release point.
COMPLY rev1.6	Requirements depend on the "level" implemented. • At the lowest levels, no site-specific meteorological data is required and conservative default assumptions are applied. • At its most detailed level, a table of wind direction (from) frequency and average speed that the wind blows from each direction is required. LIMITATION: MEI must be ≤ 3km from facility.
AIRDOS	Requirements are the same as CAP88-PC. Use of this code is discouraged because CAP88-PC is essentially an update of AIRDOS.

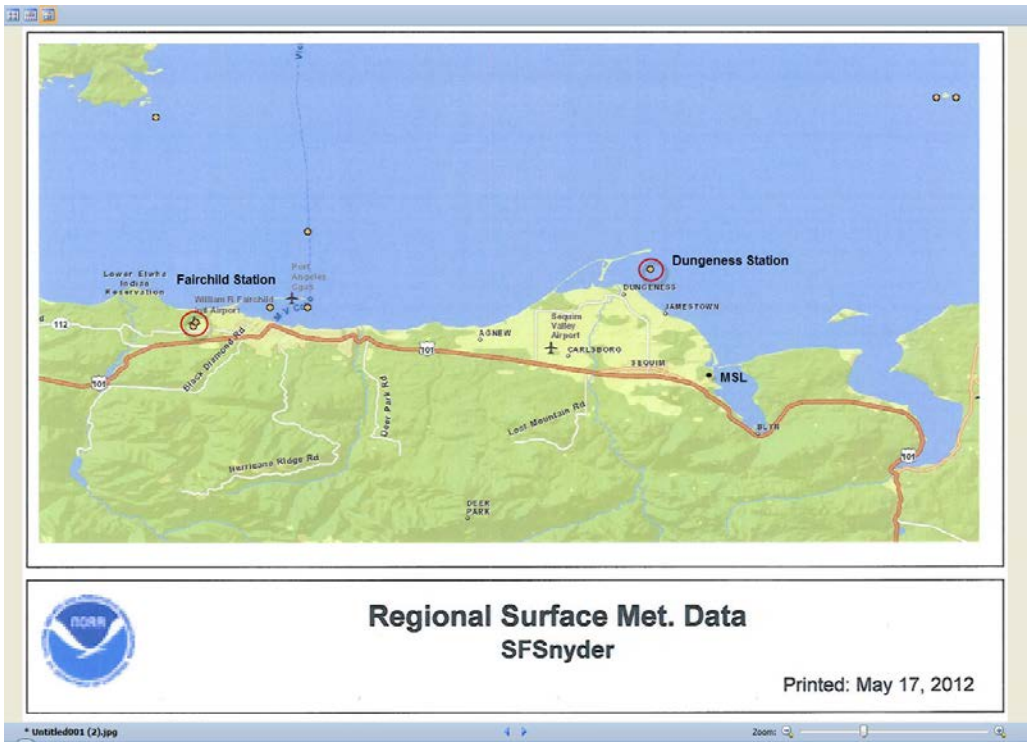

Figure 4.1. Nearby NCDC Meteorological Data Stations

Table 4.3. Wind Frequency at Locations Near the Sequim Site's MSL

Wind From	Fairchild (2007-2011 average)	Dungeness (1978-1983 average)
N	0.05	0.05
NNE	0.03	0.02
NE	0.03	0.04
ENE	0.03	0.02
E	0.06	0.07
ESE	0.04	0.04
SE	0.04	0.08
SSE	0.04	0.02
S	0.04	0.05
SSW	0.03	0.03
SW	0.09	0.10
WSW	**0.12**	0.05
W	**0.15**	**0.29**
WNW	**0.13**	0.06
NW	0.09	0.07
NNW	0.04	0.03

Bold frequency values highlight predominant wind directions.

4.3 Air Dispersion Modeling

The emission units at the Sequim Site have historically met requirements for dose limit compliance based on estimates from the COMPLY code (EPA 1989). COMPLY is applicable to sites with low levels of releases (i.e., releases that result in MEI dose well below the minor emissions unit limit of 0.1 mrem/yr). COMPLY uses simplified dispersion models that do not require site-specific joint frequency distribution (JFD) meteorological information. If CAP88-PC were to be used, the JFD would need to be created. Given the adequacy of the COMPLY results, COMPLY will be retained for dispersion modeling. The following provides a historical summary of the COMPLY code development.

In 1985, the EPA asked the National Council on Radiation Protection and Measurements (NCRP) to develop simple screening methods for assessing compliance with the Clean Air Act by users of small quantities of radionuclides. NCRP published these procedures in 1986 and 1989 in Commentary No. 3 (NCRP89). EPA's COMPLY model was developed based on the procedures in Commentary No. 3. The COMPLY computer software may be used to demonstrate compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPS) in 40 CFR 61, Subpart H and I. COMPLY calculates the effective dose equivalent (EDE) from radionuclides released from stacks and vents. Atmospheric concentrations are estimated using a Gaussian plume model and equations that account for building wake effects. The COMPLY computer software includes four levels of complexity. A user can demonstrate compliance at any level. Level 1 requests the least amount of information; however, "worst case" assumptions are used in the dose estimate. Level 4 requests the most information and uses more site-specific data, yet is still quite conservative in its dose result. The inputs necessary for the COMPLY model are listed below (Table 4.4). The table also indicates values applied for MSL at COMPLY Level 4 with no site-specific wind rose information applied.

Table 4.4. COMPLY Input Parameters

Parameter	Level Required At	Default Value	MSL Value (Level 4)
Nuclide Names	1-4	none	<varies by
Concentrations (Ci/m^3)	1	none	NA
Annual Possession Amount (Ci)	1	none	NA
Release Rates (Ci/yr *or* Ci/s)	1-4	none	<varies by
Release Height (m)	2-4	none	8 m
Building Height (m)	2-4	none	8 m
Stack or Vent Diameter (m)	2-4	none	NA
Volumetric Flow Rate (m^3/s)	2-4	0.3	NA
Distance from Source to Receptor	2-4	none	190 m[a]
Building Width (m)	2-4	none	30 m
Wind Speed (m/s)	2-4	2	2 m/s
Distances to Sources of Food (m)	2-4	none	190 m[a]
Stack Temperature (F)	4	55	NA
Ambient Air Temperature (F)	4	55	NA
Wind Rose	4	none	NA(nwr)
Building Length	4	none	NA(nwr)

NA = not applicable; NA(nwr) = not applicable because **n**o **w**ind **r**ose data is used.
(a) Smallest receptor distance either MSL-1 or MSL-5 applied to both emission units.

4.4 MEI Exposure Characteristics

Consideration of the nearest receptor (i.e., residence, school, business, or office) is used to determine the MEI location. If CAP88-PC is used for dispersion modeling, the location of least dispersion of emissions is used in conjunction with the spatial information for nearest residence, school, business, or office. If COMPLY is used with no site-specific wind data, the nearest receptor in any direction is the

MEI. If COMPLY is used with wind rose information, the nearest receptor in each compass direction is evaluated. Table 4.5 indicates the nearest receptor in each direction (Google Earth, image date September 25, 2011). The DOE exclusive use contract is applicable to the Sequim Site; therefore, the entire Sequim Site boundary is relevant to potential MEI determination.

Table 4.5. Potential MEI Locations

Direction from MSL-1 or MSL-5 toward:	Smallest distance to MSL boundary	Smallest distance to Sequim Site boundary	Smallest distance to nearest receptor outside of Sequim Site boundary
N	-	-	1,790 m res (a)
NNE	-	-	39,700 m res (a)
NE	-	-	9,630 m res (a)
ENE	-	-	2,000 m res (a)
E	-	-	1,900 m res (a)
ESE	-	-	2,620 m res
SE	-	-	3,930 m res
SSE	180 m	-	4,470 m res
S	170 m	570 m	640 m res/farm
SSW	190 m	630 m	820 m res; 290 m farm
SW	170 m	360 m (a)	420 m res (a)
WSW	140 m	230 m	290 m res
W	130 m	220 m	270 m res
WNW	140 m	230 m	270 m res
NW	170 m	280 m	520 m res
NNW	240 m	-	1,000 m res/farm

(a) Distance from MSL-1 applied; all others from MSL-5.
Dash (-) indicates a shoreline location where no potential receptor could reside or abide.
res=residence site

5.0 Boundaries

Chapter 5 of the DQO report discusses the logistics of implementing the objectives. Here the boundaries are listed as they exist in the geographic limits (spatial), as well as in the practical areas of location, support, etc. To provide a viable solution to the problem, all factors have to be taken into consideration.

5.1 Modeling Boundaries

For COMPLY, the temporal boundary is 1 year. The spatial boundary for the use of COMPLY limit the receptor location to 3 km or less. For Level 4 with no wind rose information entered, the COMPLY model assumes a Gaussian dispersion in an arbitrary downwind direction. For these cases, the code assumes that the wind blows in that direction 25 percent of the time; a generic, conservative approximation. If meteorological data usable in CAP88-PC were available in the future, the modeling boundary could be expanded to receptor locations up to 50 km.

5.2 Spatial Boundaries

The Sequim Site spatial boundary includes both the MSL and additional undeveloped land under the exclusive use contract with Battelle. All of the radioactive air emissions activities are contained within MSL (Figure 1.1). The smallest distances to potential receptor locations in each direction for both the MSL and larger Sequim Site boundaries, as well as to the nearest receptor outside of the Sequim Site, are indicated in Table 4.5.

5.3 Temporal Boundaries

Several time periods are relevant to this DQO. Air monitoring regulations require that dose to the member of the public be evaluated for each calendar year. Inputs required for the annual dose calculation, which are also considered over the same 1-year time frame, are emissions of radionuclides (Ci) and exposure characteristics (e.g., time spent outdoors, garden productivity). The radionuclide emission rates and meteorology change from one calendar year to the next. Characteristic exposure assumptions generally do not change.

Another temporal boundary relevant to this DQO is the future addition of buildings or major emission units on the Sequim Site. Changes would occur as a result of construction activities or modifications to NOCs/registrations. The impact of a new building on the Sequim Site may either change the dispersion modeling of emission units already addressed in this DQO or may introduce a new emission unit.

5.4 Practical Constraints

If ambient air monitoring is required by the regulator or deemed necessary, it is desirable to place the station near a location where the expected radionuclide air concentrations are high enough to be detectable. Given the predominant eastward wind vectors in the Sequim Site region, this would prove difficult, since the eastern shore of the site is on the ocean. Additional constraints to consider include:

- availability of space to house the station
- availability of power
- accessibility for sample retrieval
- existence of structures or vegetation between the source and sample station that might perturb transport of airborne radionuclides
- vulnerability to vandalism or other damage (by water, automobiles, etc.)
- vulnerability to external factors, such as dusts/salts and vapors, that could reduce sampler efficiency.

6.0 Decision Rules

Chapter 6 of the DQO report provides the answers to the questions that were asked in chapter 3. The decisions are based on assumptions and data inputs listed in chapter 4. The outcome of the decisions made in this section have resulted in the conclusion that ambient air monitoring is not currently needed.

6.1 Decision #1

Question #1: What radionuclides-of-concern are expected in the air effluent stream from Sequim Site?

Action #1. Use the available isotope information from existing and historical inventory and current regulatory permitting applications to establish a list of radionuclides-of-concern. Include their chemical and physical forms.

Decision #1. The emission unit registrations summarize radioactive material inventories as maximum gross alpha and gross beta/gamma values. For purposes of this evaluation, the 2011 MSL inventory, which was used for the emission unit registrations, is considered as the primary radionuclides-of-concern (Table 6.1).

Table 6.1. 2011 MSL Inventory

Nuclide	Physical Form	Possession Amount (mCi)	Release Rate (Ci/yr)
Ba-133[a]	C	4.34E-03	0.00E+00
Ba-133[a]	S	1.57E-04	1.57E-15
C-14[a]	S	7.40E-04	7.40E-13
Cs-137[a]	S	6.70E-04	6.70E-15
H-3[a]	S	7.70E-04	7.70E-13
Ni-63[a]	C	6.89E+01	0.00E+00
Po-208[b]	L	9.91E-06	9.91E-14
Pu-239[b]	S	2.62E-07	2.62E-18
Tc-99[a]	L	1.70E-04	1.70E-12

(a) A beta/gamma emitter.
(b) An alpha emitter.
C=sealed source; S=solid; L=liquid (used to identify release fraction assumption).

6.2 Decision #2

Question #2: What radionuclide release rates are routinely expected from the Sequim Site's MSL emission unit(s) of interest?

Action #2. Identify the Sequim Site emission rates for all radionuclides-of-concern, and determine if releases of the radionuclides-of-concern can be adequately and conservatively modeled by air dispersion codes, assuming a uniform emissions rate under routine operations.

Decision #2. The emission rates for all radionuclides-of-concern were identified as part of 6.1 (see Table 6.1). The COMPLY model can adequately and conservatively determine compliance with all applicable regulatory requirements for the Sequim Site given the radiological operations of the material in inventory. For normal operations, a chronic release accurately reflects emissions rates.

6.3 Decision #3

Question #3: Identify the model or process appropriate to predict the offsite location(s) of maximum impact from Sequim Site emission unit(s) of interest (see Question #2)?

Action #3. Determine the most suitable code (CAP88, AIR DOSE PC, or COMPLY) for use at the Sequim Site, to establish the MEI and the MEI location in accordance with the requirements of the selected code.

Decision #3. Given the adequacy of previous compliance determinations using COMPLY, COMPLY will continue to be used. The 190-m-to-boundary receptor location used in the emission unit registrations provides a conservative estimate of any actual offsite receptor. See Appendix A for unit release dose factors applicable to the 190-m receptor for a variety of nuclides. The closest actual resident to either MSL-1 or MSL-5 is 270 m west or west-by-northwest of MSL-5 (see Table 4.5). Given that nearby meteorological information indicate that winds blow predominantly toward the east (see Table 4.3), away from either of these close receptors, an additional level of conservatism is included.

6.4 Decision #4

Question #4: What monitoring programs currently collect data that would be required for the Sequim Site's MSL radiological air emissions compliance?

Action #4. Identify applicable resources needed for air emission compliance. Identify what aspects, if any, of other monitoring programs would be usable by the Sequim Site monitoring program; consider data, procedures, locations, and equipment.

Decision #4. Use of offsite meteorological data collected by NCDC would be useful if radiological operations were to be expanded. At the current levels of operations, no site-specific meteorological data is required. This data can be found for multiple locations around the Sequim Site on the National Oceanic and Atmospheric Administration web page (http://gis.ncdc.noaa.gov/map/cdo/). There are no environmental radiation monitoring programs near the Sequim Site. Nor would they provide any benefit to MSL operations or oversight if they existed, due to the very low emissions levels at the site.

7.0 Decision Error Assessment

Chapter 7 of the DQO report discusses the possibility that a wrong decision has been made in chapter 6 and what the possible consequences would be.

For DQOs that include sampling data, these decision error assessments are normally done statistically. Given the purpose of this DQO to select the environmental monitoring needs at the Sequim Site, the decision error assessment is done in an essay-style format.

7.1 Decision #1 Error

The current inventory of radionuclides at the Sequim Site is listed in Table 6.1. This inventory is contained entirely within MSL facilities. The limits in the emission unit registrations are more generically set for beta/gamma emitters and alpha emitters (see Table 4.1) with both EP-MSL-1 and EP-MSL-5 meeting the definition of minor emissions units. If the wrong activities were designated in the emission unit registrations, the annual COMPLY code estimates would result in dose estimates that exceed a 0.1 mrem/y dose estimate to the MEI. The COMPLY code assumptions and options could be fine-tuned to result in a smaller over-estimate of the MEI dose (e.g., through use of a site-specific wind rose). Given the very high levels of conservatism used in the COMPLY calculations, a more realistic dose estimate would be fully expected to meet acceptable regulatory requirements. Use of nuclides not approved under the emission units registration, or use of nuclides in excess of the permitted amount, would be non-routine and a violation of the permit. In this instance, modeling could be done to estimate the potential dose that occurred under these non-routine conditions. The intent of this process was not to consider non-routine events.

7.2 Decision #2 Error

The relatively low possession limits of radioactive material inventory, the material form and use, as well as the conservative receptor location (190 m), combine to make a chronic emission rate assumption completely reasonable. Non-routine operations or an unplanned bulk release would render the chronic release assumption and modeling in error. These situations are not within the scope of this document.

7.3 Decision #3 Error

The location of maximum impact is the receptor location that environmental models predict would have the least dispersion from the release. The closer-than-realistic receptor distance used in the COMPLY model creates a conservative dose estimate for this low-elevation release. Consideration of site-specific meteorology would indicate that the actual maximum air concentration would be a low concentration out at sea, where no business, residence, school, or office is located. Therefore, use of the inland and boundary receptor location assumptions within the COMPLY code for the MEI is very conservative. More realistic assumptions would significantly lower the maximum impact estimate.

7.4 Decision #4 Error

The decision to use COMPLY with no wind rose provides a result that is well under the dose impact required to meet the definition of a minor emission unit. If the impact result was greater than the 0.1 mrem minor emission unit limit, more realistic over-estimate of dose would be anticipated from use of wind rose data from nearby NCDC meteorological data collection sites in Port Angeles (Fairchild site) or the Dungeness site. If these nearby sites represented the Sequim Site region in a manner that overestimated dispersion, and thereby underestimated the dose impact, enough conservatism is introduced into the COMPLY model so that impacts would still be expected to be much lower than the 10 mrem annual limit for dose to a member of the public from radiological air emissions.

8.0 Considerations for Future Operations

Sequim Site requirements for air sampling and annual regulatory compliance have been determined to be minimal for current operations. Site emissions are very low, the nuclide inventory is relatively small, and radiological impact estimates are well below regulatory limits, even when highly over-estimating assumptions are applied. If radiological operations were expanded at the site, the following data would be useful to more realistically consider the impacts of potentially increased emissions levels. Such data collection would strengthen the quality of the offsite monitoring by significantly reducing the uncertainty of a more realistic, rather than largely overestimated, offsite impact estimate.

This discussion reflects the guidance available in DOE 1991, and updated portion, DOE 2004. The guidance document was developed under DOE Order 5400.5, but has continued to be recommended for use under DOE O 458.1. The purpose of DOE 1991 is "to specify the necessary elements for effluent monitoring and environmental surveillance of radioactive materials at DOE sites to comply with applicable federal regulations and DOE policy." DOE O 458.1 emphasizes the need to establish monitoring programs "commensurate with the nature of the DOE radiological activities and risk to the public and the environment."

8.1 Meteorological Data

If radiological operations were increased, CAP88-PC code modeling would be preferred over the COMPLY code. The CAP88-PC code calculates a more realistic dose impact estimate than the COMPLY code, which significantly overestimates impacts. In order to use CAP88-PC, more detailed and less uncertain meteorological data is required than is currently available at nearby NCDC stations (see Figure 4.1). Available wind characterization data for Sequim used information obtained from the NCDC Port Angeles, Fairchild station, and Dungeness station. The winds characterized by these data are regionally characteristic for the eastern Strait of Juan de Fuca. There is some concern that because Sequim is located deeper inside the rain shadow of the Olympic Mountains, there may be some meteorological characteristics that are unique to the Sequim Site.

Meteorological data are not only vital to environmental protection, emergency response, and consequence assessments, but are also vital for guarding the safety and health of workers and the general public (DOE 2004). To ensure that the information collected meets future Sequim Site needs, it would be useful to establish a DOE meteorological monitoring station at the site.

8.2 Background Levels of Radionuclides Offsite Air

In addition to the collection of site-specific meteorological data, monitoring of offsite ambient air for radioactive particulates would be useful to establish baseline conditions at the Sequim Site. DOE 1991, section 5.2, recommends that pre-operational assessments be performed and that background location measurements be taken for significant radionuclides and pathways. A gamma suite and alpha suite of nuclides could be analyzed on quarterly or semi-annually-composited samples to provide a baseline of the background radioactive material concentrations at the Sequim Site. Although subject to some risk, it may be useful to establish this background sampling station onsite. Under current site radiological operations, no facility emissions would be detected; therefore, sample analyses would provide accurate background

information. If operations were to increase in the future, this sampling station could be transitioned for use as the onsite ambient monitoring station, and a farther afield sampling station could be established for offsite background sampling. The risk in this approach would be that radiological operations would increase prior to collection of a full year or two of background measurements to establish better statistics on background levels.

8.3 Siting a Future Offsite Monitoring Station

Current meteorological information from the NCDC indicates that Sequim Site emission units would produce maximum air concentrations of a particulate release to the east of MSL, as a result of the highly predominant eastward winds (see Table 4.1). It is both beneficial and problematic, in that the eastern Sequim Site boundary is along the sea. The benefit results from the nearest receptor being located about 1.9 km to the east, across Sequim Bay, providing a large distance for dilution of any potential release to occur. Since maximum air concentrations of potential MSL releases are expected east of the facility, the future establishment of a sampling station at sea or on the nearby spit may not be possible, or simply problematic, for practical reasons. Given current meteorological information, sampling stations located west and south of MSL would likely not result in adequate monitoring of a potential release, due to the lack of release dispersion in those directions. To summarize, the meteorology and geography of the Sequim Site may prove challenging for siting a single monitoring station, in the event of expanded radiological operations. Monitoring of emissions from future, expanded operations may only be possible at the point of release.

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Appendix A

COMPLY Unit Dose Factors

Appendix A: COMPLY Unit Dose Factors

COMPLY v1.6 was used to determine unit-release dose factors (UDFs). These UDFs represent impacts to a hypothetical receptor 190 m from the emission unit, with an assumed 2 m/s wind speed and wind blowing toward the receptor 25 percent of the time. These assumptions are based on calculations of COMPLY v1.6 at Level 4, with no wind rose used. The appropriate solubility class to apply was based on those indicated in DOE 2006, and for ^{14}C the COMPLY default classification was applied as the only option (EPA 1989). UDFs for radionuclides either in current inventory or previously used at the Sequim Site are presented.

Table A.1 Sequim Site Unit Dose Factors

Nuclide	COMPLY Solubility Class	Unit Dose Factor (mrem per Ci/yr released)	Footnote
^{241}Am	W	11700	A
^{133}Ba	D	135	B
^{14}C	"1"	1.5	C
^{109}Cd	W	5.5	
^{57}Co	W	4.8	
^{60}Co	W	426	
^{137}Cs	D	469	A
^{154}Eu	W	345	
^{155}Eu	W	13.3	
^{3}H	V	0.004	B
^{125}I	D	84.5	
^{129}I	D	1250	
^{54}Mn	W	27.2	
^{22}Na	D	234	B
^{63}Ni	W	0.3	
^{210}Pb	D	1100	B
^{238}Pu	W	10300	
^{239}Pu	W	11200	
^{106}Ru	W	13.9	
^{90}Sr	Y	211	D
^{99}Tc	W	32.7	
^{234}U	Y	3450	
^{235}U	Y	3470	
^{238}U	Y	3110	
Natural U	Y	3290	E

A. ^{241}Am is the surrogate alpha emitter for those not specifically listed; ^{137}Cs is the surrogate beta-emitter for those not specifically listed.
B. The solubility class listed is the only option available in COMPLY v1.6.
C. Default of COMPLY v1.6 used.
D. Solubility class W is preferred, but not an option. Class Y was used as an over-estimating assumption.
E. Determined from natural uranium mass fractions: 0.000055 ^{234}U; 0.0072 ^{235}U; 0.9928 ^{238}U (DOE 2009)

Bold font: Alpha-emitting nuclides. All others are beta/gamma emitters.

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