

# **RADIATION PROTECTION PLAN**

## **Niagara Falls Storage Site Remedial and Site Services - Balance of Plant, Lewiston, New York**

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## ACRONYMS

Ac	Actinium
ACL	Administrative Control Limit
ALARA	As Low as Reasonably Achievable
ANSI	American National Standards Institute
BOP	Balance of Plant
BZ	Breathing Zone
CDE	Committed Dose Equivalent
CFR	Code of Federal Regulations
cpm	counts per minute
CRZ	Contamination Reduction Zone
DAC	Derived Air Concentration
DAC-hrs	Derived Air Concentration Hours
dmp	disintegrations per minute
ECC	Environmental Chemical Corporation
EFS	Enviro-Fix Solutions LLC
EM	Engineering Manual
ER	Engineer Regulation
EZ	Exclusion Zone
FUSRAP	Formerly Utilized Sites Remedial Action Program
GA	General Area
IWCS	Interim Waste Containment Structure
LAW	Large Area Wipe
LDE	Lens of Eye Dose Equivalent
lpm	liters per minute
mg/m <sup>3</sup>	milligrams per cubic meter
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
NFSS	Niagara Falls Storage Site Remedial and Site Services
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
NY	New York
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
Pa	Protactinium
Pb	Lead
PPE	Personal Protective Equipment
QC	Quality Control
Ra	Radium
rem	Roentgen Equivalent Man
RG	Remedial Goal
ROC	Radionuclide of Concern
ROD	Record of Decision



RP	Radiation Protection
RPP	Radiation Protection Plan
RPS	Radiation Protection Supervisor
RPT	Radiation Protection Technician
RSO	Radiation Safety Officer
RWP	Radiation Work Permit
RWT	Radiation Worker Training
SAF	Self-Absorption Fraction
SDE	Shallow Dose Equivalent
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
TEDE	Total Effective Dose Equivalent
Th	Thorium
TODE	Total Organ Dose Equivalent
U	Uranium
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

**SIGNATURES**

This Radiation Protection Plan (RPP) has been prepared by Enviro-Fix Solutions, LLC (EFS) to describe the radiological controls requirements for the Niagara Falls Storage Site (NFSS) Remediation Single Award Task Order Contract (SATOC), Lewiston, NY Project, Work conducted under this contract will be performed in accordance with applicable federal, state, and local safety and occupational health laws and regulations including Occupational Safety and Health Administration (OSHA) standards, including 29 Code of Federal Regulations (CFR) 1910 and 1926, and the United States Army Corps of Engineers (USACE) Safety and Health Requirements Manual (EM 385-1-1, 15 November 2014). The contents of the APP are subject to review and revision as new information becomes available.

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## 1.0 INTRODUCTION

Enviro-Fix Solutions, LLC (EFS) has prepared this plan for the United States (US) Army Corps of Engineers (USACE) – Buffalo District under Contract Number W912P423D0010, to conduct remedial activities at the Niagara Falls Storage Site (NFSS) located in Lewiston, NY. The NFSS is included in the government's Formerly Utilized Sites Remedial Action Program (FUSRAP). The planned remedial activities include removal and off-site disposal of radiological and/or chemical contaminated materials including soil, road bedding, building foundations, and groundwater.

This Radiation Protection Plan (RPP) presents requirements that EFS personnel and subcontractors will follow in performing work activities at the NFSS. Applicability extends to EFS personnel, EFS's subcontractors, and visitors inclusive of USACE personnel and representatives, engineers and subcontractors. Personnel supervised by organizations other than EFS must adhere to an approved RP program prepared and administered by that organization.

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## 2.0 SCOPE OF THE RADIATION PROTECTION PLAN

The scope of this RPP is specific to the remedial activities planned for the NFSS Balance of Plant (BOP) and Groundwater Operable Units (OUs). The main feature of the NFSS, referred to as the Interim Waste Containment Structure (IWCS), is not part of the BOP/Groundwater OUs and is beyond the scope of planned remedial activities; therefore, the IWCS is not covered by the requirements outlined in this RPP. With the exception of the IWCS, all work performed within the fence line of the NFSS is within the scope of this RPP.

Radiation and radioactive materials are defined as workplace and environmental hazards. Worker protection requirements for exposure to radiation and/or radioactive materials are defined in federal regulations and are maintained through the implementation of this RPP.

This RPP defines the worker protection requirements for radiation exposure control as a support document to the Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP). This plan provides the template for lower tier procedures developed and implemented as project Radiation Protection (RP) Standard Operating Procedures (SOPs) that are commensurate with the scope and extent of the radiation hazards associated with remediation activities and are sufficient to ensure compliance with the applicable regulatory requirements. This RPP outlines the functions and responsibilities of the RP personnel and describes the activities to be performed at NFSS. A list of applicable RP procedures is provided in **Table 13-1**.

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### 3.0 REGULATORY REQUIREMENTS

This RPP has been developed and the field activities described herein will be performed in accordance with the following documents:

- U.S. Army Corps of Engineers (USACE) Engineer Manual (EM) 385-1-1, *Safety and Health Requirements Manual*, (USACE, 2014).
- USACE EM 385-1-92, *Safety and Occupational Health, Requirements for Hazardous, Toxic and Radioactive Waste Activities*, (USACE, 2018).
- USACE EM 385-1-80, *Radiation Protection Manual*, (USACE 2013).
- USACE Engineer Regulation (ER) 385-1-80, *Radiation Safety*, (USACE 2010).
- US Department of Labor, Occupational Safety and Health Administration (OSHA), Chapter 29, Sections 1910.120 and 1926 of the Code of Federal Regulations (29 CFR 1910.120 and 1926).
- USEPA, National Emission Standards for Hazardous Air Pollutants (40 CFR 61).

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## **4.0 RESPONSIBILITIES AND AUTHORITIES**

### **4.1 Radiation Safety Officer (RSO)**

The RSO will be responsible for the implementation of this RPP. The RSO will:

- Have oversight of all RP activities and operations relating to radioactive sampling, radioactive sample analysis, site radioactive surveys, handling and packaging of radioactive materials, waste management, and associated operations,
- Assure that environmental monitoring addresses the site-specific emissions providing clear and accurate documentation of compliance, and that all personnel are adequately trained in RP principles commensurate to the level with each person's job function,
- Correct any work practices and/or conditions that may result in unnecessary exposure to radioactive materials,
- Lead the regulatory interface for all matters of RP and/or radioactive waste management,
- Be involved in the project work planning of all operations in contaminated areas,
- Consult with the Site Safety and Health Officer (SSHO) about any deficiencies involving project radiation safety matters.

### **4.2 Radiation Protection Supervisor (RPS)**

The RPS reports to the RSO and provides field supervision of RPTs. The RPS will:

- Provide supervision and guidance to RP Staff,
- Communicates daily task assignments,
- Provides RP related input during daily plan-of day meetings,
- Performs QC reviews of all radiological survey documentation,
- Develops Radiation Work Permits (RWPs).

### **4.3 Radiation Protection Technicians (RPTs)**

RPTs will report to the RPS. The RPTs will:

- Perform all routine radiation, contamination, and airborne monitoring surveys,
- Implements requirements of RWPs,
- Control the access of tools, personnel and equipment into and out of the Exclusion Zone (EZ), including surveys for unconditional release,
- Performs RP briefing of personnel and ensure implementation requirements,
- Perform quality control (QC) checks and operability checks of the instrumentation used,
- Perform any personnel decontamination as needed,
- Maintain and post all radiological areas with applicable signs and barriers.

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## 5.0 RADIONUCLIDES OF CONCERN

There are eight radionuclides of concern (ROCs) identified in the BOP soil and road bedding including actinium-227, protactinium-231, lead-210, radium-226 (Ra-226), thorium-230 (Th-230), uranium-234, uranium-235, and uranium-238 (U-238). However, remedial goals (RGs) are developed for only the three primary ROCs including Ra-226, Th-230, and U-238. These individual radionuclide RGs include contributions from the other long-lived daughter products actinium-227, protactinium-231, uranium-234, and uranium-235 (included in the U-238 RG) and lead-210 (included in the Ra-226 RG).

Remediation activities will require the implementation of radiological controls throughout the entire project. The use of personal protective equipment (PPE), as low as reasonably achievable (ALARA) controls, controlled waste handling practices, and other various radiological control applications will be instituted during the project to minimize personnel radiation exposure, reduce the potential risk of personnel contamination, and prevent the spread of contamination to uncontrolled areas.

The primary concern during most aspects of this project is the inhalation and/or ingestion of radioactive dust particles. To protect workers from this potential, respiratory protection will be utilized for operations that have a potential for generating air contaminants in excess of allowable exposure limits. Skin contamination is also considered a primary concern. To protect workers from this potential, PPE will be utilized when handling or coming into contact with radioactive materials, or entry into any areas controlled for surface contamination. Workers will wear specified appropriate protective equipment for protection against dermal contact with radioactive loose surface contaminants. Deliberate ingestion and inhalation of contaminants is highly unlikely. However, work habits and contamination area controls will be taken seriously and given the utmost attention in order to reduce the potential for inadvertent skin contamination and or ingestion/inhalation during work tasks not requiring respiratory protection. Additionally, no eating, drinking, smoking, or chewing will be allowed inside of the Exclusion Zones, Contamination Reduction Zones, or any radiologically posted areas.



## 5.1 Uranium

Uranium is a radioactive metal. Toxicological effects from the ingestion of uranium result from both the action of uranium as a metal and its radioactive properties. The primary toxic chemical effect of uranium is seen in kidney damage. In addition, case studies have shown that the inhalation of uranium dust may cause an increase in lung cancer incidents, which may be attributable to the decay of uranium into radon (Rn-222) and its daughters.

## 5.2 Radium

Radium is a naturally occurring radioactive element that exists in several isotopes, which are formed from the decay of uranium and thorium. Ra-226, which is a decay product of U-238, is an alpha and gamma emitter and has the longest half-life of the radium isotopes.

Radon is a decay product of Ra-226. A colorless, odorless, radioactive gas, radon can infiltrate basements and water systems, resulting in exposure via inhalation pathways.

## 5.3 Thorium

Thorium is a naturally occurring, radioactive element that exists in several isotopic forms. The isotope Th-232 is a naturally occurring, radioactive element, which decays through the emission of a series of alpha and beta particles and the formation of daughter products. Isotopes  $^{234}\text{Th}$  and  $^{230}\text{Th}$  are produced during the decay of naturally occurring U-238; the isotope Th-228 during the decay of Th-232; and the isotopes Th-231 and Th-227 during the decay of U-235.



## 6.0 OCCUPATIONAL RADIATION EXPOSURE LIMITS

Occupational Radiation Exposure Limits are established in 10 CFR 20 *Standards for Protection Against Radiation* and promulgated in EM-385-1-80 *Radiation Protection Program of the USACE*.

The radiation exposure to NFSS personnel accessing radiological areas shall be controlled to ensure that the limits shown in **Table 6-1** are not exceeded. These limits are consistent with federal regulations that are applicable to NFSS work activities involving exposure or potential exposure to radiation and/or radioactive materials and are the maximum allowed, with approval of the EFS RSO.

### 6.1 Adult Employees

**Table 6-1 Occupational Radiation Exposure Limits (10 CFR 20)**

Total Effective Dose Equivalent (TEDE)	(TEDE = DDE + CEDE)	5.0 rem/yr
Total Organ Dose Equivalent (TODE) to Maximum Exposed Organ	(TODE = DDE + CDE)	50.0 rem/yr
Lens of Eye Dose Equivalent (LDE)	(LDE)	15.0 rem/yr
Shallow Dose Equivalent (SDE) to Skin or Extremity	(SDE)	50.0 rem/yr

Where:

- DDE = Deep dose equivalent (i.e., whole body exposure to external penetrating radiation)
- CEDE = Committed effective dose equivalent (e.g., internal exposure from inhalation, ingestion, injury)
- CDE = Committed dose equivalent

### 6.2 Embryo/Fetus

In the event that a Site worker declares herself pregnant, that worker's task assignments shall be controlled to limit the radiation exposure to the embryo/fetus. That limit shall be based on the time from conception to birth.

Dose equivalent limit to embryo/fetus: 0.5 rem for entire pregnancy



### **6.3 Radiation Exposure to Minors**

The NFSS Project does not employ minor individuals (individuals less than 18 years old) to perform work in a radiation environment.

### **6.4 Exposure to Visitors and Members of the Public**

Members of the public may receive radiation exposure from the NFSS Project controlled and/or monitored activities either as visitors onsite or by occupancy adjacent to the site. A visitor may be a member of the public or may be a representative or employee of a company or agency performing work onsite.

Radiation exposure to the public shall be controlled to limit doses to:

$<0.10 \text{ rem/yr}$

Radiation exposure to visitors onsite or individuals offsite shall be controlled to limit doses to:

TEDE  $< 0.10 \text{ rem/yr}$

Additionally, the U.S. Environmental Protection Agency (EPA) and EM 385-1-80 set an offsite dose limit via air particulate emissions of:

$0.01 \text{ rem/yr}$

### **6.5 ALARA Provision**

Work controls for NFSS radiological activities shall be performed in accordance with the requirements of this plan and shall incorporate provisions for reducing radiation exposures to levels that are considered ALARA, including implementation of time, distance, and shielding concepts to limit external radiation exposure. The primary internal radiation exposure pathway of concern for the work at NFSS is through potential inhalation of radioactive particulates. Work controls will include the use of dust suppression and soil surfactants to minimize airborne particulate levels and subsequent exposure of the individual to the radiological environment. Process or other engineering controls are the preferred methods for maintaining exposures to radiation and radioactive materials ALARA.



Additional controls that are evaluated for inclusion into the work control include the following:

- Control of access to radioactive materials,
- Techniques to reduce exposure times,
- Techniques to increase distance between the individual and the source,
- Use of PPE when engineering and administrative controls are ineffective.

Based on the expected radioactivity levels and our team's past experience, radiation exposures to workers are expected to be orders of magnitude below the federal limit. Therefore, we have established site administrative control limits (ACLs) at ten percent (10%) of the federal limit, as well as an ALARA goal for site workers equivalent to 20% of the total effective dose equivalent (TEDE) ACL, and 10% of the CDE, LDE, and SDE ACL limits, consistent with EM 385-1-80 ALARA goals. The ACL and ALARA goal values (in units of rem/yr) are shown in **Table 6-2**.

**Table 6-1 ACL and ALARA Goal Values**

Dose Quantity	10 CFR 20	Site ACL	ALARA Goal
TEDE	5	0.5	0.1
CDE	50	5	0.5
LDE	15	1.5	0.15
SDE	50	5	0.5
Embryo/Fetus	0.5	.5	NA

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## 7.0 SURVEYS AND AIR MONITORING

The RPTs will perform radiological survey and air monitoring activities during all aspects of the work at the NFSS. Initial incoming surveys of all equipment and facilities will be performed upon mobilization to confirm baseline radioactivity levels. During operations, routine radiation/contamination surveys will be conducted in and around work areas to document the effectiveness of our contamination controls. Gamma walkover surveys will be conducted to support and guide soil excavation activities. Contamination Reduction Zones (CRZs) will be surveyed in accordance with an established routine survey schedule to ensure the area is kept free of radioactive contamination. Conditional and unconditional release surveys will be conducted when equipment is either being relocated or demobilized from the Site. Contamination surveys will be conducted of all radiologically posted areas as necessary to track the potential for changing conditions based upon job functions being conducted in the area. Perimeter, General Area (GA), and Breathing Zone (BZ) air monitoring will also be conducted throughout remedial activities, as required by the activity hazards present.

### 7.1 Radiation Surveys

Radiation/exposure rate surveys give the RP personnel, as well as the worker, an indication of the amount of external occupational radiation exposure per unit time that an individual will receive while performing assigned tasks in a specific area.

Specific exposure rate surveys are needed to determine the disposition of radioactive material or if engineering controls are needed to reduce the exposure to the worker. This particularly applies during entry into areas that have not been previously surveyed and into demolition/excavation areas. Additionally, gamma exposure rate surveys will be performed when radioactive material debris is concentrated into piles or areas for waste storage.

Exposure rate surveys shall be performed in accordance with the RPP implementing procedures. Prior to using a meter, the individual performing the survey shall verify that the meter is in calibration and the batteries are in good working condition and that the meter performance test has been completed.



While performing exposure rate surveys, consideration is given to the types of radiation that are present in the work area so that hazards to personnel in the work area can be identified. Should any action levels be identified during the survey, the technician will take the appropriate action necessary and perform required notifications. All required dose rate surveys will be documented by the individual performing the survey.

## 7.2 Contamination Surveys

Radioactive contamination surveys are an important part of the RP Program. Based on results of contamination surveys that are performed in the various work areas, storage areas, and support areas, assessments can determine the appropriate controls to be implemented for radioactive material and to establish RP requirements for personnel working in an area or on equipment.

There are two basic types of radioactive contamination: fixed and removable (smearable or loose surface). Radioactive contaminants are external exposure hazards only as long as the contamination remains fixed. Removable radioactive contaminants represent both external and internal exposure hazards. Routine contamination surveys are primarily conducted to determine smearable levels while special contamination surveys are for smearable and fixed.

Routine contamination surveys are typically performed in conjunction with exposure rate surveys. Contamination surveys are performed using disk smears and/or large area wipes (LAWs). All smear results will be recorded in disintegrations per minute (dpm) per 100 square centimeters (dpm/100 cm<sup>2</sup>) unless otherwise indicated on the Radiological Survey Form. A drawing/photograph of the survey area or item may be completed by the surveyor if appropriate, and attached to the survey form. The individual survey point shall be numbered and the number circled, indicating a smear location on the drawing. Smears will normally be counted on site using a dual channel scaler or proportional counter, however in some instances, "field counting" may be appropriate using a portable hand-held detector. Any detectable activity on the large area smear (i.e., masslin) will be further investigated and augmented with 100 cm<sup>2</sup> smears to determine the exact extent of the loose contamination and determine if decontamination of the area, equipment, tool, etc. is necessary.

Care must be taken to avoid damage to the Mylar surfaces of detectors. Scan speed should be no greater than 1/2 probe width per second and, at a distance of 1/2" or less for beta-gamma, 1/4" or





less for alpha detection, or as needed to achieve acceptable minimum detectable concentrations from the surface being surveyed. Audible indicators should be used. The total indicated counts per minute (cpm); minus the background cpm, divided by the detector efficiency, will equal the dpm per smear area.

Contamination surveys will be performed in accordance with SOPs to evaluate radiological conditions and verify that radiological work activities are being adequately controlled. Survey data will be used for the RWP development, job evaluations, environmental reporting, trend analysis, and informing personnel of radiological conditions. Survey results will be made available to workers entering radiologically controlled areas through RWP briefings and daily toolbox meetings.

A variety of survey instruments are routinely used for scanning and frisking, and smear counting. The selected instruments will be used by qualified technicians at proper distances, scan speeds, and count times to ensure that the detection limits of those instruments are less than the acceptable surface contamination levels identified in **Table 7-1**. All instruments will be operated in accordance with the respective technical manuals and SOPs.

It should be understood that scanning minimum detectable activities may vary depending upon background count rate and calibration efficiencies. However, scan speed, background, and count times will be utilized in such a manner that minimum detectable activities for alpha and beta-gamma are kept as low as possible and <75% of the criteria in **Table 7-1** for fixed and loose surface activities.

**Table 7-1 Acceptable Surface Contamination Levels**

Nuclide <sup>a</sup>	Average dpm/100 cm <sup>2</sup>	Maximum dpm/100 cm <sup>2</sup>	Removable dpm/100 cm <sup>2</sup>
U-nat, U-235, U-238 and associated decay products	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th <sup>232</sup> , Sr <sup>90</sup> , Ra <sup>223</sup> , Ra <sup>224</sup> , U <sup>232</sup> , I <sup>126</sup> , I <sup>131</sup> , I <sup>133</sup>	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr <sup>90</sup> and others noted above.	5,000	15,000	1,000

All values represent allowable increment above background.

RP staff will perform routine radiological surveys at a specified frequency consistent with the RPP implementing procedures. The RSO will routinely review surveys with regard to necessity and



frequency consistent with good radiological protection practices and regulatory requirements.

The following are surveys that will normally be conducted for this project:

- Daily surveys of active work areas and access/egress points,
- Weekly surveys of offices and break areas,
- Pre-job surveys to support RWP requirements, as necessary,
- Radiological air monitoring of workers and active work areas,
- Perimeter air monitoring,
- Release of material from Restricted Areas,
- Radioactive material shipments,
- Monitoring spills or spread of radioactive material,
- Establishing and verifying radiological controlled area boundaries and postings,
- Monitoring areas and accesses that may have a high potential for change.

### **7.3 Radiological Air Monitoring**

The primary operational RP concern at the site during work activities will be airborne radioactivity generated from remediation operations, etc. An air-sampling program consistent with this RPP and implementing procedures will be implemented to ensure compliance with occupational (derived air concentration [DAC]) and environmental (air effluent) limits. The air-sampling program will include perimeter, general work area (GA) and breathing zone (BZ) samples. Four perimeter monitoring stations, and one offsite station will be established to confirm effluent airborne radioactivity levels. GA monitors will be located near the work activities most likely to have the highest airborne activity. BZ air samplers will be provided to the person (s) most likely to be exposed in a given work group. The number of breathing zone air samples will depend on the level of airborne activity that is expected to be generated based upon the task being performed.

All air sampling equipment will use dry glass fiber or membrane filter paper as the sampling media. Low-volume air samplers will usually average a draw volume of 1.0 - 4.0 cubic feet per minute (cfm) of air. High-volume air samplers average a typical draw volume of 3.0 – 10.0 cfm of air. The actual volume of each air sampler will be dependent upon model and individualized settings. Personal or lapel air samplers will use a dry glass fiber or membrane filter paper as a sample media and will typically operate at 2-5 liters per minute (lpm).

All air samples taken at the site will be screened for gross alpha/beta-gamma activity. Elevated levels of alpha and/or beta-gamma activity will be cause for the air sample to be shipped to the



analytical laboratory for alpha/gamma spectrometry. The radiological contaminant airborne action levels and actions to be taken are listed in **Table 7-2**.

Air sampling may be used to determine, if respirators are needed for a given type of excavation or sampling activity. If respirators are not being used for a given activity, air sample results are reviewed to determine if action levels have been exceeded that would compel the need for respirators. In addition, the air sampling results will be reviewed to determine the need for dust suppression measures.

Perimeter air sampling will be performed at site perimeters to measure airborne particulate concentrations as a result of the excavation and soil handling activities. Air samplers will be in place prior to commencement of intrusive activities at locations specified by the RSO. The samples will be collected during excavation or any intrusive activity. Four perimeter air sample stations located at the approximate compass cardinal directions will run continually (24/7) during site operations. Additionally, perimeter air samplers will be run for 30 days prior to onsite activities to establish background levels.

Results of the samples will be compared against the air effluent values identified in 10 CFR 20, Appendix B. For the purpose of the onsite screening, all alpha activity will be assumed to be from Th-230, the most restrictive alpha-emitting radionuclide of concern with an effluent limit of  $2\text{E-}14$  micro-Curies per milliliter ( $\mu\text{Ci/ml}$ ); and a derived air concentration (DAC) limit of  $3\text{E-}12$   $\mu\text{Ci/ml}$ . Likewise, for the purposes of onsite screening, all beta activity will be assumed to be from Pb-210, the most restrictive beta emitting radionuclide of concern (note that actinium-227 was not selected to establish screening limits due to the combination of its low abundance and low energy beta). Pb-210 has an effluent level of  $6\text{E-}13$   $\mu\text{Ci/ml}$  and a DAC of  $1\text{E-}10$   $\mu\text{Ci/ml}$ .

#### 7.4 Air Sample Analyses

Information required for analysis includes date, counter background, counter efficiency, sample identification and location, time the sample was started and stopped, flow rate, count start time, total count time, and total counts of the counter, and self-absorption factor (SAF). The alpha airborne activity analysis will have a SAF of 0.7(glass fiber) or 1.0 (membrane) applied. This factor will correct for the alpha absorption on the filter and media that are not seen by the detector. No SAF is required for airborne beta analyses. Calculated results will be recorded in microcurie



per cubic centimeter ( $\mu\text{Ci/cc}$  or  $\mu\text{Ci/ml}$ , which are equivalent units), unless otherwise indicated.

Samples shall be carefully removed from the packaging to prevent loss of sampled material. Counting a sample consists of placing the filter paper in a planchet and positioning the planchet directly under the counter probe. Counting time will be established to ensure an acceptable minimum detectable activity (MDA). Acceptable MDA is typically 10% of the applicable DAC or air effluent value as established in 10 CFR 20, Appendix B. Field counts may be performed using a count rate meter, but must be followed with the standard procedure using a scaler.

## 7.5 Operational Action Levels

A decision-making protocol for an upgrade in levels of protection and/or withdrawal of personnel from an area based on atmospheric hazards is outlined in **Table 7-2**. The action level values in **Table 7-2** are based on modified 10CFR20 limits as discussed in more detail following **Table 7-2**; these modifications are summarized as follows:

- Work area action levels are set to 30% of the DAC value to ensure no exposures exceed 12 DAC-hrs per the EM 385-1-1 definition of an airborne radioactivity area,
- Perimeter action levels are set to 20% of the effluent limit to ensure NESHAP compliance.

**Table 7-2 Operational Action Levels**

Type of Airborne Radioactivity Measurement	Activity	Action
Total Alpha Particulate-Work Area	$9\text{E-}13 \mu\text{Ci/ml}$	Stop operations that are presenting the problem until engineering controls can be established that will reduce airborne levels to below this level
Total Alpha Particulate - Perimeter	$4\text{E-}15 \mu\text{Ci/ml}$	Stop operations that are presenting the problem, evaluate work tasks in order to reduce airborne levels and reoccurrence
Total Beta Particulate – Work Area	$3\text{E-}11 \mu\text{Ci/ml}$	Stop operations that are presenting the problem until engineering controls can be established that will reduce airborne levels to below this level
Total Beta Particulate - Perimeter	$1.2\text{E-}13 \mu\text{Ci/ml}$	Stop operations that are presenting the problem, evaluate work tasks in order to reduce airborne levels and reoccurrence



USACE EM 385-1-1 refers to 10 CFR 20, Appendix B for airborne levels. The basis for action is at 1 DAC for any radionuclide. *Airborne Radioactivity area* means a room, enclosure or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations:

- In excess of the DACs specified in Appendix B, to §20.1001 – 20.2401, or
- To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an annual limit intake (ALI) or 12 DAC-hours.

Should airborne levels average 30% of 1 DAC for a 40-hour week and the person was not wearing a respirator, the person could receive 12 DAC-hours. In order to prevent exceeding this requirement, respiratory equipment will be worn during operations that are anticipated to generate elevated airborne radioactivity, and the work area air monitoring action level will “flag” potential activity prior to meeting the requirement for tracking DAC-hours and/or the need to post an area as an “*Airborne Contamination Area*.”

The perimeter operational action level is based on 40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAP).

The EPA sets an offsite dose limit of 10 millirem (mrem) per year, as stated in the following excerpt from 40 CFR 61.102:

“Emissions of radionuclides, including iodine, to the ambient air from a facility regulated under this subpart shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.”

Since the 10 CFR 20 Appendix B air effluent values are based on 50 mrem/year, the action level for perimeter air monitor results will be set to 1/5 of the appropriate 10 CFR 20 Appendix B air effluent limits.

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## 8.0 BIOASSAYS AND TLD BADGES

EFS will provide and issue external whole-body dosimeters to all site personnel/vendors/visitors entering radioactive material areas to perform work. Internal exposure will be monitored by general work area and breathing zone air sampling/DAC hour tracking. If an individual exceeds the operational action level of 12 DAC-hours in one week, a urine bioassay will be performed to confirm internal exposure.

Upon completion of all work, when dosimeters have been processed, EFS will send the required U.S. Nuclear Regulatory Commission (NRC) Form to each employee showing a breakdown of their accumulated dose for the work period. A copy of all DAC-hour tracking, bioassay analytical and dosimeter monitoring results shall be provided to USACE and the EFS PM.

All external dosimetry shall be processed by a National Voluntary Laboratory Accreditation Program (NVLAP) certified laboratory.

The RSO may perform radiological assessments to augment the results of routine monitoring when inconsistencies and other incidents occur. For example, lost dosimeters and unexpected airborne contamination events will be investigated and a radiological assessment of potential exposure will be performed and documented. The results of radiological assessments may be used as an exposure record and recorded in an individual's radiation exposure record.

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## 9.0 TRAINING

Before any work activity that may expose an individual to sources of radiation, that individual shall be trained to the potential risks associated with the project work activities. This training shall be based on the types of work and work locations that are specific to the individual's work assignment. This training shall be presented and the worker evaluated on a graded approach that considers the types of radiation, the potential exposure levels, and the risks to the individual associated with his/her work assignment. EFS will provide Radiation Worker Training (RWT) for NFSS staff. The records generated for the training program will be maintained at the site and will be available for review.

RWT is an approximately 6–8-hour course consisting of classroom lecture and instruction, practical factors exercise where individuals demonstrate their proficiency in donning and doffing anti-contamination clothing and performance of self-monitoring for radioactivity, as well as a comprehensive written exam. A minimum score of 80% is required on both the exam and the practical factors portion. A minimum of 4 hours annual refresher training will also be required.

Training will include the following:

- Radiation Fundamentals,
- Biological Effects of Radiation,
- ALARA & Dose Limits,
- Precautions and controls used to control exposure,
- Personnel Monitoring Programs,
- Prenatal Exposure Risks,
- Radiological Postings and Limits,
- Contamination Control,
- Radiological Dosimetry/Instrumentation,
- Radiological Emergencies,
- Practical Factors Review,
- Worker Responsibilities.

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## **10.0 WORK SUPPORT ACTIVITIES**

### **10.1 Access Control**

Site access during project activities will be through the main gate on Pletcher Road. EFS will have control and responsibility for Site access during remediation activities. This control will be coordinated with the USACE and property owners prior to mobilization. Site access control will include:

- Allowing only authorized personnel to enter Site areas while the remediation is being performed,
- Ensuring physical barriers (such as the fences, gates, and locks) are maintained,
- Proper posting of the site,
- Implementing sign-in and sign-out protocols for personnel moving on and off site, and
- Ensuring that personnel are properly trained and qualified to be on site or in specific work areas.

All visitors will be required to notify the PM upon their arrival at the Site. Once on site, all visitors are required to first report to the field trailer and sign the site entry and exit log. All visitors will receive a brief site safety orientation by the RSO or his designee.

### **10.2 Radiation Work Permits**

RWPs will be used for NFSS Soils Remediation. The EFS developed task specific RWPs will include dosimetry requirements, minimum PPE and any additional RP measures necessary to safely perform the work.

### **10.3 Engineering Controls**

Implementation of engineering controls can reduce the need for PPE by separating the worker from the radiologically contaminated material. During investigation activities dust may be generated. The Site Superintendent, RSO, and SSHO will be constantly alert to the possibility of unacceptable dust levels. Control measures will be implemented for all operations where dust is likely to be generated. Careful planning and implementation of controls will reduce potential dust concentrations. There are a number of specific construction practices, which will reduce levels of airborne particulates. These include:



- Providing for a misting spray during soil removal activities,
- Wetting and misting equipment and contaminated materials,
- Reducing the active work area surface and limiting the number of soil removal/processing operations.

#### **10.4 Posting Requirements**

The entry control program is defined in accordance with the results of the radiological monitoring. This begins with posting the locations that allow access or entry into the areas containing the radiation sources. Posting should be at each access point to a controlled or restricted area of material removal activities at the NFSS. The RP staff will manage access of personnel to potential sources of radiation and/or radioactive materials.

The following information is placed in conspicuous locations in controlled areas. The following postings will provide notification to individuals of rights and responsibilities.

- NRC Form 3,
- Notice to Employees (10 CFR 19.11),
- OSHA Poster (3165).

#### **10.5 Control of Radioactive Materials**

The radioactive materials that require controls to prevent unauthorized access or removal fall into two broad categories: (1) discrete sources that may have some value or use and (2) radioactive waste. The first category will typically be in the form of sources used to perform radiation measurement instrumentation operability checks. The control of radioactive waste from remediation efforts will be defined in work plans, with supporting RPP requirements, to ensure wastes are properly prepared for packaging and transport. Routine leak checks will be performed on each source at the frequency determined by the radiation type (alpha, beta, or gamma).

#### **10.6 Storage and Inventory**

Any radioactive source that is licensed to and/or used by EFS at the NFSS shall be stored in a secured location to prevent unauthorized access or removal. Sources shall be stored when not in use. When sources are removed from storage, a log shall be maintained that includes the following:

- Source description,
- Name of person to whom source is assigned,
- Location of source use,



- Date of removal,
- Date of return.

At the beginning and at the end of the project, an inventory of radioactive sources licensed to or maintained by EFS shall be performed that includes the following:

- Sources obtained since last inventory,
- Sources disposed of since last inventory,
- Description and location of all existing sources.

## 10.7 Decontamination

Decontamination is the process of removing or neutralizing potentially harmful contaminants that have accumulated on personnel and equipment in order to reduce the spread of contamination outside the EZ. Decontamination is critical to the safety and health of Site workers and also protects the community by minimizing the off-site migration of contaminants. One of the most important aspects of controlling contaminated material migration is the prevention of the spread of contamination. Good contamination prevention will minimize employee and public exposure.

The decontamination process is composed of a series of steps performed in a specific sequence. The basic concept is that more heavily contaminated items will be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items.

During work activities at the Site, all items taken into an EZ must be considered contaminated and must be carefully inspected and/or decontaminated before leaving the site. Any contaminated equipment and material will be cleaned and decontaminated to the satisfaction of the RSO or designee prior to leaving the EZ and will satisfy the **Table 7-1** release criteria. Items not decontaminated will be disposed of as waste.

Radiation detection instruments will be used at the site to monitor for contamination. Portable instruments will be used to monitor or frisk personnel upon exiting EZs and for releasing equipment from EZs and/or the site. The monitoring equipment will typically consist of a dual alpha/beta scintillation detector coupled to an appropriate ratemeter, or equivalent. Instruments equipped with either an alpha sensitive zinc sulfide scintillation detector or a gas flow proportional detector configured with a sample holder will be used to count smears for assessing removable contamination.



#### 10.7.1 Personnel Decontamination

After doffing PPE, personnel will frisk themselves for radioactive contaminants with an appropriate survey instrument to determine if personnel decontamination is warranted. Monitoring is required upon exiting an EZ or any other area under radiological controls as directed by the RSO. If skin contamination is suspected, workers will be required to stay in the area and contact RP technicians for assistance. RP technicians under direction of the RSO or SSHO shall perform skin decontamination and subsequent monitoring. The need for bioassay sampling will be evaluated on a case-by-case basis. Upon release from the area workers will be directed to wash hands and face to remove any potential chemical contaminants.

#### 10.7.2 Equipment Decontamination

Equipment decontamination procedures are summarized below. Any equipment used in an EZ will be decontaminated at the excavation area by removing all loose soil. Subsequent decontamination will be performed as necessary until verified clean, and may include:

- Washing and/or wiping until visibly clean,
- Low pressure, non-phosphate, detergent wash with wiping.

A conditional release survey will be completed at the excavation area prior to moving the equipment to the next work location on site. Small tools and other equipment (i.e., field meters, etc.) will be wrapped in plastic prior to being moved between contaminated areas of the site and will be decontaminated prior to being moved to un-contaminated areas of the site or off site. All equipment will be decontaminated and surveyed in accordance with requirements of the task-specific RWP. As much equipment as possible will be dedicated for single use for the duration of the project and, upon final release, will be surveyed and verified in conformance with the site unrestricted (free) release limits.

Equipment requiring maintenance or repair will generally be decontaminated prior to servicing. Reusable sampling equipment and any other tools used for intrusive work will be decontaminated between sampling locations, as necessary. Following decontamination, all equipment will be surveyed by an RP technician.



## 10.8 Instrumentation

Detection sensitivities capable of detecting the ROCs to Minimum Detectable Concentrations (MDCs) will be estimated, using the guidance in NUREG-1575 [Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)] and NUREG-1507. Instrumentation and survey techniques will be chosen to achieve these sensitivities for the NFSS land areas, for both scanning and direct measurements. This will assure identification of areas of elevated activity of a size and activity level that could adversely impact the survey. All instruments will have current calibrations for the radiations and energies found at NFSS, using National Institute of Standards and Technology (NIST)-traceable standards. Operational and background checks will be performed at the beginning of each day of survey activity and whenever there is reason to question instrument performance. Defective instruments will be removed from service and data obtained with that instrument since its previous acceptable performance, will be reviewed for acceptability.

All portable instrumentation will be QC source-checked on a daily basis to ensure instruments are responding correctly. QC checks will be conducted by comparing the instrument's response to a designated radiation source and to ambient background.

QC source checks will consist of one-minute integrated counts with the designated source position in a reproducible geometry, performed at the designated location. Background checks will be performed in an identical fashion with the source removed. The results of the background and QC checks will be recorded on a daily source check log.

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## 11.0 RADIOACTIVE MATERIAL SPILLS

### 11.1 Material Spills

Material spills could occur during remediation activities. Ultimately, a spill could contaminate receiving surface water or cause a release of airborne contaminants. A small spill should be cleaned up immediately, but should not trigger activation of a response team. Should a spill occur, the immediate response will include closing off the area of the spill, if possible, cleanup with excavation equipment or hand tools, and sweeping, as appropriate. Any spill that results in a discharge to off-site surface water will be contained by soil berms as needed.

#### 11.1.1 Notifications

All radioactive material spills will be reported immediately to the RSO and SSHO. The sequence of reporting will be as follows:

- The PM or SSHO will immediately notify the Contracting Officer Representative regardless of the size of the spill.
- EFS and the Contracting Officer Representative will jointly determine the nature of the spill, its size, and if anyone has been injured as a result of the spill and whether it requires immediate notification to regulatory agencies.

Upon notification of a spill, project activity may be immediately suspended and all necessary equipment and personnel will be diverted to spill control and containment. In the event of a significant spill, a Spill Incident Report will be submitted to the Contracting Officer Representative.

#### 11.1.2 Spill Response Equipment

Given the nature of this project, all the necessary equipment and personnel necessary to deal with a release of radioactive material will be available on site. In addition to the heavy equipment and PPE, which is critical to spill control, EFS will have on hand an ample amount of hand tools and containers on hand for spill cleanup.

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## 12.0 RECORDS MANAGEMENT

Work activities that involve potential radiation exposure to individuals are required by applicable regulatory agencies to include records that document the work was performed in compliance with applicable parts of the regulations. Records generated for NFSS activities in accordance with the provisions of this plan shall be maintained for the life of the EFS corporate entity or until disposition is legally authorized.

At a minimum, the following types of records, as pertinent to NFSS work activities, shall be produced and retained:

- Individual monitoring records,
- Bioassay results,
- Workplace monitoring records,
- Worker preparation and training records,
- Records of incidents,
- Records of reviews and audits of the RPP.

### 12.1 Administrative Records

Administrative records generated in support of remediation work activities that involve handling radioactive materials shall be maintained within a records management system that should facilitate storage, tracking, and retrieval. For purposes of this plan, the types of records that shall be maintained in this system shall include, but not be limited to the following:

- Medical records,
- Training records,
- Written declaration of pregnancy by project employees,
- Internal audits of the RPP,
- Source inventory records,
- Copies of licenses and permits, with amendments, for activities.

### 12.2 Monitoring and Workplace Records

EFS is responsible for administering the radiological work controls and will establish and maintain records of radiological measurements and assessments of the workplace. The types of records to be included are as follows:

- Area radiation survey maps and data,
- Surface contamination maps and data,



- Air monitoring data,
- Effluent release monitoring data (not anticipated),
- Material release survey data,
- Waste packaging and disposal records,
- Instrument calibration and maintenance records.

### **12.3 Dosimetry Reports**

NFSS workers who perform work involving occupational radiation exposure limited by an applicable regulatory authority will be monitored in accordance with provisions of this RPP.

Regulatory agencies require certain reports that are based on these results to be produced and issued. These reports will typically be for the following:

- Reports to the individual,
- Reports to employers (non-EFS).

### **12.4 Reports to Individuals**

Federal regulations require that the licensee or agency responsible for the control of occupational exposure to individuals and responsible for monitoring those individuals as part of that control may be required to provide written reports of the results of that monitoring to the individual.

### **12.5 Reports to Employers (Non-EFS)**

At the written request of an individual who has been monitored for occupational radiation exposure by EFS, but is not an employee of EFS, EFS will provide a written record to that individual's employer or to any other agent specified by the individual. That record will contain a summary for the period of exposure monitored by EFS.



### 13.0 RADIATION PROTECTION PROCEDURES

EFS will implement the RP requirements of this plan by following SOPs. A list of SOPs planned for use at the NFSS is provided below in **Table 13-1**. Should the need arise, additional SOPs may be required or an existing SOP may require revision. Changes to and addition of SOPs will be accomplished using ‘Field Change Requests’ which will be approved by field supervision and the PM for timely implementation.

**Table 13-1 Radiation Protection Standard Operating Procedures**

Procedure Number	Procedure Title
EFS-RP-01	Access Control
EFS-RP-02	Radiological Postings
EFS-RP-03	Radiation Work Permits
EFS-RP-04	Radiological Surveys
EFS-RP-05	Unrestricted Release Requirements
EFS-RP-06	Survey Documentation and Review
EFS-RP-07	Measurement of Airborne Radioactivity
EFS-RP-08	Portable Count Rate Instruments
EFS-RP-09	Portable Dose Rate Instruments
EFS-RP-10	Low Volume Air Samplers
EFS-RP-11	Fixed Counting Systems
EFS-RP-12	Radioactive Material Control
EFS-RP-13	Dosimetry Issue
EFS-RP-14	Embryo Fetus Protection
EFS-RP-15	Radiological Records
EFS-RP-16	Radiation Worker Training
EFS-RP-17	<i>RESERVED</i>
EFS-RP-18	<i>RESERVED</i>
EFS-RP-19	<i>RESERVED</i>
EFS-RP-20	<i>RESERVED</i>

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