

		<b>ES&amp;H Section Program Documentation</b>	
<b>Procedure Number/Name</b> Fermilab-ERPP			<b>Original Date:</b> 12/23/2021
<b>Written by:</b> Holly Hall		<b>Reviewed and Updated By:</b> Holly Hall	<b>Date:</b> 02/25/2022

# Environmental Radiological Protection Program (ERPP)

## Approvals

Written By: \_\_\_\_\_ Date: \_\_\_\_\_

Holly Hall, Radiation Physicist

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

Matthew Quinn, SRSO

Reviewed By: \_\_\_\_\_ Date: \_\_\_\_\_

Bridget Iverson, Environmental Protection Manager

Approved By: \_\_\_\_\_ Date: \_\_\_\_\_

Amber Kenney, Chief Safety Officer

## Revision History

Updated by	Description of Change	Revision Number	Revision Date
Holly Hall	Initial release as a separate document.	0	12/23/2021
Holly Hall	Incorporated comments from DOE review, updated implementation plan schedule, updated clearance documentation numbers, and minor editorial changes.	1	02/25/2022

## Table of Contents

Approvals .....	1
Revision History .....	2
Table of Contents.....	3
1.0 Introduction .....	4
2.0 Scope of Operations.....	4
3.0 Elements of DOE O 458.1 Implementation for the ERPP.....	7
4.0 Responsibilities .....	8
5.0 Limitation and Optimization of Public Dose .....	8
6.0 Implementation Plan .....	46
7.0 References .....	47

## 1.0 Introduction

Department of Energy (DOE) Order 458.1: *RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT* [DOE2020] requires sites to have a compliant Environmental Radiological Protection Program (ERPP). This document applies to the activities described in the Scope of Radiological Operations (see below) of the Fermi National Accelerator Laboratory (Fermilab), operated under contract with the DOE. It constitutes Fermilab's implementation plan for the requirements of DOE O 458.1. Fermilab maintains and implements several plans and programs for ensuring that the management of facilities, wastes, effluents, and emissions does not present risk to the public, workers, or the environment.

## 2.0 Scope of Operations

Fermilab, located in DuPage and Kane Counties, Illinois, and Lead, South Dakota, is a single-program laboratory dedicated to basic research in high-energy physics, related support activities and associated scientific research programs. High energy physics research involves the creation of new states of matter and the study of these states on a microscopic (atomic, nuclear, and sub-nuclear) scale. These states are created in the interaction of accelerated particle beams with other targets fixed in space or with other particle beams. As of October 2011, upon completion of the operation of the proton-antiproton colliding beam experimental physics program based upon the Tevatron collider, there is presently no operational colliding beam experimental program on the Fermilab site although operations with colliding beams remains consistent with the scope of this ERPP. A major portion of the research activities conducted at Fermilab involves the acceleration and delivery of particle beams to particle and nuclear physics experiments built and operated by collaborations of scientists assembled from many nations. These experiments and their constituent apparatus may also be calibrated by and used to study cosmogenic radiation. Also, Fermilab is a principal collaborator in the experimental program of the Large Hadron Collider at the European Organization for Nuclear Research and a participant in other accelerator-related endeavors at other laboratories both in the U. S. and elsewhere. New accelerator-related projects are being developed for the near, and intermediate, term futures. In addition, Fermilab is the base of support of several non-accelerator experiments in particle physics, particle astrophysics, and quantum information endeavors that utilize much of the same technology base as does the accelerator-based research program. Some of these activities may be managed by Fermilab at locations that are not part of the government-owned Illinois site. This recent evolution of the Fermilab program does not, in of itself, require modification of this ERPP.

Fermilab also participates in applied physics and engineering activities designed to support the physics research program and to provide for transfer of technology developed at Fermilab to society at large. A major emphasis at the present time is accelerator development, materials science, detector technology, and quantum information systems directed toward future use both in the United States and in international collaborations. Important examples of transfer of technology include the research and development toward the advancement of use of particle accelerators for routine medical treatments, and for radiobiological and medical research. Industrial applications of accelerators are also being

pursued. Some of these involve partnerships with private enterprise and other institutions, notably at the Illinois Accelerator Research Center, being developed on the Fermilab site. Other practical applications are being investigated. These practical applications as they develop are not envisioned to, by themselves, require modification of this ERPP.

Finally, education is an important part of Fermilab's mission. Educational activities range from elementary school and high school level activities at Fermilab to the sponsorship of graduate students working toward advanced degrees.

To accomplish its mission, Fermilab engages in the design, construction, commissioning, operating and, as necessary, decommissioning of a large particle accelerator and related apparatus used for physics experiments. Components developed at Fermilab are used both on the Fermilab site and at other research facilities worldwide. Fermilab also operates related support facilities that provide equipment components for the physics experiments. The operation of the physical plant of Fermilab is included within the scope of this ERPP.

Radiological work is conducted in the radiation fields produced by the accelerator as well as with manufactured sources and materials radio-activated by the accelerated beams. Radioactive sources are utilized for calibration purposes and as important components of the particle detectors. Radioactive materials are sometimes incorporated as part of the experimental apparatus and beamline components. Work with all of these sources of radiation is a part of routine operations at Fermilab. Radioactive waste is generated in the course of these operations. Collection and preparation of such waste for its transport to DOE-approved disposal sites is also conducted at Fermilab. Other shipments of radioactive materials are made to and from the Fermilab site in accordance with applicable transportation regulations.

Fermilab evaluates radiological exposure to the environment or members of the public via prompt radiation produced by accelerator operations, air-immersion, inhalation, and ingestion pathways.

A comprehensive environmental monitoring program, managed in accordance with DOE requirements, notably DOE Order 458.1, *Radiation Protection of the Public and the Environment*, and accepted national standards in the context of an Environmental Management System (EMS), is an important part of the Fermilab environment, safety, and health program. Fermilab also participates in environmental monitoring that addresses environmental concerns related to both current and past practices in compliance with regulatory agency requirements. The occupational radiological activities associated with the management of the ionizing radiation components of Fermilab's EMS and DOE O 436.1, *Departmental Sustainability*, are conducted within the Scope of this ERPP.

Fermilab is assigned the leadership role in the development of the Long Baseline Neutrino Facility (LBNF) that will build and operate a target facility on the Fermilab site that will use a high intensity proton beam to produce a high intensity neutrino beam to be sent through the earth to the LBNF Far Site at Sanford Underground Research Facility (SURF) in Lead, South Dakota. Large neutrino detectors, both on the near site (Batavia, IL) and far site (Lead, SD) will comprise the Deep Underground Neutrino Experiment (DUNE). The acronym for the entire project is LBNF/DUNE. While the "far" detector in South Dakota will be placed in space owned by SURF, DOE has leased the physical space for this detector and its support facilities and Fermilab will operate this experimental facility with corresponding responsibilities for environment, safety, health, and quality within this "Leased Space." Although it is anticipated that

environmental radiological impacts of DUNE will be minimal, this ERPP applies to radiological activities conducted by Fermilab in this space. At the time of this revision, radiological operations for LBNF/DUNE have not begun. If necessary, this ERPP will be updated or a separate ERPP will be developed to reflect the applicable requirements prior to radiological operations commencing at the LBNF far site. This ERPP may also be applicable to additional workspaces managed in locations other than the physical site in Illinois designated as the Fermilab site.

It is appropriate to review the magnitude of radiological hazards at Fermilab that were taken into account in developing this ERPP. These radiological conditions are continually monitored by the Radiological Control Organization (RCO) to promptly detect deviations from normal conditions. Conditions are evaluated through review of surveys, dosimetry reports and special radiological measurements. Fermilab's ES&H management system conducts periodic evaluations of radiological protection and radiological conditions, commonly in coordination with associated reviews with other environment, safety, and health disciplines. New projects, programs and experiments are reviewed for radiation safety concerns throughout their development. Environmental and public exposures at Fermilab are maintained considerably lower than the limits set forth in DOE and Environmental Protection Agency (EPA) regulations. It is improbable that members of the public could exceed the limits prescribed in the regulation, based on exposure histories at Fermilab and the nature of the activities of such individuals at Fermilab. Within the present scope of Fermilab's radiological operations, Fermilab does not anticipate seeking temporary dose limits as described in O 458.1 Contractor Requirements Document (CRD) section 2.c. There have never been any Hazard Category 1, 2, or 3 nuclear facilities on the Fermilab site. Furthermore, there are no plans for such facilities at Fermilab and thus environmental radiation protection provisions for Hazard Category 1, 2, or 3 nuclear facilities are not included in this ERPP.

Ordinary operating conditions do not present any identified circumstances under which a member of the public would receive an internal exposure. There are no occupied areas at Fermilab in which, under typical conditions, airborne radioactivity presents a hazard requiring specific control measures. Hence, neither real-time air monitoring nor air sampling are generally performed, except as needed for particular conditions identified well in advance by radiation protection and operational staff members. The established vigorous survey and monitoring continues to assure that surface contamination levels remain small, consistent with conditions present throughout the life of the Laboratory. Fermilab has limited beta-gamma contamination and essentially no alpha contamination. The probability of having both forms of contamination simultaneously is extremely small. Commonly found accelerator-produced isotopes at Fermilab include, but are not limited to,  $^3\text{H}$ ,  $^7\text{Be}$ ,  $^{11}\text{C}$ ,  $^{13}\text{N}$ ,  $^{15}\text{O}$ ,  $^{22}\text{Na}$ ,  $^{45}\text{Ca}$ ,  $^{54}\text{Mn}$ ,  $^{60}\text{Co}$ ,  $^{65}\text{Zn}$ , and  $^{175}\text{Hf}$ . When contamination is found, decontamination is the preferred course of action and the buildup of contamination in the workplace is thus rendered unlikely. Should the program of Fermilab be modified in the future in a way that encompasses significant decontamination and decommissioning activities, the need for additional monitoring of contamination levels and internal exposures will be evaluated and implemented proactively to assure compliance with requirements.

### 3.0 Elements of DOE O 458.1 Implementation for the ERPP

#### 3.1 Fermilab Policy for Environmental Radiological Protection

The Fermilab Environmental Policy is Fermilab's policy for conducting scientific research and all other lab operations with regard for the protection of the community and the environment, and in compliance with all applicable environmental laws and regulations, of which DOE O 458.1 is one.

#### 3.2 Key elements of ERPP Implementation

Environmental radiological protection at Fermilab is implemented through a number of individual programs addressing specific areas of environmental protection. Table 1 lists programs, plans, and reports that implement and document the Fermilab environmental radiological protection program.

**Table 1.** Fermilab Environmental Radiological Protection Program Documents

Major Programs, Plans and Reports	Responsible Organization	Document Status
Annual Site Environmental Report (ASER)	EPD	Prepared annually
Environmental ALARA Program Plan	RCO	In draft <sup>2</sup>
Environmental Monitoring Plan (EMP)	Environmental Protection Department (EPD)	In place <sup>1</sup>
Fermilab Environment, Safety and Health Manual (FESHM)	EPD	In place
Fermilab Radiological Control Manual (FRCM)	RCO	In place <sup>1</sup>
Groundwater Management Plan (GMP)	EPD	In place
NESHAP Report	RCO	Prepared annually
Procedure for calculations in support of the ASER	RCO	In draft <sup>2</sup>
Radiological Release and Clearance of Materials and Equipment program document, Technical Basis Document, and associated procedures	RCO	In draft <sup>2</sup>
Radioactive Low-Level Waste Certification Program	EPD/HCTT	In place

<sup>1</sup>Revisions may be required. Refer to the implementation schedule in Section 6.0 of this document.

<sup>2</sup>Refer to implementation schedule in Section 6.0 of this document.

#### 3.3 Graded Approach

As required by O 458.1 CRD section 2.a.(1), the Fermilab ERPP has incorporated a graded approach, which ensures that the level of effort expended to address a potential issue or problem is commensurate with the hazard or risk to the public and the environment from the associated Fermilab operation or activity. In this ERPP the graded approach is applied by clearly identifying and justifying those O 458.1 requirements that do not apply to operations or activities at Fermilab. The graded approach is also incorporated into each of the specific programs that implement the ERPP.

#### 4.0 Responsibilities

As indicated in the Fermilab Environmental Policy, all individuals at Fermilab are responsible for following Fermilab Environment, Safety and Health Manual (FESHM) and Fermilab Radiological Control Manual (FRCM) policies and procedures. Therefore, implementation of O 458.1 requirements is the responsibility of every organization and individual at Fermilab.

The RCO is the lead organization for facilitating O 458.1 implementation and assisting other organizations and individuals. The Radiation Physics Operations department (RPO) has a lead role, in conjunction with Facilities Engineering Services Section (FESS) for implementing release and clearance of property requirements found in section 2.k of the O 458.1 CRD. EPD, RPO, FESS and the Radiation Physics Science department (RPS) share responsibilities associated with reporting required in section 2.l of the O 458.1 CRD.

#### 5.0 Limitation and Optimization of Public Dose

##### 5.1 Implementation of DOE O 458.1 General Requirements

The CRD of DOE O 458.1 identifies four general requirements for contractors in paragraph 1. The requirements are incorporated in the implementation matrix below.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status	Implementation/Documentation Reference
1.a.	The contractor must establish and implement a program to protect the public and the environment against undue risk from radiation associated with DOE radiological activities through application of the Specific Requirements (paragraph 2.) in this CRD.	Full Compliance	This ERPP document fulfills this requirement.
1.b.	The contractor must provide a schedule for full implementation of the Specific Requirements in this CRD as directed by DOE.	Full Compliance	Refer to this ERPP, section 6.0
1.c.	The contractor must develop documentation that demonstrates how the Specific Requirements in this CRD are implemented.	Full Compliance	This ERPP document fulfills this requirement.
1.d.	The contractor must obtain DOE line management approval of the documentation demonstrating compliance with the Specific Requirements in this CRD.	Full Compliance	Obtained with DOE acceptance of this ERPP

##### 5.2 Environmental Radiological Protection Program

The general requirements for an ERPP are stated in paragraph 2.a. of the DOE O 458.1 CRD. Fermilab has determined that all articles of this section are applicable to the Laboratory.



O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status	Implementation/Documentation Reference
2.a.	<u>Environmental Radiological Protection Program.</u> The contractor conducting radiological activities must develop and implement a documented program which addresses compliance with the Specific Requirements in this CRD that are relevant to the particular activities being conducted.	Full Compliance	This ERPP document fulfills this requirement. Policies, plans, and procedures that address the specific requirements of the CRD are documented in the implementation matrix for each requirement in the sections that follow.
2.a.(1)	The program, (documented by the contractor's plans, procedures, protocols and other documents developed to implement the relevant requirements of this CRD) must be tailored to these activities and reflect a graded approach commensurate with the hazard or risk to the public and the environment resulting from the DOE operations.	Full Compliance	This ERPP document fulfills this requirement. Policies, plans, and procedures that address the specific requirements of the CRD are documented in the implementation matrix for each requirement in the sections that follow.
2.a.(2)	Where long-term stewardship and institutional controls for protection of the public and the environment are necessary to meet the Specific Requirements in this CRD, the contractor must ensure that the need for the controls is documented and maintained and to the extent the contractor is responsible, implement the controls. If the contractor is not responsible for implementation of the controls, the contractor must provide reasonable assurance that necessary controls are being implemented by the responsible party prior to conducting activities that can affect the public or the environment.	Full Compliance	FRCM  RWPs

### 5.3 Public Dose Limit

Doses to members of the public from Fermilab activities shall not exceed 100 mrem in a calendar year. Additionally, by order of the Fermilab Director as a long-standing policy, off site exposures due to Laboratory operations have been subject to a guideline of 10 mrem in a calendar year. This annual limit and the other requirements of DOE O 458.1 CRD paragraph 2.b are contained in FRCM Chapter 11, *Environmental Radiation Monitoring and Control*.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.b	<u>Public Dose Limit.</u> The contractor must establish and implement procedures and practices to address the following elements related to the public dose limit:	Outlined in sections below.	
2.b.(1)	DOE radiological activities, including remedial actions and activities using Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), must be conducted so that exposure of members of the public to ionizing radiation will:	Outlined in sections below.	

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<b>2.b.(1)</b> <b>(a)</b>	<p>Not cause a total effective dose (TED) exceeding 100 mrem (1mSv) in a year, an equivalent dose to the lens of the eye exceeding 1500 mrem (15 mSv) in a year, or an equivalent dose to the skin or extremities exceeding 5000 mrem (50 mSv) in a year, from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose excepting:</p> <ol style="list-style-type: none"> <li>1 Dose from radon and its decay products in air [Radon is addressed separately e.g., under paragraphs 2.f. and 2.h. of the Specific Requirements in this CRD and under Title 40 Code of Federal Regulations (CFR) Part 61, Subparts Q and T];</li> <li>2 Dose received by patients from medical sources of radiation, and by volunteers in medical research programs;</li> <li>3 Dose from background radiation; and</li> <li>4 Dose from occupational exposure under Nuclear Regulatory Commission (NRC) or Agreement State license or to general employees regulated under 10 CFR Part 835.</li> </ol>	Full compliance	<p>FRCM Article 1104, <i>Public Dose Limits</i></p> <p>Equivalent doses to the lens of the eye, the skin, or extremities to the public that exceed the stated limits are not considered credible</p>
<b>2.b.(1)</b> <b>(b)</b>	Comply with As Low As Reasonably Achievable (ALARA) requirements in paragraph 2.d. of the Specific Requirements in this CRD.	Full compliance	<p>FRCM Article 1105, <i>Responsibilities</i></p> <p>Fermilab Environmental ALARA Program Plan</p>
<b>2.b.(2)</b>	The public dose limit applies to members of the public located off DOE sites and on DOE sites outside of controlled areas, and to those exposed to residual radioactive material subsequent to any remedial action or clearance of property.	Full compliance	<p>FRCM Article 212, <i>Dose Limits for Visitors, Individuals Under 18 Years of Age, and Members of the Public</i></p> <p>FRCM Article 1104, <i>Public Dose Limits</i></p>

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

#### 5.4 Temporary Dose Limits

If special circumstances could affect a Fermilab radiological activity in such a manner that the potential dose to a member of the public could exceed a Total Effective Dose (TED) of 100 mrem in a year, Fermilab will submit a request for specific authorization for a temporary public dose limit higher than 100 mrem in a year to the responsible DOE Site Office Manager.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<b>2.c</b>	<u>Temporary Dose Limit.</u> If special circumstances could affect a DOE radiological activity in such a manner that the potential dose to a member of the public could exceed a TED of 100 mrem (1 mSv) in a year the contractor must submit a request for specific authorization for a temporary public dose limit higher than 100 mrem (1 mSv) in a	Full Compliance	FRCM Article 1104, <i>Public Dose Limits</i>

WARNING: Paper copies of this procedure may be obsolete after it is printed.  
The current version of this procedure is found at: ESH DocDB 6806

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
	year to the responsible Field Element Manager. This request must include documentation that justifies the need for the increase, the alternatives considered, and the application of the ALARA process. The specific exposure pathways excepted in paragraphs 2.b.(1)(a) 1-4 of the Specific Requirements in this CRD are also excepted for temporary dose limits.		

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

### 5.5 As Low as Reasonably Achievable (ALARA)

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<b>2.d.(1)</b>	An ALARA process must be implemented to optimize control and management of radiological activities so that doses to members of the public (both individual and collective) and releases to the environment are kept as low as reasonably achievable. The process must be applied to the design or modification of facilities and conduct of activities that can expose the public or the environment to radiation or radioactive material.	Full compliance	Fermilab Environmental ALARA Program Plan  FRCM Chapter 3, Part 5, <i>Fermilab ALARA Program</i>  FRCM Chapter 8, <i>ALARA Management of Accelerator Radiation Shielding</i>  Radiation Safety Subcommittee (RSSC) serves as the ALARA committee and ensures ALARA is implemented uniformly throughout Fermilab
<b>2.d.(2)</b>	The ALARA process must: consider DOE sources, modes of exposure and all pathways which potentially could result in the release of radioactive material into the environment, or exposure to the public; use a graded approach; and, to the extent practical and when appropriate, be coordinated with the 10 CFR Part 835 ALARA process.	Full compliance	Fermilab Environmental ALARA Program Plan  FRCM Chapter 3, Part 5, <i>Fermilab ALARA Program</i>

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

### 5.6 Demonstrating Compliance with the Public Dose Limit

Fermilab evaluates compliance with public dose limits through a formal annual assessment of exposure pathways including direct radiation, air-immersion, and ingestion pathways. The dose assessments are published annually in the *ASER*; air emissions assessments are also provided to the EPA in a report submitted under the requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61 Subpart H).

Inputs to the Fermilab dose assessment include on-site area monitor data, air emissions and liquid effluent monitoring data. Data are collected as part of the EMP, which is updated annually and submitted to DOE. Data collected under the EMP is published annually, and posted publicly, in the ASER. Data quality objectives (DQOs) are established as part of the Fermilab area monitoring program, and sampling and monitoring objectives are established for environmental monitoring.

The Fermilab external dosimetry program is accredited by the DOE Laboratory Accreditation Program. Models used to calculate dose are also DOE- and EPA-approved.

The Fermilab EMP includes monitoring of air emissions, liquid effluents, and environmental receptors (e.g., surface water, groundwater, soils, etc.). Please refer to the EMP for complete details of the monitoring programs.

Prior annual dose assessments considered impacts to the maximally exposed individual (MEI) off-site. All dose assessments performed to date show that the total dose to the MEI averages less than 1% of the 100-mrem public dose limit; consequently, detailed evaluation of dose to the lens of the eye, skin, and extremities is not required. Additionally, since the dose is less than 25 mrem, only DOE sources are considered in these assessments.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.e	<u>Demonstrating Compliance with the Public Dose Limit.</u> The contractor must establish and implement procedures and practices to demonstrate compliance with the public dose limit and to address the following elements:	Outlined in sections below.	
2.e.(1)	Dose evaluations to demonstrate compliance with the public dose limit in paragraph 2.b.(1) of the Specific Requirements in this CRD and assess collective dose must include the following:	Outlined in sections below.	
2.e.(1) (a)	<p>The TED to members of the public from exposure to radiation, airborne effluents, and liquid effluents, of DOE origin.</p> <ol style="list-style-type: none"> <li>1 Compliance may be demonstrated by calculating dose to the representative person or to the maximally exposed individual (MEI).</li> <li>2 Determination of the representative person or the MEI must include members of the public both on DOE sites outside of controlled areas and off DOE sites.</li> <li>3 If it is suspected that any of the dose limits specified in paragraph 2.b.(1)(a) of the Specific Requirements in this CRD may be exceeded or the estimated TED for members of the public exceeds 25 mrem (0.25 mSv) in a year, then dose to the lens of the eye, skin, and extremities must be evaluated.</li> </ol>	Full Compliance	<p>FRCM Article 1104, <i>Public Dose Limits</i></p> <p>ASER and associated procedure</p> <p>The TED threshold of 25 mrem is not likely to be approached and is explicitly stated in FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i></p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.e.(1)  (b)	<p>Analytical models that consider likely exposure pathways, such as:</p> <ol style="list-style-type: none"> <li>1 Direct external radiation from sources located on-site;</li> <li>2 External radiation from airborne radioactive material;</li> <li>3 External radiation from radioactive material deposited on surfaces off-site;</li> <li>4 Internal radiation from inhaled airborne radioactive material;</li> <li>5 Internal radiation from radioactive material ingested with water, and with food from terrestrial crops or animal products (e.g., meat, eggs, milk);</li> <li>6 Internal radiation from radioactive material ingested with aquatic food products such as fish, shellfish, crustaceans (e.g., crayfish, shrimp, crab, lobsters), and aquatic plants and algae;</li> <li>7 External or internal radiation due to residual radioactive material on, or in, cleared real property; and</li> <li>8 Any other pathway unique to the DOE site or activity.</li> </ol>	Full Compliance	<p>FRCM Article 1104, <i>Public Dose Limits</i></p> <p>ASER and associated procedure</p> <p>NESHAP report</p> <p>EMP</p>
2.e.(1)  (c)	<p>The dose to members of the public from DOE-related exposure sources only, if the projected DOE-related dose to the representative person or MEI is 25 mrem (0.25mSv) in a year or less. If the DOE-related dose is greater than 25 mrem in a year, the dose to members of the public must include both major non-DOE sources of exposure (excluding dose from radon and its decay products in air, background radiation dose, occupational doses and doses due to medical exposures) and dose from DOE-related sources;</p>	Full Compliance	<p>FRCM Article 1104, <i>Public Dose Limits</i></p> <p>ASER procedure</p> <p>FRCM policy does not allow MEI dose to exceed 25 mrem in a year. Fermilab has design, controls and monitoring in place such that there are no credible circumstances where MEI could exceed 25 mrem in a year. Historical MEI doses from Fermilab operations have been well below 25 mrem/year.</p>
2.e.(1)  (d)	<p>Collective dose for members of the public resulting from radiation emitted and radioactive materials released from DOE radiological activities only (not including radon and its decay products). Collective dose for members of the public must be representative of the total dose and of adequate quality for supported comparisons, trending or decisions. Consistent with the graded approach, collective dose estimates may be truncated by distance (e.g., 50 miles) or individual dose level (e.g., 10 microrem) when integration of doses beyond such thresholds does not significantly affect data quality objectives. Where it is of concern, collective dose for members of the public resulting from radon and its decay products released by DOE radiological activities needs to be calculated separately from other radionuclides.</p>	Full Compliance	<p>FRCM Article 1104, <i>Public Dose Limits</i></p> <p>ASER and associated procedure</p> <p>NESHAP report</p> <p>-see also,</p> <p>ESH-RPO-MON-01, <i>Routine Monitoring Program</i>, which includes collecting representative environmental dosimetry data in many areas where the public may be present</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.e.(2)	The estimated individual dose to the MEI or representative person that is representative of the persons or group likely to receive the most dose and is based on pathway and exposure parameters that are not likely to underestimate or substantially overestimate the dose, and, the collective dose (population dose) that is a realistic as practicable estimate of the sum of the doses to all members of the actual exposed population.	Full compliance	ASER and associated procedure
2.e.(3)	Site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of DOE radiological activities, land use, food supplies, and exposure pathway information must be updated, as necessary, to document significant changes that could affect dose evaluations.	Full compliance	ASER and associated procedure
2.e.(4)	Values of assumed default or site-specific parameters used in calculations must be identified and included with the documentation of the calculations.	Full Compliance	ASER and associated procedure
2.e.(5)	Direct measurements must be made, to the extent practicable, to obtain information characterizing source terms, exposures, exposure modes, and other information needed in evaluating dose.	Full compliance	ASER and associated procedure  FRCM Chapter 5, Part 5, <i>Radiological Monitoring and Surveys</i>  FRCM Article 812.5, <i>Special Technical Considerations</i>
2.e.(6)	Models for dose evaluation calculations must be appropriate for their purpose. Dose evaluation models that are codified or approved for use by regulators of DOE or by DOE must be used where applicable. Alternatives to such codified or approved dose evaluation models to be used for demonstrating compliance must be approved by the Field Element Manager.	Full compliance	The certified CAP88-PC4.1 code for public doses from radioactive air emission, or special Monte Carlo codes, such as MARS, are used by the Radiation Physics organization to calculate public doses.  Documented in NESHAP report and ASER.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.e.(7)	DOE-approved dose coefficients must be used to evaluate doses resulting from DOE radiological activities. Use of alternative dose coefficients must be approved by the Chief Health, Safety and Security Officer or by a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.	Full compliance	ASER and associated procedure  FRCM Appendix 2A: <i>Weighting Factors for Organs and Tissues</i>  FRCM Table 8.1, <i>Radiation Weighting Factors for Various Particles</i>  FRCM Table 8.2, <i>Neutron Radiation Weighting Factors According to ICRP Publication 103</i>  FRCM Chapter 11 specifies the use of DOE-STD-1196-2021, <i>Derived Concentration Technical Standard</i> <sup>2</sup>
2.e.(8)	Doses to members of the public from airborne effluents must be evaluated with the CAP-88 model or another EPA-approved model or method to demonstrate compliance with applicable subparts of 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants.	Full compliance	ASER and associated procedure  NESHAP Report  FRCM Article 1107, <i>Management of Environmental Airborne Radioactivity</i>
2.e.(9)	Environmental monitoring must be conducted to characterize routine and non-routine releases of radioactive material from radiological activities, estimate the dispersal pattern in the environs, characterize the pathway(s) of exposure to members of the public and estimate the doses to individuals and populations in the vicinity of the site or operation commensurate with the nature of the DOE radiological activities and the risk to the public and the environment. Radiological monitoring must be integrated with the general environmental and effluent monitoring. Environmental monitoring must include, but is not limited to:	Full compliance	ASER and associated procedure  NESHAP report  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>  FRCM Appendix 11A, <i>Sources, Measurement and Control of Environmental Radiation</i>  -see also,  ESH-RPO-MON-01, <i>Routine Monitoring Program</i>  EMP
2.e.(9) (a)	Effluent Monitoring	Full compliance	EMP  ASER  NESHAP report  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.e.(9)  (b)	Environmental Surveillance	Full compliance	EMP  ASER  NESHAP report  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>
2.e.(9)  (c)	Meteorological Monitoring. Meteorological monitoring must be commensurate with the level of site radiological activities, the site topographical characteristics, and the distance to critical receptors. The scope must be sufficient to characterize atmospheric dispersion and model the dose to members of the public over distances commensurate with the magnitude of potential source terms and possible pathways to the atmosphere.	Full compliance	per EMP, "An on-site meteorological station is maintained near the New Muon Laboratory, north of Wilson Street, in the northern portion of the site. Air temperature, wind velocity and direction, relative humidity, precipitation, and solar radiation are logged at this site."  ASER
2.e.(9)  (d)	Pre-operational Monitoring. Prior to the startup of a new site, facility or process with the potential to expose the public or environment to radiation or radioactive material, it is necessary to ensure that adequate knowledge exists to understand: 1) radiological background; 2) pertinent environmental and ecological parameters; and 3) potential pathways for human exposures or ecological/natural resource impacts either from existing data or documents (for example, NEPA evaluations or existing monitoring and surveillance programs, etc.) or from the conduct of a pre-operational study initiated at least one year prior to startup of a new operation.	Full compliance	FESHM 8010 Environmental Management System  EMP  FRCM Chapter 5, Part 5, <i>Radiological Monitoring and Surveys</i>  -see also,  ESH-RPO-MON-01, <i>Routine Monitoring Program</i>
2.e.(10)	Site-specific environmental monitoring criteria must be established to ensure that representative measurements of quantities and concentrations of radiological contaminants are conducted and that the effects from DOE radiological activities on members of the public and the environment are monitored sufficiently to demonstrate compliance with the Specific Requirements in this CRD.	Full compliance	EMP  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>  Compliance demonstrated via ASER

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

<sup>2</sup> FRCM Chapter 11 update in progress at the time of the revision to this ERPP to reflect the use of DOE-STD-1196-2021 rather than DOE-STD-1196-2011

## 5.7 Airborne Radioactive Effluents

Fermilab monitors facility emissions and ambient air for radiological content. Facilities that conduct monitoring of airborne effluents use systems compliant with ANSI/HPS N13.1-2011, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and*

*WARNING: Paper copies of this procedure may be obsolete after it is printed.*

*The current version of this procedure is found at: ESH DocDB 6806*



*Ducts of Nuclear Facilities.* The Environmental Monitoring Plan establishes the implementation practices for radiological surveillance of materials and effluents. Standard operating procedures are established for each activity, as well as actions necessary for remedy.

Fermilab facilities are not required to be continuously monitored (as per 40 CFR 61.93[b][4][i]), but Fermilab does perform periodic confirmatory measurements and/or takes a graded approach to ascertain that dose from the emissions remain below the threshold of 0.1 mrem in any given year. The 40 CFR 61, Appendix D methodologies are used to estimate potential emissions from small emission sources. The dose impacts from all Fermilab facilities with radioactive effluents are evaluated by a combination of the following methods:

- Performing assessments of airborne emission impacts through NESHAPs reviews of facilities that are known to work with or process radioactive materials;
- Continuous monitoring of certain facilities, such as beamline target and absorber area emission stacks;
- Periodic confirmatory sampling of accelerator facilities;
- Inventory method for small quantities of radioactive materials used for research or material processing purposes, and;
- Determination of the external exposure component of dose through the use of optically stimulated dosimeters (OSLs) and track etch dosimeters.

The air-emission dose to members of the public from DOE-related activities is calculated with CAP88-PC, an EPA-approved dose modeling program, and a SOP is used for calculating dose to all environmental receptors. The dose to the MEI will vary due to the stack emission parameters, location of the source term, facility operations schedule, and site meteorological conditions. The EMP describes the airborne radioactive effluent surveillance program.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.f.	<b><u>Airborne Radioactive Effluents</u></b> The contractor must establish and implement procedures and practices related to airborne radioactive effluents so that radiological activities are conducted in a manner such that the release of radioactive material to the atmosphere will:	Outlined in sections below.	
2.f.(1)	Be evaluated using the ALARA process established in paragraph 2.d. of the Specific Requirements in this CRD;	Full compliance	Fermilab Environmental ALARA Program Plan

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.f.(2)	Not cause radon-222 flux rates to exceed 20 pCi (0.7 Bq) m <sup>-2</sup> -sec <sup>-1</sup> averaged over the surface area overlaying waste, including the covering or other confinement structures, wherever radium-226 wastes are accepted for storage or disposal (See 40 CFR Part 61, Subparts Q and T);	Not applicable	This article addresses radon-222 flux rates exceeding 20 pCi (0.7 Bq) per m <sup>2</sup> per second where waste containing radium-226 is present. While Fermilab may hold or store laboratory or bench-top quantities of radium-226, this usage would not generate quantities of radium-226 waste from which radon-222 flux rates could be measured, and the presence of significant quantities of this type of waste is not anticipated at Fermilab. Therefore, this article and 40 CFR Part 61, Subparts Q and T are not applicable.
2.f.(3)	(3) Meet compliance agreements under 40 CFR Part 61, Subparts H, Q, and T;	Full compliance	NESHAP QA Plan  Demonstrated in annual NESHAP report  As discussed in section 2.f.(2), 40 CFR Part 61 Subparts Q and T are not applicable.
2.f.(4)	(4) Not cause the radon-220 and radon-222 decay product concentration, including background, to exceed 0.03 WL in buildings that are being released from DOE control. Further, a reasonable effort must be made to meet a 0.02WL generic guideline for annual average radon-220 and radon-222 decay product concentration, including background, in such buildings; and	Not applicable	Fermilab activities do not release radon in sufficient quantities to exceed 0.03 WL in buildings released from DOE control. Further, Fermilab activities do not release radon in sufficient quantities to exceed a 0.02 WL in such buildings. Therefore, this article is not applicable.
2.f.(5)	(5) Not exceed 3 pCi/L annual average radon-220 and radon-222 concentration, not including background, at the site boundary if DOE activities release radon-220 and radon-222 or their decay products.	Not applicable	Fermilab activities do not release significant concentrations of radon. Article 2.f.(5) establishes radon decay product concentration limits at the site boundary if DOE activities release radon. Fermilab activities do not release radon in sufficient quantities to exceed 3 pCi/L at the site boundary. Therefore, this article is not applicable.

<sup>1</sup>Implementing documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

## 5.8 Control and Management of Radionuclides from DOE Activities in Liquid Discharges

Surface water sampling is a significant component of Fermilab's monitoring program. Fermilab relies extensively on water to provide cooling for the accelerators and associated equipment. The Laboratory's surface water system is sampled to: assess the potential for direct or indirect impacts on the environment and the public, identify actual impacts on the environment, e.g., the food chain, and confirm compliance with a number of permits and regulations, including Derived Concentration Standards (DCSs) specified by DOE.

Precipitation that falls to the site is collected and retained in lakes and ponds for use primarily as cooling water. A network of pipes and ditches is used to transfer cooling water between operational locations. Excess surface water is released from the site to "Waters of the State" at six discharge locations (outfalls). The outfalls are noted in Fermilab's Geographical Information System (GIS).

Discharge from the outfalls is regulated by permit. Fermilab holds a site-specific permit under the state-run, federal National Pollutant Discharge Elimination System (NPDES). Fermilab is required to monitor for specified parameters at each outfall and report the results monthly to the Illinois Environmental Protection Agency.

Numerous sumps located throughout the site collect, store and discharge water that drains from below ground tunnels, buildings, other structural footers and from "bathtubs" in experimental areas. Collected water, especially those in experimental areas, may be contaminated with radionuclides. Fermilab regularly monitors sumps associated with the accelerator complex to ensure the environment and members of the public are adequately protected.

Fermilab maintains a piping system for conveying sanitary sewer waste resulting from site activities. Fermilab does not operate a treatment system. Sanitary effluent is discharged either to the Warrenville municipal treatment system to the east or to the Batavia municipal treatment system to the west. At the point of discharge from Fermilab's sewage piping system to the two municipal sewer systems, automated, self-contained samplers are operated to take composite samples on a continuous basis from the waste streams to confirm compliance of Fermilab's sanitary discharge with DOE requirements, and state and local regulations.

Fermilab routinely conducts groundwater surveillance and compliance monitoring. The primary purposes for this activity is to monitor the impacts of current physics operations; to determine the extent and understand the impact of past activities; and to provide a basis for projecting the potential impacts of planned activities on future groundwater conditions through computer groundwater flow modeling.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.g. (1)-(3)	<p><b>Control and Management of Radionuclides from DOE Activities in Liquid Discharges.</b> The contractor must establish and implement procedures and practices related to control and management of radionuclides from DOE activities in liquid discharges. Operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities must:</p> <p>(1) Characterize planned and unplanned releases of liquids containing radionuclides from DOE activities, consistent with the potential for on- and off-site impacts and provide an assessment of radiological consequences as necessary to demonstrate compliance with the Specific Requirements of this CRD.</p> <p>(2) Comply with the ALARA process requirements in paragraph 2.d. of the Specific Requirements in this CRD.</p> <p>(3) Conduct activities to ensure that liquid releases containing radionuclides from DOE activities are managed in a manner that protects ground water resources now and, in the future, based on use and value considerations.</p>	Full compliance	<p>EMP</p> <p>Fermilab Environmental ALARA Program Plan</p> <p>FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i></p> <p>FESHM Chapter 8025, <i>Wastewater Discharge to Sanitary Sewers</i></p> <p>FESHM Chapter 8026, <i>Surface Water Protection</i></p>
2.g.(4)	Conduct activities to ensure that liquid discharges containing radionuclides from DOE activities do not exceed an annual average (at the point of discharge) of either of the following:	Outlined in sections below.	
2.g.(4) (a)	5 pCi (0.2 Bq) per gram above background of settleable solids for alpha-emitting radionuclides.	Not applicable; Fermilab does not discharge settleable solids containing alpha-emitting radionuclides.	
2.g.(4) (b)	50 pCi (2 Bq) per gram above background of settleable solids for beta-gamma-emitting radionuclides.	Full compliance	<p>EMP</p> <p>FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i></p>
2.g.(5)	Except for tritium and sanitary sewers, apply Best Available Technology (BAT) if at the point of discharge:	Not Applicable	Discharges are always below the Derived Concentration Standard (DCS) values specified in DOE-STD-1196-2021, <i>Derived Concentration Technical Standard</i> <sup>2</sup> . No BAT is required at Fermilab. Should the unlikely conditions in sections 2.g.(5)(a-c) arise at Fermilab, this ERPP and the EMP will be revised to address it.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<b>2.g.(5) (a-c)</b>	<p>(a) The annual average concentration of a given radionuclide is greater than the DOE-approved derived concentration standard (DCS) value for water contained in the derived concentration Standard (DCS) value for water contained in the Derived Concentration Technical Standard, DOE-STD-1196-2021, or for multiple radionuclides, the composite DCS must be the sum of the fractional DCS values derived from DOE-approved DCS values;</p> <p>(b) The discharge contributes greater than 10 mrem (0.1 mSv) annual TED to members of the public; or</p> <p>(c) The collective dose from all DOE sources is greater than 100 person-rem (1 person-Sv) and the liquid discharge contributes 50 percent or more of this collective dose.</p>	Full compliance	<p>Fermilab's annual average concentration is well below the DOE DCS values specified in DOE-STD-1196-2021, <i>Derived Concentration Technical Standard</i><sup>2</sup>. See 2.g.(5) above.</p> <p>FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i></p>
<b>2.g.(6)</b>	Control releases of tritium in a manner that has been established by application of the ALARA process.	Full compliance	<p>EMP</p> <p>Fermilab Environmental ALARA Program Plan</p> <p>FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i></p>
<b>2.g.(7)</b>	Conduct radiological activities to ensure that radionuclides from DOE activities contained in liquid effluents do not cause private or public drinking water systems to exceed the drinking water maximum contaminant levels in 40 CFR Part 141, <i>National Primary Drinking Water Regulations</i> .	Full compliance	<p>Monitored as described in EMP</p> <p>FRCM Article 1104, <i>Public Dose Limits</i></p>
<b>2.g.(8)</b>	Control discharges into sanitary sewers in accordance with the following requirements:	Outlined in sections below.	
<b>2.g.(8) (a)</b>	Except for excreta from patients and medical research volunteers treated with radioactive material, discharges of liquids containing radionuclides from DOE activities into non-Federally owned sanitary sewers are prohibited unless:	Full compliance	<p>EMP</p> <p>FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i></p> <p>Fermilab Environmental ALARA Program Plan</p> <p>ASER</p>
<b>2.g.(8) (a)1</b>	The material is readily soluble (or readily dispersed biological materials) in water;	Full Compliance	<p>EMP</p> <p>FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i></p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.g.(8) (a)2	Such discharges comply with ALARA process requirements;	Full compliance	Fermilab Environmental ALARA Program Plan  FRCM Chapters 3, Part 5, <i>Fermilab ALARA Program</i> and 11, <i>Environmental Radiation Monitoring and Control</i>
2.g.(8) (a)3	BAT is applied to discharges of liquid releases containing radionuclides from DOE activities if the average monthly concentration level at the point of discharge into the sanitary sewer is greater than five times the DOE-approved DCS values for ingestion except for tritium which is addressed under paragraph 2.g.(6);	Not Applicable	Discharges are always below the DCS values. No BAT is required at Fermilab. Should the unlikely condition that the condition specified in 2.g.(8)(a)3 arises at Fermilab, this ERPP and the EMP will be revised to address it.
2.g.(8) (a)4	Releases do not result in an annual discharge (above background) into sanitary sewers in excess of 5 Ci (185 GBq) of tritium; 1 Ci (37 GBq) carbon-14 or 1 Ci (37 GBq) of all other radionuclides combined;	Full compliance	EMP  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>  ASER
2.g.(8) (a)5	DOE operations are conducted to minimize long-term buildup of radionuclides in the sewage treatment plants that may create handling and disposal issues or interfere with plant operations;	Full compliance	EMP  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>
2.g.(8) (a)6	The contractor notifies the responsible Field Element Manager of unusual discharges to sanitary sewers from DOE facilities;	Full Compliance	EMP  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>
2.g.(8) (a)7	The contractor prepares and provides a report that describes and summarizes such discharges to sanitary sewers to the responsible Field Element Manager at least annually; and	Full compliance	EMP  ASER
2.g.(8) (a)8	Existing agreements, contracts, statements of understanding or other formal arrangements with other agencies concerning the discharge of liquids containing radionuclides from DOE activities to sanitary sewers are not violated.	Full Compliance	Fermilab complies with contracts maintained with the cities of Batavia and Warrenville for the discharge of liquid effluents to sanitary sewers.
2.g.(8) (b)	DOE facilities discharging liquids containing radionuclides from DOE activities into sanitary sewer systems owned by the Federal government are not subject to the requirements in paragraph 4.g.(8)(a) of this Order if:	Not applicable	Fermilab does not discharge liquids to sanitary sewer systems owned by the Federal government.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.g.(8) (b)1	The system provides treatment in accordance with the environmental radiological protection program and	Not applicable	Fermilab does not discharge liquids to sanitary sewer systems owned by the Federal government.
2.g.(8) (b)2	Sludge from the system is disposed of in accordance with this Order and applicable Federal, State, and municipal regulations.	Not applicable	Fermilab does not discharge liquids to sanitary sewer systems owned by the Federal government.
2.g.(9)	Prohibit the use of soil columns.	Full compliance	FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>
2.g.(10)	Manage the disposition of non-process water potentially containing radionuclides from DOE activities to protect soil and ground water and prevent the creation of future cleanup sites.	Full compliance	EMP
2.g.(11)	Ensure that storm water runoff containing radionuclides from DOE activities is considered, as appropriate, as a pathway of exposure that has the potential for on- and off-site impacts. Using a graded approach, the receiving ecosystem including, but not limited to, wetlands, floodplains, streams, ponds, basins and lakes must be monitored to evaluate human or ecological impacts when warranted based on site specific risk.	Full Compliance	EMP

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

<sup>2</sup> FRCM Chapter 11 update in progress at the time of the revision to this ERPP to reflect the use of DOE-STD-1196-2021 rather than DOE-STD-1196-2011.

## 5.9 Radioactive Waste and Spent Nuclear Fuel

FESHM Chapter 8020, Chemical and Radioactive Waste Management, and the Fermilab Low-Level Waste Certification Program (LLWCP) describe the program which ensures safe management of radioactive waste at Fermilab in accordance with all applicable State, Federal, and DOE regulations.

Fermilab does not dispose of waste on-site, nor does it manage spent nuclear fuel, transuranic waste, high level radioactive waste, or byproducts of uranium and thorium mill tailings. Fermilab does not manage waste with significant quantities of radium or thorium. Any waste that contains DOE-owned or -produced radionuclides is managed as low-level waste at Fermilab, including accelerator-produced radioactive material, or naturally-occurring radioactive material (NORM). All low-level wastes are managed as required by the LLWCP, disposal facility Waste Acceptance Criteria (WAC) and the supporting Fermilab Radiological Protection Program.

Fermilab packages radioactive waste, in accordance with site standard operating procedures, disposal facility waste acceptance criteria, and Department of Transportation (DOT) requirements. Packaging characterization and treatment requirements for specific wastes are established in the approved waste profiles of the disposal facility. Consideration of the structural

integrity and leachability of waste forms in the disposal cells, as well as long-term stewardship of the disposal facility, are integral parts of the Waste Acceptance requirements.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.h.	<b>Radioactive Waste and Spent Nuclear Fuel.</b> The contractor must establish and implement procedures and practices to ensure that management, storage, and disposal of radioactive waste and spent nuclear fuel on DOE sites address the following elements:	Outlined in sections below.  Requirements for spent nuclear fuel are not applicable to Fermilab.	
2.h.(1)	Radiological activities must be conducted in a manner such that radiation exposure to members of the public from management and storage of radioactive waste complies with ALARA process requirements and does not result in a TED greater than 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.	Full compliance	FESHM Chapter 8021, <i>Chemical and Radioactive Waste Management</i>  FRCM Chapter 4, Part 4, <i>Radioactive Waste Management</i>  Fermilab Environmental ALARA Program Plan  ASER
2.h.(2)	Management of spent nuclear fuel, and high-level and transuranic wastes at a disposal facility which is not regulated by the NRC must comply with the requirements of this CRD and 40 CFR Part 191, <i>Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes</i> .	Not applicable to Fermilab; Fermilab does not manage spent nuclear fuel nor high-level and transuranic wastes.	
2.h.(3)	Management, storage and disposal of low-level radioactive waste must be conducted in a manner such that exposure to members of the public to radiation from radioactive waste complies with ALARA process requirements, and does not exceed a TED of 25 mrem (0.25 mSv) in a year from all exposure pathways and radiation sources associated with the waste, except for transportation and radon and its decay products.	Full compliance	FRCM Chapter 4, Part 4, <i>Radioactive Waste Management</i>  FESHM Chapter 8021, <i>Chemical and Radioactive Waste Management</i>  LLWCP  ASER  In general, the public is prohibited from all areas where radioactive waste may be present, as established by the Site Security Plan.



O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.h.(4)	Management, storage and disposal of 11e.(2) byproduct material, as defined in Section 11e.(2) of the Atomic Energy Act (AEA) and other wastes containing uranium and thorium and their decay products which are not subject to the requirements of 40 CFR Part 192, <i>Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings</i> , are not at facilities licensed by the NRC, or are not disposed of at DOE low-level waste disposal facilities, must be in accordance with the requirements of paragraph 2.h. of the Specific Requirements in this CRD and DOE-approved plans.		Fermilab does not manage uranium or thorium mill tailings or waste produced by the extraction or concentration of uranium or thorium. Other wastes containing uranium or thorium are managed via the LLWCP and are disposed of at low-level waste facilities.
2.h.(5)	Discrete sources of radium-226, accelerator produced radioactive material, or naturally-occurring radioactive material (NORM) that pose a threat similar to discrete sources of radium-226, which are defined as Section 11e.(3) or 11e.(4) byproduct material in the AEA, must be managed as high-level waste, low-level waste or 11e.(2) material as appropriate under DOE AEA authorities and in compliance with the Specific Requirements in this CRD and the requirements in the CRD to DOE O 435.1 Chg 1.	Full compliance	FRCM Chapter 4, Part 4, <i>Radioactive Waste Management</i>  FESHM Chapter 8021, <i>Chemical and Radioactive Waste Management</i>  LLWCP  ASER  In general, the public is prohibited from all areas where radioactive waste may be present as established by the Site Security Plan.

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

### 5.10 Protection of Drinking Water and Ground Water

Fermilab maintains a Groundwater Management Plan (GMP) for effective integration of requirements among all site programs and activities to ensure that federal, state, county, local, and other requirements pertaining to groundwater protection and management are incorporated in a consistent, effective manner. This plan documents Fermilab's effort to eliminate or minimize adverse impacts of operations on groundwater. Its purpose is to determine the extent and understand the impact of past activities, remediate adversely affected areas, and monitor current operations. In addition, the data collected by the groundwater monitoring program provides a basis for projecting the potential impacts of planned activities on future groundwater conditions through computer groundwater flow modeling. The plan is driven by Fermilab's commitment to protect groundwater resources and it is an integral element of the Environmental Management System. Groundwater surveillance and compliance monitoring at Fermilab is carried out as required under the Resource Conservation and Recovery Act (RCRA) and the Fermilab Environmental Monitoring Strategy. The program helps to fulfill the environmental protection and monitoring requirements outlined in DOE O 458.1.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.i.(1)	The contractor must establish and implement procedures and practices to ensure that DOE sites provide a level of radiation protection for persons consuming water from a drinking water system operated by DOE, directly or through a DOE contractor, which is equivalent to that provided to members of the public by the community drinking water standards of 40 CFR Part 141, <i>National Primary Drinking Water Regulations</i> (that is, not exceed the radionuclide maximum contaminant levels (MCLs).	Not applicable to Fermilab; The drinking water system is provided by the local municipalities. No drinking water system is operated by DOE, directly or through a DOE contractor.	
2.i.(2)	The contractor must protect ground water from radiological contamination to ensure compliance with dose limits in the Specific Requirements in this CRD and consistent with ALARA process requirements. To that end the contractor must ensure that:	Outlined in sections below.	
2.i.(2) (a)	Baseline conditions of the ground water quantity and quality are documented;	Full compliance	Fermilab Groundwater Management Plan  EMP  FESHM Chapter 8011, <i>Groundwater Protection – Excavations and Wells</i>  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>
2.i.(2) (b)	Possible sources of, and potential for, radiological contamination is identified and assessed;	Full compliance	Fermilab Groundwater Management Plan  EMP  Fermilab Environmental ALARA Program Plan  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>  NEPA and Shielding Assessments identify possible sources  Environmental Monitoring program demonstrates compliance
2.i.(2) (c)	Strategies to control radiological contamination are documented and implemented;	Full compliance	EMP  Fermilab Environmental ALARA Program Plan  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.i.(2) (d)	Monitoring methodologies are documented and implemented; and	Full compliance	Fermilab Groundwater Management Plan  EMP  FRCM Article 1106, <i>Management of Environmental Waterborne Radioactivity</i>  Environmental Monitoring Standard Operating Procedures
2.i.(2) (e)	Ground water monitoring activities are integrated with other environmental monitoring activities.	Full compliance	Fermilab Groundwater Management Plan  EMP  FESHM Chapter 8011, <i>Groundwater Protection – Excavations and Wells</i>  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

### 5.11 Protection of Biota

Fermilab has established policies and programs for monitoring the environment for radiation to protect biota consistent with the requirement of DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* [DOE2019].

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.j.	<b>Protection of Biota.</b> The contractor must establish and implement procedures and practices to ensure that biota are protected and to address the following elements:	Outlined in sections below.	
2.j.(1)	Radiological activities that have the potential to impact the environment must be conducted in a manner that protects populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems from adverse effects due to radiation and radioactive material released from DOE operations.	Full compliance	FRCM Article 1104, <i>Public Dose Limits</i>  EMP
2.j.(2)	When actions taken to protect humans from radiation and radioactive materials are not adequate to protect biota then evaluations must be done to demonstrate compliance with paragraph 2.j.(1) of the Specific Requirements in this CRD in one or more of the following ways:	Not applicable	Fermilab activities to protect humans from radiation and radioactive materials are determined to be adequate to protect biota. Additional discussion

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
			is found in FRCM Article 1104, <i>Public Dose Limits</i> .
2.j.(2) (a)	Use DOE-STD-1153-2019, <i>A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota</i> .	Full compliance	FRCM Article 1104, <i>Public Dose Limits</i>  EMP
2.j.(2) (b)	Use an alternative approach to demonstrate that the dose rates to representative biota populations do not exceed the dose rate criteria in DOE-STD-1153-2019, Table 2.2.	Full compliance	FRCM Article 1104, <i>Public Dose Limits</i>  EMP
2.j.(2) (c)	Use an ecological risk assessment to demonstrate that radiation and radioactive material released from DOE operations will not adversely affect populations within the ecosystem.	Full compliance	FRCM Article 1104, <i>Public Dose Limits</i>  EMP

<sup>1</sup> Under development. Refer to the implementation schedule in Section 6.0.

## 5.12 Release and Clearance of Property

Section 2.k of O 458.1 requires procedures and practices for the release or clearance of property that potentially contains residual radioactive material. Fermilab has developed a material release program, *ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment*, in accordance with the requirements of O 458.1. The release process is based on process knowledge, field surveys and/or laboratory analysis. The plan is consistent with the requirements of the 2000 DOE suspension of recycling metals from radiological areas.

The *ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment* and the associated technical basis document and implementing procedure describe the release and clearance of personal property. They include a description of the measurement protocols, an evaluation of measurement methods, and the release criteria utilized. Fermilab adopts the pre-approved surface activity guidelines from DOE O 5400.5, *Radiation Protection of the Public and the Environment*, Figure IV-1 and the draft DOE G 441.1-XX, *Control and Release of Property with Residual Radioactive Material for use with DOE 5400.5, Radiation Protection of the Public and the Environment*. All measurement equipment used for measuring surface activity is sufficiently sensitive to meet these activity guidelines. For volumetric activity, Fermilab has adopted the *Indistinguishable from Background* (IFB) criteria discussed in DOE-STD-6004-2016, *Clearance and Release of Personal Property from Accelerator Facilities* [DOE2016]. If specific authorized limits are determined to be necessary, they must be requested and approved in accordance with the process described in DOE O 458.1 Section 2.k. If established Authorized Limits are found to be not protective, appropriate, or practical to apply for a specific type or portion of property, further clearance for that specific type or portion of property must not proceed without revised

Authorized Limits. The authorized limits used will be documented in the clearance documentation.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.	<u>Release and Clearance of Property.</u> The contractor must establish and implement procedures and practices to ensure that release or clearance of property with the potential to contain residual radioactive material must be conducted in accordance with DOE direction and in accordance with the requirements in paragraph 2.k. of the Specific Requirements in this CRD.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control  ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control
2.k.(1)	Property control and clearance processes must be developed and implemented in accordance with the dose limits in paragraph 2.b of the Specific Requirements in this CRD under any plausible use of the property and the ALARA process requirements in paragraph 2.d of the Specific Requirements in this CRD must be met before property is cleared.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i>  FRCM Chapter 3, Part 5, <i>Fermilab ALARA Program</i>  FRCM Chapter 11, Article 1102, <i>Scope</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control  ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(2)	Dose Constraints. Unless alternative dose constraints are approved by issuance of a directive or memorandum by the Chief Health, Safety and Security Officer or for NNSA, the Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer, the following dose constraints for DOE residual radioactive material must be applied to each specific clearance of property for any actual or likely future use of the property:	Outlined in sections below.	
2.k.(2) (a)	Real property – a TED of 25 mrem (0.25 mSv) above background in any calendar year;	Full Compliance	FRCM Article 1104, <i>Public Dose Limits</i>
2.k.(2) (b)	Personal property - a TED of 1 mrem (0.01 mSv) above background in any calendar year.	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Article 1104, <i>Public Dose Limits</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control</p>
2.k.(3)	Residual Radioactive Material. Property potentially containing residual radioactive material must not be cleared from DOE control unless either:	Outlined in sections below	
2.k.(3) (a)	The property is demonstrated not to contain residual radioactive material based on process and historical knowledge, radiological monitoring or surveys, or a combination of these; or	Documents in draft. See Section 6.0 for implementation schedule.	<p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<b>2.k.(3)</b>  <b>(b)</b>  <b>(1 – 4)</b>	<p>The property is evaluated and appropriately monitored or surveyed to determine: those stated in 2.k.(3)(b)<del>1-4</del>.</p> <p>1 The types and quantities of residual radioactive material within the property;</p> <p>2 The quantities of removable and total residual radioactive material on property surfaces (including residual radioactive material present on and under any coating);</p> <p>3 That for property with potentially contaminated surfaces that are difficult to access for radiological monitoring or surveys, an evaluation of residual radioactive material on such surfaces is performed which is:</p> <p>a Based on process and historical knowledge meeting the requirements of paragraph 2.k.(5) of the Specific Requirements in this CRD and monitoring and or surveys, to the extent feasible and</p> <p>b Sufficient to demonstrate that applicable specific or pre-approved DOE Authorized Limits will not be exceeded; and</p> <p>4 That any residual radioactive material within or on the property is in compliance with applicable specific or pre-approved DOE Authorized Limits.</p>	Not applicable	<p>Fermilab does not plan to clear radioactive items at this time. If that occurs, the documents below will be modified:</p> <ul style="list-style-type: none"> <li>a. This ERPP</li> <li>b. ESH-RP-ERPP-01- Radiological Release and Clearance of Materials and Equipment</li> <li>c. ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</li> <li>d. ESH-RPO-MON-09- Surveys for Release and Clearance of Materials and Equipment from Radiological Control</li> </ul>
<b>2.k.(4)</b>	<p>Evaluation of the Need for Maintaining Institutional Controls for Real Property. Real property under evaluation for clearance from DOE radiological controls must be evaluated against the need for maintaining institutional controls or impacting long-term stewardship of adjacent DOE real property. In situations where transfer of the real property to other use would impact long-term radiological protection of adjacent DOE properties, it must be demonstrated that the impact of the property clearance would not result in noncompliance for the adjacent property with the requirements of applicable statutes, regulations or DOE directives.</p>	Full compliance	<p>FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(5)	Process and Historical Knowledge. Contractors responsible for radiological clearance of property, when they rely in part, on process knowledge as a basis for clearance decisions, must establish a documented evaluation process, using a graded approach, for applying process and historical knowledge to determine if property potentially contains residual radioactive material.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control
2.k.(5) (a)	This process must include procedures for evaluating operational records and operating history, including the use of any radioactive materials or radiation generating devices.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control
2.k.(5) (b)	For real property, this process must address each specific property individually. If several parcels of land are contiguous, or if several structures are located in the same area and have a common operational history, a single evaluation for all of the properties is acceptable.	Full compliance	FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>



O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(5) (c)	If available process and historical knowledge cannot demonstrate that property does not contain residual radioactive materials, radiological monitoring or surveys must be conducted to supplement process and historical knowledge evaluations.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control  ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control
2.k.(5) (d)	If not supplemented by radiological surveys, process and historical knowledge evaluations must be adequate to determine:  1 Whether the property has ever been used for radiological activities or in areas that could have resulted in the presence of residual radioactive material within or on the property or  2 Whether property formerly containing residual radioactive material has been decontaminated and demonstrated to meet DOE Authorized Limits, and has not been used in a manner or in areas that could have resulted in the re-contamination of the property.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control
2.k.(5) (e)	For property that is determined to potentially contain residual radioactive material under paragraph 2.k.(5)(d) <u>1</u> of the Specific Requirements in this CRD or determined to be re-contaminated under paragraph 2.k.(5)(d) <u>2</u> of the Specific Requirements in this CRD, the process and historical knowledge evaluation must also include an assessment of the types and quantities of residual radioactive material and the sources and pathways by which the property became contaminated.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control
2.k.(6)	Authorized Limits.	Outlined in sections below.	

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(6)  (a)	Authorized Limits for the clearance of any property with residual radioactive material must provide reasonable assurance that the requirements of paragraphs 2.k.(1) and 2.k.(2) of the Specific Requirements in this CRD are met. Authorized Limits may be applied to property for which process knowledge cannot establish the absence of residual radioactive material and in which the presence of residual radioactive material cannot be determined.	Full compliance	<p>No specific authorized limits are used at Fermilab at this time.</p> <p>FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<p><b>2.k.(6)</b></p> <p><b>(b)</b></p>	<p>Authorized Limits must:</p> <p>1 Be developed in accordance with the ALARA requirements in paragraph 2.d. of the Specific Requirements in this CRD.</p> <p>2 Be based on the applicable dose constraint, supported by a complete exposure pathway analysis using appropriate methodologies, techniques, parameters and models (such as the RESRAD family of codes) that meet DOE quality assurance requirements under the CRD to DOE O 414.1D Quality Assurance, dated 4-25-11.</p> <p>3 Be expressed in terms of concentration of radioactivity per unit surface area (e.g., dpm per 100 cm<sup>2</sup>), radioactivity per unit mass (e.g., pCi per gram) or volume (e.g., pCi per ml), total radioactivity, or DOE controls and restrictions, if applicable.</p> <p>4 Explicitly state any restrictions or conditions on future use of the property necessary to ensure the basic dose limit and applicable dose constraint are not exceeded.</p> <p>5 In addition to paragraphs 2.k.(6)(b)1-4 of the Specific Requirements in this CRD for clearance of personal property only:</p> <p>a Be based on expected annual quantity of property to be cleared or</p> <p>b Be based on expected total amount of property cleared over the life of the project for specific remedial action or decontamination and decommissioning projects and</p> <p>c Prior to clearance of metals, the contractor must provide the necessary information to support a determination by the Field Element Manager that there is no practical internal DOE opportunity for reuse or recycle of the material or equipment.</p> <p>6 Authorized limits must be submitted to the Field Element Manager to obtain DOE approval.</p>	<p>Full compliance</p>	<p>No specific authorized limits are used at Fermilab at this time.</p> <p>FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(6) (c)	<p>Applications for DOE approval of Authorized Limits must contain the following:</p> <ol style="list-style-type: none"> <li>1 A description of the property.</li> <li>2 Specific limits proposed for each radionuclide or group of radionuclides and/or external radiation exposure, surrogate metrics, or conditions used to limit radionuclides.</li> <li>3 Potential collective dose to the exposed population and the potential dose to a member of the public most likely to receive the highest dose for both: actual or likely future use, and plausible future use of the property.</li> <li>4 ALARA assessments conducted under paragraph 2.d. of the Specific Requirements in this CRD for the proposed clearance action to include, at a minimum, the effects of: <ol style="list-style-type: none"> <li>a Implementing the proposed Authorized Limits;</li> <li>b Implementing alternative levels of residual radioactive material instead of the proposed Authorized Limits;</li> <li>c Not implementing the proposed Authorized Limits, i.e., not proceeding with the proposed clearance action.</li> </ol> </li> <li>5 A description of the procedures and radiological monitoring or surveys to be used to demonstrate compliance with proposed limits.</li> <li>6 Identification of any restrictions or conditions on the future use of the property upon which the proposed limits are based, and the means by which the restrictions or conditions will be implemented and maintained.</li> <li>7 An estimated date for when the property will be cleared and an estimate of when the property will be released from DOE control.</li> </ol>	Full compliance	<p>No specific authorized limits are used at Fermilab at this time.</p> <p>FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(6)  (d)	Property covered by Authorized Limits is subject to 10 CFR Part 835 requirements unless the criteria in paragraphs 2.k.(6)(a) through (c) of the Specific Requirements in this CRD have been met and the Authorized Limits have been approved by a Cognizant Secretarial Officer in consultation with the Chief Health, Safety and Security Officer as required by the 10 CFR Part 835 exclusion.	Full compliance	No specific authorized limits are used at Fermilab at this time.  FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i>  FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(6) (e)	<p>Revision of Authorized Limits. If established Authorized Limits are found to be not protective, appropriate or practical to apply for a specific type or portion of property, further clearance for that specific type or portion of property must not proceed without revised Authorized Limits.</p> <p>1 An application for revised Authorized Limits must be submitted in accordance with the requirements in paragraphs 2.k.(6)(a) through (d) of the Specific Requirements in this CRD.</p> <p>2 In addition to the requirements of applicable paragraphs of 2.k.(6) of the Specific Requirements in this CRD, requests for approval of revised Authorized Limits must include a justification for the need for the revised Authorized Limits. Justifications for revised Authorized Limits must be based upon one of the following:</p> <p>a Complying with existing Authorized Limits would pose a clear and present risk of injury to general employees or members of the public; or</p> <p>b Complying with existing Authorized Limits, would produce environmental harm (e.g., destruction of artifacts, ecological damage, loss of cultural assets) that is clearly excessive compared to the potential health benefits to persons exposed to affected properties; or</p> <p>c Complying with existing Authorized Limits is unreasonably costly relative to long-term benefits and where the residual radioactive material does not pose a clear present or future potential of exceeding the public dose limit of paragraph 2.b. of the Specific Requirements in this CRD; or</p> <p>d Portions of the project or activity for which the scenarios or assumptions used to establish the existing Authorized Limits are overly conservative, or where more appropriate scenarios or assumptions indicate that other limits are applicable or appropriate for protection of the public and the environment; or</p> <p>e New information which indicates the existing Authorized Limits are not sufficient to meet the protective requirements established by DOE.</p>	Full compliance	<p>No specific authorized limits are used at Fermilab at this time.</p> <p>FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(6)  (f)	<p>Pre-Approved Authorized Limits.</p> <p>1 The following values have been pre-approved by DOE for use as Authorized Limits, and may be used as specified below instead of developing specific Authorized Limits.</p> <p>a For radium-226 and radium-228 in soil - 5 pCi/gram (0.2 Bq/gram) in excess of background levels, averaged over 100 m<sup>2</sup>, in the first 15 cm depth of the surface layer of soil; and 15 pCi/gram (0.56 Bq/gram) in excess of background levels, averaged over any subsequent 15 cm subsurface layer of soil plus an ALARA assessment. If both thorium-230 and radium-226 or both thorium-232 and radium-228 are present and not in secular equilibrium, the appropriate pre-approved limit must be applied to the radionuclide with the higher concentration.</p> <p>b Previously approved guidelines and limits (such as the surface activity guidelines) may continue to be applied and used as Pre-Approved Authorized Limits until they are replaced or revised by Pre-Approved Authorized Limits issued by the Department.</p> <p>2 Pre-Approved Authorized Limits may be used for any radiological activity instead of developing specific Authorized Limits if their use is documented in the environmental radiological protection program and the specific application of the Authorized Limits is approved by the responsible Field Element Manager.</p>	Documents in draft. See Section 6.0 for implementation schedule.	<p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control adopts the pre-approved surface activity authorized limits from DOE O 5400.5 and the IFB criterion for volumetric contamination. No other pre-approved authorized limits are used at Fermilab.</p> <p>FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control</p>
2.k.(6)  (g)	Documentation of Approved Authorized Limits. Approved Authorized Limits and approved revised Authorized Limits and supporting documentation must be made available to the public.	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Chapter 4, Part 1, <i>Radioactive Material Identification, Storage, and Control</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ASER</p>
2.k.(7) (a-c)	Clearance of Environmental Restoration, Deactivation and Decommissioning, and Other Cleanup Materials.	Not applicable to Fermilab; Fermilab currently has no plan to release material with residual radioactivity. Further, Fermilab does not perform activities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).	
2.k.(8)	Radiological Monitoring or Surveys.	Outlined in sections below.	

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
<b>2.k.(8)</b> <b>(a)</b>	<p>All radiological monitoring or surveys performed in support of clearance of property</p> <ol style="list-style-type: none"> <li>1 Use methodologies sufficient to meet measurement objectives such as those in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), the Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME) or other methodologies approved by DOE;</li> <li>2 Meet Measurement Quality Objectives;</li> <li>3 Use DOE-approved sampling and analysis techniques, if applicable; and</li> <li>4 Include an evaluation of non-uniformly distributed residual radioactive material, if applicable.</li> </ol>	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>FRCM Chapter 5, Part 5, <i>Radiological Monitoring and Surveys</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control</p>
<b>2.k.(8)</b> <b>(b)</b>	<p>Instrumentation used for radiological monitoring or surveys must be capable of detecting and quantifying residual radioactive material consistent with the applicable Authorized Limits, and be:</p> <ol style="list-style-type: none"> <li>1 Periodically maintained and calibrated on an established frequency;</li> <li>2 Appropriate for the type(s), levels, and energies of the radiation(s) encountered; and</li> <li>3 Appropriate for existing environmental conditions and routinely tested for operability.</li> </ol>	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Chapter 5, Part 5, <i>Radiological Monitoring and Surveys</i></p> <p>FRCM Chapter 5, Part 6, <i>Instrumentation and Calibration</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control</p>



<b>O 458.1 CRD Citation</b>	<b>O 458.1 CRD Requirement Text</b>	<b>Compliance Status<sup>1</sup></b>	<b>Implementation/Documentation Reference</b>
<b>2.k.(9)</b>	Documentation and Verification. Any contractor responsible for radiological clearance of property must ensure that final radiological monitoring or surveys are conducted and that documentation is prepared that shows that the clearance meets applicable DOE Authorized Limits, or other applicable requirements including associated restrictions or institutional controls (See DOE P 454.1).	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control</p>
<b>2.k.(10)</b>	Public Notification of Clearance of Property. Information on approved Authorized Limits, any approved revised Authorized Limits, use of pre-approved Authorized Limits, results of radiological monitoring and surveys of cleared property with type and quantity of property cleared, and independent verification results must be summarized in the Annual Site Environmental Report.	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ASER and associated procedure</p>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.k.(11)	Final Clearance Documentation. Clearance of property must be documented. The contents of the documentation or the mechanism for documenting information may be tailored to the need, situation, and type of property being cleared. For ongoing, routine clearances, e.g., clearance of personal property from controlled areas, such documentation may be based on the general process(es) rather than each specific clearance. In general, the documentation must describe the clearance process(es) and the property being cleared. The documentation must serve to demonstrate requirements have been met, show criteria used for clearance, identify the property's destination or disposition, as appropriate, and provide additional confidence to DOE and assurance to other interested parties that the public and the environment are being protected. The documentation must indicate any Authorized Limits, including any revised or pre-approved Authorized Limits, used for the clearance, and include information and data supporting the clearance of property such as radiological certification and independent verification results. An annual summary of cleared property must be prepared and submitted to the Field Element Manager.	Documents in draft. See Section 6.0 for implementation schedule.	<p>FRCM Chapter 2, Part 4, <i>Release Certification Program for Facilities Containing Radioactive Materials</i></p> <p>FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i></p> <p>ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment</p> <p>ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control</p> <p>ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control-see also,</p> <p>Material Move Request (MMR) form accompanies most material transfers and documents material destination and disposition, as required in FRCM Chapter 4.</p>

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

### 5.13 Records, Retention and Reporting Requirements

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.l.	<b>Records, Retention and Reporting Requirements.</b> The contractor must establish and implement recordkeeping, retention and reporting procedures and practices to ensure that the following elements are addressed:	Outlined in sections below.	
2.l.(1)	Records must be maintained to document compliance with the Specific Requirements in this CRD.	Full compliance	<p>FRCM Chapter 7, <i>Radiological Records</i></p> <p>This ERPP</p>
2.l.(2)	Required records include the following:	Outlined in sections below.	

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.I.(2) (a)	Information and data necessary to identify and characterize releases of radioactive material to the environment, their fate in the environment, and their probable impact on radiation dose to members of the public, and any impacts on ecological systems.	Full compliance	FRCM Chapter 7, <i>Radiological Records</i>  Fermilab Radionuclide Air Emissions Manual
2.I.(2) (b)	Documentation of individual and collective dose to members of the public due to radiological activities. This includes documentation of site-specific information on radiation source dispersion patterns, location and demography of members of the public in the vicinity of the radiological activity and assumed default values or site-specific parameters used in calculations.	Full compliance	FRCM Chapter 7, <i>Radiological Records</i>  Fermilab Radionuclide Air Emissions Manual
2.I.(2) (c)	Requests for specific authorization for temporary public dose limits, and subsequent approvals and other related actions.	Full compliance	FRCM Chapter 7, <i>Radiological Records</i>  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>
2.I.(2) (c)	Requests for specific authorization for temporary public dose limits, and subsequent approvals and other related actions.	Not applicable to Fermilab. Should the need for temporary public dose limits arise, this ERPP will be updated.	
2.I.(2) (d)	Identification of radiological activities subject to environmental radiological protection program requirements, and descriptions of the measures to be used in implementing these requirements.	Full compliance	FRCM Chapter 7, <i>Radiological Records</i>  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>  Fermilab Radionuclide Air Emissions Manual
2.I.(2) (e)	Documentation of actions taken to implement the ALARA process identified in paragraph 2.d. of the Specific Requirements in this CRD.	Full compliance	FRCM Article 742, <i>ALARA Records</i>  Fermilab Environmental ALARA Program Plan  -see also,  RWPs, ALARA Plans
2.I.(2) (f)	Documentation of actions taken to demonstrate compliance with the public dose limit (See paragraph 2.e.(1) of the Specific Requirements in this CRD).	Full compliance	FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>  FRCM Article 731, <i>Record Requirements</i>  Compliance documented through the ASER.

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.I.(2) (g)	Documentation of actions taken to implement the BAT selection process in regulating liquid discharges, including documentation of analyses and factors considered to be important, including alternative processes, for the BAT selection process.	Not applicable to Fermilab; The only potentially radioactive liquid discharges are: 1) very low levels of tritium to the surface, which are performed in a manner established by the ALARA process and, 2) discharges into sanitary sewers, for which extensive monitoring data exists to demonstrate that levels are far below DCS values.  Should the unlikely conditions in sections 2.g.(5)(a-c) arise at Fermilab, this ERPP and the EMP will be revised to include this documentation.	
2.I.(2) (h)	Effluent monitoring and environmental surveillance information and data, including:  1 Results of effluent monitoring for determining sources of radiation and radioactive material that provide direct exposure to members of the public and releases of radioactive material in liquid or airborne effluent;  2 Results of surveys for radiation and radioactive material in the environment;  3 Results of surveys, measurements, and calculations used to determine the dose to members of the public and ecological receptors from external and internal radiation sources;  4 Meteorological data used in assessing dose; and  5 Results of pre-operational monitoring.	Full compliance	FESHM Chapters 8000, <i>Environmental Management System</i>  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>  FRCM Chapter 7, <i>Radiological Records</i>
2.I.(2) (i)	Documentation related to the long-term management of radioactive waste and residual radioactive material.	Full compliance	FRCM Chapter 4, Part 4, <i>Radioactive Waste Management</i>  FESHM 8021, <i>Chemical and Radioactive Waste Management</i>  LLWCP

<b>O 458.1 CRD Citation</b>	<b>O 458.1 CRD Requirement Text</b>	<b>Compliance Status <sup>1</sup></b>	<b>Implementation/Documentation Reference</b>
<b>2.I.(2) (j)</b>	Final documentation for clearance of property containing residual radioactive material.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control  ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control  -see also,  Material Move Request (MMR) form accompanies most material transfers and documents material destination and disposition
<b>2.I.(2) (k)</b>	Documentation of:  1 Approved Authorized Limits for routine clearance of property for unrestricted or restricted use and the scenarios evaluated in selecting the limits; and  2 Approved revised Authorized Limits for clearance of property.	Documents in draft. See Section 6.0 for implementation schedule.	FRCM Chapter 4, Part 2, <i>Release and Transportation of Radioactive Material</i>  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control
<b>2.I.(2) (l)</b>	Annual summaries related to clearance of property.	Documents in draft. See Section 6.0 for implementation schedule.	ASER summarizes property cleared each year.  ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment  ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control  FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i>

O 458.1 CRD Citation	O 458.1 CRD Requirement Text	Compliance Status <sup>1</sup>	Implementation/Documentation Reference
2.I.(3)	Records required by the Specific Requirements in this CRD must be maintained by, or transferred to, DOE upon cessation of a DOE radiological activity at a site.	Full compliance	FRCM Chapter 7, <i>Radiological Records</i>  Fermilab will transfer all documents required by the CRD to DOE upon cessation of operations
2.I.(4)	Records must be retained until final disposition is authorized by DOE.	Full compliance	Policy on Records Management  FRCM Chapter 7, <i>Radiological Records</i>
2.I.(5)	<b>Reporting.</b>	Outlined in sections below.	
2.I.(5) (a)	Reporting requirements are contained in the CRDs to DOE O 232.2, <i>Occurrence Reporting and Processing of Operations Information</i> , dated 8-30-11, and DOE O 231.1B, <i>Environment, Safety and Health Reporting</i> , dated 6-27-11.	Full compliance	FESHM 3000, <i>Investigation and Reporting</i>
2.I.(5) (b)	The contractor must notify the Field Element Manager within 30 calendar days when it has been identified that any Specific Requirement in this CRD that is not required to be reported under paragraph 2.I.(5)(a) has not been met.	Full compliance	FRCM Chapter 11, <i>Environmental Radiation Monitoring and Control</i> .
2.I.(6)	Units. Unless otherwise specified, the quantities used in the reports and records required by the Specific Requirements of this CRD must be clearly indicated in special units of curie, rad, roentgen, or rem, including multiples and subdivisions of these units, or other conventional units, such as dpm, dpm/100 cm <sup>2</sup> , or mass units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv) may be provided parenthetically for reference with scientific standards.	Full compliance	FRCM Article 713, <i>Recordkeeping Standards</i>

<sup>1</sup> Documents may be under development or under revision. Refer to the implementation schedule in Section 6.0.

## 6.0 Implementation Plan

Fermilab commits to the schedule shown in Table 2 for implementing (i.e., updating and approving documentation) outstanding, applicable articles for environmental radiation protection which were not previously implemented.

**Table 2.** Program and Plan Revisions for Implementation of Outstanding Articles

Implementation Document	Responsible Organization	Implementation Due Date
ESH-RP-ERPP-01-Radiological Release and Clearance of Materials and Equipment	RCO	5/1/2022
ESH-RP-ERPP-02-Technical Basis for Release of Materials and Equipment from Radiological Control	RCO	5/1/2022

ESH-RPO-MON-09-Surveys for Release and Clearance of Materials and Equipment from Radiological Control	RCO	5/1/2022
FRCM Chapter 7 Updates	RCO	5/1/2022
FRCM Chapter 11 Updates	RCO	5/1/2022
Fermilab Environmental ALARA Program Plan, to be incorporated into FRCM Chapter 11	RCO	8/1/2022
Procedure for calculations in support of the ASER	RCO	8/1/2022

## 7.0 References

See Section 5.0 for Fermilab implementing documents.

[DOE1993] U.S. Department of Energy (DOE), “Radiation Protection of the Public and the Environment”, DOE Order 5400.5, 1990, Change 2, 1-7-1993.

[DOE2016] U.S. Department of Energy (DOE), “Clearance and Release of Personal Property from Accelerator Facilities”, DOE-STD-6004-2016, 5-19-2016.

[DOE2019] U.S. Department of Energy (DOE), “A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota”, DOE-STD-1153-2019, 2-12-2019.

[DOE2020] U.S. Department of Energy (DOE), “Radiation Protection of the Public and the Environment”, DOE Order 458.1, Chg. 4, 9-15-2020.

[DOE 2021] U.S. Department of Energy (DOE), “Derived Concentration Technical Standard”, DOE-STD-1196-2021, 7-7-2021.