Fermilab	ES&H Section Procedures	
Procedure Number/Name ESH-RP-ERPP-03 – Radiological Dose Assessment for the Annual Site Environmental Report (ASER)		**Original Date:** 03/22/2022
Written by: Holly Hall	**Reviewed and Updated By:** N/A – Initial Issue	**Date:** N/A

Approvals

Written By: Holly Hall, UID:hollyh Digitally signed by Holly Hall, UID:hollyh Date: 2022.03.22 08:58:41 -05'00' Date: 03/22/2022

Holly Hall, Radiation Physicist

Reviewed By: Kamran Vaziri, UID:vaziri Digitally signed by Kamran Vaziri, UID:vaziri Date: 2022.03.22 14:18:02 -05'00' Date: 03/22/2022

Kamran Vaziri, Radiation Physicist

Reviewed By: Diane Reitzner, UID:reitzner Digitally signed by Diane Reitzner, UID:reitzner Date: 2022.03.22 15:15:13 -05'00' Date: 03/22/2022

Diane Reitzner, Radiation Physicist

Approved By: Wayne Schmitt Digitally signed by Wayne Schmitt Date: 2022.03.22 16:54:03 -05'00' Date: 03/22/2022

Wayne Schmitt, Radiation Physics Science Department Head

Approved By: Matthew Quinn Digitally signed by Matthew Quinn Date: 2022.03.22 19:08:58 -05'00' Date: 03/22/2022

Matt Quinn, Senior Radiation Safety Officer

Revision History

Updated by	Description of Change	Revision Number	Revision Date
Holly Hall	Initial Issue	0	03/22/2022

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Procedure

1.0 Purpose

The purpose of this procedure is to document the methodology for data and information used to provide radiological dose assessments as reported in the Annual Site Environmental Report (ASER).

2.0 Scope

This procedure is applicable to the radiological dose reporting aspects of the ASER for the Fermi National Accelerator Laboratory (Fermilab) site located in DuPage and Kane counties, Illinois. Reporting of environmental monitoring and sampling data is not included in the scope.

3.0 Summary

This procedure provides instruction and background information used to implement requirements of DOE O 458.1 (DOE11) and the Fermilab ERPP (HA21). A summary of various radiological dose assessments and other parameters are reported in the ASER. It provides instructions to evaluate the annual dose to the Maximally Exposed Individual (MEI), both offsite and onsite, and collective dose for the population within 50 miles (80 km) around Fermilab. It also provides guidance to summarize the clearance of property, assess dose to biota, and report unplanned radiological releases.

4.0 Definitions

Clearance of Property: The removal of property that contains or may contain residual radioactive material from DOE radiological control under 10 CFR Part 835 and DOE O 458.1.

Collective Dose: The sum of the total effective dose to all persons in a specified population received in a specified period of time. Collective dose is expressed in units of person-rem (or person-sievert).

Derived Concentration Standard (DCS): A quantity representing the concentration of a given radionuclide in either water or air that results in a member of the pubic receiving 100 mrem effective dose (1 mSv) following continuous exposure for one year for each of the following pathways; ingestion of water, submersion in air, and inhalation. DCS values are specifically those set forth in DOE-STD-1196-2021 in support of implementation of DOE O458.1, “Radiation Protection of the Public and the Environment”

Dose: A general term for absorbed dose, equivalent dose, effective dose, committed equivalent dose, committed effective dose, or total effective dose as defined in 10 CFR 835.

General Access Area (GAA): A designated area that is accessible to all personnel including the public.

Maximally Exposed Individual (MEI): A hypothetical individual who – because of realistically assumed proximity, activities, and living habits – would receive the highest radiation dose, taking into account all pathways, from a given event, process, or facility.

Maximally Exposed Offsite Individual (MEOI): The MEI who would receive the highest radiation dose outside of the site boundary.

Property Protection Area (PPA): A security area that is established to protect employees and Government buildings, facilities, and property.

Public Visitor: An individual who has no business with Fermilab and is restricted to designated General Access Areas (public areas) during public access hours or to attend an approved program or event consistent with the Site Security Plan, such as an approved evening public lecture. Public visitors are on site for the sole purpose of attending Fermilab public tours or events; school visits; attending public lectures, performances, symposia, or colloquia; visiting Fermilab's public exhibits in the Lederman Center or Wilson Hall; or visiting Fermilab's outdoor areas.

Total Effective Dose (TED): Sum of the effective dose (for external exposures) and the committed effective dose.

5.0 Responsibilities

5.1 ERPP Manager

- Identifies and evaluates site activities that have the potential for radiological impacts on the environment and the public.
- Performs radiological dose assessments in support of the ASER and submits them to the lead ASER author.

5.2 NESHAP Radiation Physicist

- Calculates and reports dose from airborne emissions offsite and onsite using the CAP-88 software. This individual may be the same as the ERPP Manager.

5.3 External Dosimetrist

- Provides a determination of the dose at the site boundary near the Railhead storage area annually.

6.0 Health and Safety Warnings

None.

7.0 Prerequisites

Material & Equipment

- None.

Training Required

- The NESHAP Radiation Physicist shall have procedure-specific training for determining the airborne effluents and CAP-88 dose using the *Fermilab Radionuclide Air Emissions Manual* (VA19). This training shall be documented in Section 13.
- The ERPP Program Manager shall have procedure-specific training for the implementation of the *Fermilab Radionuclide Air Emissions Manual* (VA19) and associated spreadsheets

8.0 Procedural Steps

8.1 **Maximally Exposed Offsite Individual (MEOI):** Calculate the Total Effective Dose (TED) to the MEOI in units of millirem (mrem)/y and millisievert (mSv)/y and provide an estimated natural background dose.
NOTE 1: It is Fermilab policy that dose to the MEOI should not exceed 10 mrem/year.
NOTE 2: If it is suspected that the estimated TED for members of the public exceeds 25 mrem (0.25 mSv) 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, then dose to the lens of the eye, skin, and extremities must be evaluated.

NOTE 3: 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.

8.1.1 Air Pathway: Instructions for estimating the dose to the MEOI are detailed in the *Fermilab Radionuclide Air Emissions Manual* (VA19). The software CAP-88 (which stands for Clean Air Act Assessment Package - 1988) is used to assess dose from airborne emissions by using a Gaussian plume model to characterize the average dispersion of airborne radionuclides released from elevated stacks or diffuse sources.

8.1.1.1 The ASER should report the estimated activity released to air during the year in units of curies (Ci) and becquerels (Bq) as calculated using the *Fermilab Radionuclide Air Emissions Manual* (VA19). Include the totals by radionuclide released and the half-life of each of the radionuclides reported.

8.1.1.2 As needed, update the 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 to document significant changes that could affect dose evaluations.

8.1.1.2.1 Review the population data file. The population data used for CAP-88 should be updated within two years of the most recent census.

8.1.1.2.2 Update the meteorological data file using measurements from the Fermilab onsite monitoring station. These measurements include wind speed, direction, and the horizontal standard deviation in the wind direction (also known as sigma A), as well as air temperature, relative humidity, dewpoint temperature, and precipitation amount. If the meteorological tower data is unavailable for more than 10 days, then the data from the nearby DuPage Airport will be used.

8.1.1.2.3 Review the land use parameter values. Typically, the default Illinois agricultural values and Urban food source scenario are considered representative for the surrounding area. If other values are used, include a discussion of the use of values other than the default in the ASER.

8.1.1.3 The CAP-88 software will automatically determine the location and dose for the MEOI.

8.1.1.3.1 The ASER should compare the calculated dose value to the 10 mrem per year air emission standard under 40 CFR 61.92 and describe the relevant regulatory requirements. The following language is provided as an example but may be modified: “Fermilab, as a DOE laboratory, is subject to Subpart H of this regulation which specifically exempts Fermilab from the requirements of 40 CFR 61.10. Since Fermilab emissions have always been kept well below 1% of the 10 mrem/yr. maximum allowed by the standard, according to 40 CFR 61.93(b)(4)(i) continuous monitoring is not required”

8.1.1.3.2 The ASER should state that because the doses are calculated based on actual radionuclide(s) concentration release rates rather than measured concentration, they represent potential or estimated doses. Data should be presented using scientific notation (e.g., 3.2×10^{-3} for 0.0032), where appropriate. The number of significant figures should also be appropriate to the quality of these data.

8.1.1.3.3 The ASER should specifically state the version of CAP-88 used for air calculations.

8.1.2 Direct Radiation: Determine the dose to the MEI at the site boundary.

8.1.2.1 Area monitors are placed near the site boundary to measure dose from the Railhead storage area (FU22). The External Dosimetrist provides a determination of the dose at the site boundary near the Railhead storage area via memo.

8.1.2.2 Calculate the dose from muons at the site boundary using the “Offsite Muon” spreadsheet. This spreadsheet uses the measured values from various beamlines as documented in EP Note No. 19 (VA00) and scaled by the number of protons for the year.

8.1.2.3 Estimate the dose from skyshine at the site boundary by summing the estimate of skyshine at the nearest site boundary provided in the current shielding assessments for each active experiment, beamline, and accelerator. If the shielding assessment does not document a skyshine evaluation, calculate the skyshine contribution with assistance from the Radiation Physics Science department. Use the summed value as a conservative dose estimate for the MEOI from skyshine.

8.1.2.4 Sum the results of the railhead, muon, and skyshine external doses to determine a conservative, bounding, external dose.

8.1.3 Liquid Effluent Pathways: Determine if liquid effluents are likely exposure pathways that could contribute significantly to the total dose. Historically, Fermilab liquid effluents radioactivity concentrations are extremely low. Typically they are small fractions of the Derived Concentration Standard (DCS)

values from DOE-STD-1196-2021, *Derived Concentration Technical Standard* (DOE21) that would result in annual effective dose of 100 mrem (1 mSv). Fermilab has performed calculations to estimate the dose from ingesting liquid effluents as drinking water, partaking in recreational activities, and ingesting fish harvested from Fermilab waters using conservative concentrations and assumptions (MA95, WO16). Even using conservative assumptions, doses were estimated to be small fractions of the 100 mrem limit. For this reason, liquid effluents are typically not considered likely exposure pathways to the MEI and only require calculations if the average annual concentration of a liquid effluent exceeds 1% of the DCS value.

8.1.3.1 If the average annual concentration of radioactivity in liquid effluents (e.g., sanitary sewers, outfalls) exceeds 1% of the DCS value (or the sum-of-fractions of the DCS value for multiple radionuclides), calculate the dose to the MEI from the ingestion of drinking water pathway ($ED_{ingestion}$). Since Fermilab liquid effluents are not directly used as drinking water and undergo significant dilution prior to being part of a community drinking water system, consider the dilution of the water to the drinking water system.

$$ED_{ingestion} = Effluent\ Concentration\ \left(\frac{\mu Ci}{mL}\right) x \frac{100\ mrem}{DCS\ value\ \left(\frac{\mu Ci}{mL}\right)} x Dilution\ Factor$$

8.1.3.2 If the average annual concentration of radioactivity in surface water offsite or liquid effluents (considering dilution in the receiving body of water) exceeds 1% of the DCS value (or the sum-of-fractions of the DCS value for multiple radionuclides), calculate the dose to the MEI from the ingestion of contaminated fish (ED_{fish}). The assumptions and methodology to support this calculation are documented in EP Note 31 (WO16).

$$ED_{Fish} = Water\ Concentration\ \left(\frac{pCi}{mL}\right) x \frac{50\ lb}{year} x \frac{453.6\ g}{lb} x \frac{1mL}{g} x \frac{0.037pCi}{Bq} x \frac{2.1x10^{-11}Sv}{Bq} x \frac{100{,}000mrem}{Sv}$$

8.1.4 Sum the doses calculated from the applicable pathways to the MEOI to determine the TED.

8.1.4.1 The ASER should clearly describe the location of critical receptors and the scenarios used to calculate the estimated doses.

8.1.4.2 If the maximum dose through the various pathways is for different individuals, the report should briefly explain why these doses are not truly additive, but that Fermilab sums the dose from the various pathways as a bounding estimate.

8.1.4.3 Include a comparison of the dose to the MEOI with DOE, EPA, or other standards and with the natural background of 311 mrem from NCRP Report 160, *Ionizing Radiation Exposure of the Population of the United States* (NC09). Provide the doses in millirem (mrem)/y and millisievert (mSv)/y.

8.2 **Collective Dose:** Estimate the collective (population) dose in units of person-rem (person-Sv) in a year using the total population within 50 miles (80 km) and provide an estimated background dose.

8.2.1 Within two years of the most recent census, update the estimate of the total population within 50 miles (80 km) around the site to be used for the collective dose estimates.

8.2.2 Air: The collective dose to the population from airborne effluents is automatically calculated by CAP-88.

8.2.3 Direct Radiation: Use the inverse square relationship to estimate the dose beyond the site boundary using the site boundary external dose determined in section 8.1.2 for any sectors above natural background.

8.2.4 Liquid Effluents: If liquid effluent release is determined to be a likely pathway in section 8.1.3, estimate the collective dose by multiplying the individual dose estimated by the total population who use the water source for drinking water.

8.2.5 Sum all pathways to estimate the collective dose.

8.2.6 Compare to the annual dose received from natural background by multiplying the estimated population within the 50-mile radius by the estimated individual background dose from section 8.1.4.3.

8.3 **Dose to Individuals Onsite but Outside of Controlled Areas:** Certain portions of the Fermilab site are typically open to public visitors. These areas are designated as General Access Areas (public areas). Restricted Property Protection Areas (non-public areas) are not considered accessible to public visitors and are controlled through various measures. The technical basis for the occupancy factors assumed in this section is located in Attachment A of this document.

8.3.1 Determine the potential dose from airborne emissions using CAP-88.

8.3.1.1 Use an alternative population file to model that an individual is in each sector at a mid-point distance from the release point accessible to the public (currently about 250 m to simulate the nearest public area from the simulated release point). Use the “local” food option since food will not be grown at this site. Adjust the dose calculated for the MEI by a factor of 0.05 to account for 400 hours of likely but conservative onsite time (400h/8760h).

8.3.1.2 Use an alternative population file to model the dose to a village resident in the East and East-Northeast directions. Use the “urban” food option. Do not adjust for occupancy since village residents reside onsite.

8.3.2 Prompt radiation (direct and skyshine) is measured using a network of area dosimeters located in various GAAs (public areas) (FU22). The occupancy factors shown in Table 1 below should be used to estimate the dose to the MEI from the net area dosimeter readings.

Table 1. Occupancy Factors for General Access Areas on Fermilab Site

Area Type	Recommended Occupancy Factors
Fermilab Village Residences	8760 hours
Fermilab Children's Center	2690 hours
General Access Areas other than those listed above	400 hours (1/5)
Outdoors areas with only transient pedestrian or vehicular traffic, parking lots, vehicular drop off areas	250 hours (1/8)

8.3.3 Fish Ingestion: Fishing by public visitors is currently permitted in Fermilab surface water except for the Booster Ring Pond, the Main Ring Ponds & Lake Logo, the Village Oxidation Pond, and the Main Injector Pond (FE20). If the average annual concentration of radioactivity in any other surface water onsite exceeds 1% of the DCS value (or the sum-of-fractions of the DCS value for multiple radionuclides), calculate the dose to the MEI from the ingestion of contaminated fish (ED_{fish}) using the methodology described in Section 8.1.3.2.

8.3.4 Sum the TED to the onsite MEI.

NOTE 1: If it is suspected that the estimated TED for members of the public exceeds 25 mrem (0.25 mSv) 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, then dose to the lens of the eye, skin, and extremities must be evaluated.

NOTE 2: 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.

8.4 Dose Summary: Summarize the dose to the MEI and the collective dose to the population using the sample format of Table 2 below.

Table 2: Example Radiological Dose Reporting Table

Pathway	**Dose to the Maximally Exposed Individual (MEI)** mrem (mSv)	**% of DOE 100 mrem/y Limit**	**Estimated Collective (Population) Dose** person-rem (person-Sv)	**Population within 80 km***	**Estimated Background Radiation Population Dose** person-rem (person-Sv)
Air				*	Pathway-specific background doses need not be estimated
External				*	Pathway-specific background doses need not be estimated
Water (if applicable)				*	Pathway-specific background doses need not be estimated

Other Pathways (if applicable)				*	Pathway-specific background doses need not be estimated
All Pathways	{Note: This should be the total dose to the MEI, but it should not be the sum of the individual pathway doses unless all the pathway-specific MEI doses are to the same receptor **}		{Note: This should normally be the sum of the average pathway-specific Population Doses}		

* Pathway-specific populations should be specified only if they are significantly different from the total population.

** Fermilab sums the MEOI doses from various pathways to different receptors as a bounding case. The conservative nature (overestimation of dose) should be discussed. Other unrealistic assumptions, such as assumed occupancy factors for exposures of 24 hours/day for 365 days, should be explained if they are used in establishing bounding dose estimates. Although reported doses should not underestimate likely doses, DOE prefers dose estimates to be as realistic as possible.

8.5 **Dose to Biota:** DOE O 458.1 requires the protection of 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. The DOE Standard, DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE19) is used to evaluate and report compliance with the biota protection requirements of DOE O 458.1. Table 3 below lists the absorbed dose rate criteria for various biota.

Table 3. Absorbed dose rate criteria to aquatic and riparian animals and terrestrial plants and animals from exposure to radiation or radioactive materials to the aquatic or terrestrial environment.

DOE Category	**Average Dose Rate Criteria**
Aquatic Animals	Absorbed dose < 1 rad/d (10 mGy/d)
Riparian Animals	Absorbed dose < 0.1 rad/d (1 mGy/d)
Terrestrial Plants	Absorbed dose < 1 rad/d (10 mGy/d)
Terrestrial Animals	Absorbed dose < 0.1 rad/d (1 mGy/d)

8.5.1 Use the RESRAD-BIOTA software to implement a graded approach to evaluate doses to biota in relation to the established dose criteria in Table 3. The RESRAD-BIOTA software uses soil, sediment, and water radionuclide concentration data to determine whether radionuclide concentrations at a site are likely to result in doses exceeding those listed in Table 3 and would, therefore, have the potential to impact resident populations of plants and animals.

8.5.1.1 Perform a Level 1 General Screening by entering the maximum concentrations of each radionuclide in each of the sampling mediums into the RESRAD-BIOTA software for a terrestrial and an aquatic ecosystem.

8.5.1.2 If the sum of fractions (the summed ratios between the radionuclide concentrations in environmental media and the radionuclide-specific

biota concentration guide) is less than 1.0, the dose to an aquatic or terrestrial receptor is below the biota dose limit, and the general screening evaluation has passed.

8.5.1.3 If the sum of fractions is greater than 1.0, further investigation is required. Follow the guidance in DOE-STD-1153-2019 to complete the site-specific analysis.

8.5.2 Prepare a summary report of the biota evaluation. Describe the results in the ASER.

8.6 Clearance of Property

8.6.1 Describe any approved Authorized Limits in the ASER, including the use of pre-approved Authorized Limits, and any requests for new authorized limits.

8.6.2 Summarize the results of radiological monitoring and surveys of cleared personal property in the ASER using *Radiological Clearance Forms* and the process described in the site's technical basis document (DU22) and survey procedure (HA22a). This should include the type and quantity of property cleared and any independent verification results.

8.6.3 Summarize the clearance of real property for the calendar year, if any, in the ASER.

8.6.4 Describe the dose to the MEI from the clearance of property in the ASER. Because Fermilab uses the Indistinguishable from Background criterion and methodology of DOE-STD-6004-2016, *Clearance and Release of Personal Property from Accelerator Facilities* (DOE16) and the pre-approved authorized limits for surface contamination, personal property releases at Fermilab do not add to the potential public dose. (DU22)

8.7 Radioactive Releases to Surface Water and Sanitary Sewer: The ASER will describe the amount of radioactivity released to the surface water. It will also describe the amount of radioactivity released to the sanitary sewer and compare to the limits from DOE O 458.1 section 2.g.(8)(a)4.

8.8 **Unplanned Releases:** Describe any unplanned radiological releases to the environment at Fermilab in the previous year in the ASER.

8.8.1 If there were unplanned radiological releases, state the basis for any estimates regarding the magnitude of potential impacts of unplanned releases. Discuss the date the release(s) occurred, the amount of material released, an explanation of the release, and corrective actions taken. In the case where releases are insignificant with respect to normal release-related doses (i.e., a few percent or less), they should be reported as such. If they exceed appropriate limits, this should also be noted and provide the process and corrections needed to address the excess dose limits.

8.8.2 If there were no unplanned radiological releases, use the following sample language: "There were no unplanned radiological releases during [Calendar Year]."

9.0 Data and Records Management

Numerous records are used to support the information provided in the ASER. The following records are required:

Document	Storage Location	Retention Period
Radionuclide Air Emissions Annual Report for Fermilab	DocDB	75 years
CAP-88 General, Synopsis, and Summary Reports and Meteorological Data	ERPP files on SharePoint	75 years
Biota Dose Evaluation Annual Report for Fermilab	ERPP files on SharePoint	75 years
Area Monitor Quarterly Reports	As specified in ESH-RP-MON-07 (FU22)	75 years
R.P. Form #128, *Radiological Clearance Form*	As specified in ESH-RP-MON-09 (HA22a)	75 years
Environmental sampling data	As specified in Environmental Protection Department procedures	As specified in Environmental Protection Department procedures

10.0 Quality Assurance/Quality Control

This procedure is subject to a review frequency requirement of 3 years and is due in March 2025.

11.0 References

DOE11 U.S. Department of Energy, “Radiation Protection of the Public and the Environment”, DOE O 458.1 (Initial issue February 11, 2011, current version as of this writing is Chg. 4, September 15, 2020).

DOE16 U.S. Department of Energy, “Clearance and Release of Personal Property from Accelerator Facilities”, DOE-STD-6004-2016 (May 2016).

DOE19 U.S. Department of Energy, “A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota”, DOE-STD-1153-2019 (February 2019).

DOE20 U.S. Department of Energy, “Guidance for Preparation of the 2020 Department of Energy Annual Site Environmental Reports”, (March 2020).

DOE21 U.S. Department of Energy, “Derived Concentration Technical Standard”, DOE-STD-1196-2021 (July 2021).

DU22 DuVall, C., [Draft] “Technical Basis for Release of Materials and Equipment from Radiological Control”, ESH-RP-ERPP-02 (in draft as of March 2022).

FE20 “Fermilab Recreational Guidelines”, (March 2020).

FE21 “Policy on Access to Fermilab”, (August 2021).

FE21a “Procedure on Access to Fermilab”, (August 2021).

FE22 "Site Security Plan", (in draft as of March 2022).

FU22 Fulgham, J., "Routine Area Monitoring Program", ESH-RPO-MON-07 (in draft as of March 2022).

HA22 Hall, H., "Environmental Radiological Protection Program", Rev. 1, (February 2022).

HA22a Hall, H., [Draft] "Surveys for Release and Clearance of Materials and Equipment from Radiological Control", ESH-RPO-MON-09 (in draft as of March 2022).

MA95 Marshall, E. and D. Cossairt, "Analysis of Radiological Exposure Pathways for Tritium Discharged to On-site Surface Waters", EP Note 10 (April 1995).

NC04 National Council on Radiation Protection and Measurements, "Structural Shielding Design for Medical X-Ray Imaging Facilities", NCRP Report No. 147 (2004).

NC05 National Council on Radiation Protection and Measurements, "Structural Shielding Design and Evaluation for Megavoltage X- and Gamma-Ray Radiotherapy Facilities", NCRP Report No. 151 (2005).

NC09 National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States", NCRP Report No. 160 (2009).

VA00 Vaziri, K., "Summary of MERL On-site and Off-site Radiation Surveys for the 1999 Fixed Target Runs", EP Note 19, (April 2000).

VA19 Vaziri, K. et al, "Fermilab Radionuclide Air Emissions Manual", (May 2019).

WO16 Wolter, M. et al, "Potential Tritium Uptake by Members of the Public Due to Consumption of Fish Caught in the Fermilab Pond System", EP Note 31 (October 2016).

12.0 SOP Signature Sheet

This table indicates all qualified personnel, and documents that they have read and understood this procedure and completed necessary On-the-Job Training (OJT) and Procedure Specific Training listed in Section 7.0 and tracked in Section 13.0. By signing below, the qualified individual agrees to adhere to the requirements and guidelines contained within this procedure along with all other applicable work authorization documents. Only persons who have signed below and have been authorized may perform work covered by this SOP.

Name	Signature	Date	Department Head/Team Leader

13.0 Procedure Specific Training Checklist

This table indicates all qualified personnel, and documents that they have completed necessary On-the-Job Training (OJT) and Procedure Specific Training. Only persons who have signed below and have been authorized by the relevant department head or team leader may perform work covered by this SOP.

Topic	Name	Signature	Date	Department Head/Team Leader
Use of CAP-88				
Fermilab Radionuclide Air Emissions Manual and associated spreadsheets				

14.0 Attachments

Attachment A: Technical Basis for the Expected Fermilab Occupancy of Members of the Public

Attachment A: Technical Basis for the Likely Fermilab Site Occupancy by Members of the Public

Background

The Fermilab site is 6,800-acres, and its facilities are a combination of research laboratories, office complexes, support facilities and housing units. To the degree possible, a campus-like atmosphere is maintained.

The public may be admitted to certain areas of the site based on controls and processes outlined in the Site Security Plan (FE22), the Policy on Access to Fermilab (FE21) and Procedure on Access to Fermilab (FE21a), which establish both General Access Areas (GAAs) and Property Protection Areas (PPAs). GAAs are open to the public during access hours, while PPAs have higher levels of security and access restrictions. The site perimeter is unfenced, but roads have staffed control points for access control. Roadways that are off limits to visiting members of the public are clearly marked with signs. Property Protection Areas are controlled by mechanisms specified in the Site Security Plan.

Members of the public are permitted onsite to access GAAs during public access hours as specified in the site security plan.

Requirements of DOE Order 458.1

DOE O 458.1, *Radiation Protection of the Public and the Environment* (DOE11) requires an evaluation of the potential dose to a member of the public both on DOE sites outside of controlled area in addition to offsite. The estimated individual dose to the MEI is to be "based on pathway and exposure parameters that are not likely to underestimate or substantially overestimate the dose" (DOE11, Section 2.e.(2)). Additionally, guidance from the DOE states that the MEI dose calculation "should be an estimate based on a scenario and parameters that approximate an actual situation. The estimate should be reasonable but not likely to underestimate the dose. Calculation of the dose to a person spending 100 percent of his or her time at the fence line is useful for comparison purposes, but it overestimates the dose to the representative person or the MEI and biases comparative analyses. The 2020 ASERs should contain estimates based on realistic situations and should clearly describe the location of critical receptors and the scenarios used to calculate the estimated doses." (DOE20)

Site Occupancy Estimates

The *likely* occupancy based on a realistic situation by a member of the public in many of the GAAs is expected to be much less than 24 hours a day, 365 days a year. One exception to this is the Fermilab Village area, where a reasonable scenario can be postulated in which an individual spends 24 hours a day, 365 days a year (8760 hours/year) in the area. This is conservative because it would be more likely for an individual to leave the site for some portion of each week for recreation and community activities.

The second most-likely occupied area onsite is the Fermilab Children's Center, which is open between 0645 and 1730 (10.75 hours/day, 5 days a week). A realistic scenario can be imagined where an individual occupies this area for all of the open hours while attending the Children's Center for day care,

although this is conservative because it is likely that they would not attend from open to close without any days away from site.

For all other locations onsite, assuming a member of the public is onsite for the entirety of the public access hours would substantially overestimate the likely dose to the onsite MEI. For GAAs other than the Village area and the Children's Center, it is reasonable to assume that any member of the public will be onsite no more than 400 hours, or approximately one day per week. This scenario is also conservative for the occupancy of a recreational visitor who might visit the site for one hour each day.

Dose to the onsite MEI will be calculated using a conservative location for both airborne and direct radiation. The doses for these pathways will be summed, even though it is unlikely that the same location will have the maximum dose for both pathways. This provides additional conservatism to the calculation without substantially overestimating the potential dose.

Therefore, the estimated dose for a GAA other than the Fermilab Village or Children's Center may be adjusted by this occupancy factor of 1/5. Additionally, the occupancy factor for infrequently-occupied outdoor areas such as parking lots and roads is assumed to be 1/8, consistent with the methodology used for Fermilab Shielding Assessments. This is a conservative occupancy factor compared to the recommendations by the National Council on Radiation Protection and Measurement (NC04, NC05), which recommend an occupancy factor of 1/40 for these types of areas.

Table A.1. Occupancy Factors for General Access Areas on Fermilab Site

Area Type	**Recommended Occupancy Factors**
Fermilab Village Residences	8760 hours
Fermilab Children's Center	2690 hours
General Access Areas other than those listed above	400 hours (1/5)
Outdoors areas with only transient pedestrian or vehicular traffic, parking lots, vehicular drop off areas	250 hours (1/8)