DRAFT

RADIOLOGICAL SURVEY PLAN FOR BUILDINGS AND CONSOLIDATED MATERIALS WITHIN AREA IV OF THE SANTA SUSANA FIELD LABORATORY

VENTURA COUNTY, CALIFORNIA

SEPTEMBER 2011

U.S. Department of Energy

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prepared for

U.S. Department of Energy (DOE)

prepared by

CDM with support from Science Applications International Corporation (SAIC)

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LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
AETR	Advanced Epithermal Thorium Reactor
Am	americium
ANSI	American National Standards Institute
Ba	barium
Be	beryllium
Boeing	The Boeing Company
BPRGs	Preliminary Remediation Goals for Radionuclides in Buildings
Cd	cadmium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cm	curium
Co	cobalt
cpm	counts per minute
Cs	cesium
D&D	Decontamination & demolition
DCGLs	Derived Concentration Guideline Levels
$DCGL_{EMC}$	Derived Concentration Guideline Levels used for elevated measurement comparison
$DCGL_W$	Derived Concentration Guideline Levels used for statistical tests (Wilcoxon Rank Sum)
DHS	California Department of Health Services
DOD	Department of Defense
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQO	Data Quality Objective
EA	Environmental Assessment
EBR	Experimental Breeder Reactor
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
Eu	europium
FONSI	Finding of No Significant Impact
ft	foot/feet
ft^2	square foot/feet
H	hydrogen
H-3	hydrogen-3 (tritium)
HSA	Historical Site Assessment
in	inch(es)
in/sec	inches per second

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

LBGR	Lower Bound of the Gray Region
LSC	liquid scintillation counting
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MeV	million electron Volts
min	minute(s)
MQOs	Measurement Quality Objectives
mrem/y	millirem per year
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Testing
NMDF	Nuclear Materials Development Facility
Np	neptunium
NRC	U.S. Nuclear Regulatory Commission
NUREG	U.S. Nuclear Regulatory Commission Regulation
OMR	Organic Moderated Reactor
PARCC	Precision, Accuracy, Representativeness, Comparability and Completeness
PCOCs	Potential Contaminants of Concern
Pm	promethium
PRGs	Preliminary Remediation Goals
Pu	plutonium
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RMHF	Radioactive Materials Handling Facility
SEFOR	Southwest Experimental Fast Oxide Reactor
SGR	Sodium Graphite Reactor
SNAP	System for Nuclear Auxiliary Power
SOP	Standard Operating Procedure
SPTF	Sodium Pump Test Facility
Sr	strontium
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
Th	thorium
U	uranium
Y	yttrium
y	year(s)

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EXECUTIVE SUMMARY

The decommissioning, demolishing and disposal of buildings remaining within Area IV of the Santa Susana Field Laboratory (SSFL) will be conducted under several plans and decision documents. This building survey plan presents the field procedures that will be implemented to characterize the structures for remaining radionuclides. Results of the building surveys will be used to disclose risks to workers, the community, and the environment that could result from building demolition and materials transport. Results will also be used to support the development of a decontamination and demolition (D&D) plan that will be specifically address how the buildings will be demolished and materials disposed. The D&D plan may address additional sampling that may be needed to address waste disposal acceptance criteria. Governing what is required for D&D activities and obtaining approvals from the California Department of Toxic Substances Control for D&D, is a Standard Operation Procedure (SOP). The SOP describes the process and steps that will be followed to achieve D&D acceptance of facility D&D, but the specifics of D&D will be presented in individual facility D&D plans.

SSFL AREA IV RADIOLOGICAL SURVEY PLAN FOR BUILDINGS AND CONSOLIDATED MATERIALS

Portions of the U.S. Department of Energy's (DOE's) Energy Technology Engineering Center within Area IV of the Santa Susana Field Laboratory have been radiologically contaminated as a result of the testing of equipment, materials and components for nuclear and energy related programs. Existing buildings and consolidated materials (e.g., asphalt and concrete surfaces) will be demolished as an integral part of the remediation of Area IV. In preparation for demolition, DOE determined that data is specifically needed with which to:

- determine the current radiological status of remaining structures;
- evaluate risk to workers as a result of building D&D activities;
- assess the risk to workers and to members of the public associated with the transportation of building debris; and
- evaluate risk to the general environment.

This draft "Radiological Survey Plan for Buildings and Consolidated Materials within Area IV of the Santa Susana Field Laboratory" utilizes technical approaches defined in the *Multi-Agency Radiation Survey and Site Investigation (MARSSIM)* to characterize those structures for which additional radiological data is needed. MARSSIM is a multi-agency consensus document of the U.S. Environmental Protection Agency (EPA), Department of Defense (DOD), Nuclear Regulatory Commission (NRC), and DOE which provides information on planning, conducting, evaluating and documenting building surface (and surface soil) final status radiological surveys. Although MARSSIM protocols are primarily used to demonstrate compliance with dose or risk-based regulations or standards, in this case they are used to characterize buildings and consolidated structures to acquire additional needed data as DOE proceeds with SSFL cleanup and closure activities. In using MARSSIM, the quality and quantity of data can be carried forward into the final status survey process as appropriate and be integrated with other site data in the development of waste stream profiles.

As an integral part of the survey plan development process, DOE reviewed and incorporated relevant information contained in EPA draft historical site assessments regarding the identification of radiological potential contaminants of concern. Following this analysis, the

MARSSIM graded approach was applied to the remaining Area IV buildings and their locations. The graded approach recognizes that more survey effort is required in site areas that have a greater potential for contamination. Class 1 areas are defined as those that potentially have the most contamination, while Class 2 areas have less potential contamination, and Class 3 areas are expected to have very minimal contamination, if any at all.

Wearing protective clothing, survey team members will perform radiation surveys using field detection instruments to measure the amount of radioactivity present. Surveys will also include collecting samples of contamination to determine the type of radioactive materials present and in what amounts. Walls, floors, ceilings and other surfaces within building as well as building exteriors will be surveyed and sampled. Survey results will be sent to a laboratory for analysis and results will be used in future D&D planning, and related efforts. (The survey plan includes buildings and concrete and asphalt surfaces such as parking lots but excludes materials and equipment such as tables, filing cabinets, and storage shelves which are not part of buildings. Contamination on materials and equipment will be evaluated as part of a separate survey.

The radiological survey for buildings and consolidated materials within Area IV of the Santa Susana Field Laboratory is expected to be completed by spring, 2012.

1.0 INTRODUCTION

This survey plan describes the collection of scan survey data, fixed point samples/measurements, gross alpha and beta smear samples, tritium smears, radionuclide ratio sampling and dose rate samples for the radiological potential contaminants of concern (PCOCs) for buildings and consolidated materials (e.g., concrete and asphalt surfaces) that have been determined to be present in Area IV of the Santa Susana Field Laboratory (SSFL). The data collected pursuant to this plan will be used to:

- determine the current radiological status of remaining structures;
- evaluate risks to workers as a result of building decontamination and demolition (D&D) activities;
- assess the risk to workers and to members of the public associated with transportation of building debris; and
- evaluate risk to the general environment.

Additional building or consolidated material data may be required to meet other needs such as waste characterization, waste stream profiling, and clearance of materials and equipment. Although information collected pursuant to this survey plan will be fully utilized to meet all relevant data needs, additional surveys may reasonably be required to augment existing data to meet such additional needs.

The SSFL is jointly owned by The Boeing Company (Boeing) and the federal government (administered by the National Aeronautics and Space Administration [NASA]) and is operated by Boeing. A portion of the SSFL that is owned by Boeing was leased to the U.S. Department of Energy (DOE). The SSFL is located in the southeast corner of Ventura County, 30 miles northwest of downtown Los Angeles, California. The SSFL occupies 2,800 acres and is divided into four administrative and operational areas. Area IV of the SSFL makes up 290 acres located in the westernmost administrative and operational portion of SSFL.

DOE is planning to complete remediation of Area IV, including building D&D, in compliance with applicable regulations. The environmental data necessary to demonstrate compliance needs to be of known quality and adequate for the purposes of risk determination for workers and for members of the public as a result of the transportation of project wastes. This plan provides the survey methods and quality control provisions that will be used to document the current conditions of all remaining structures within Area IV. Results of these building radiological surveys will be incorporated into a survey report such that all data is available for use in development of a building D&D plan for SSFL Area IV structures. This survey plan is based on consensus approaches of the Department of Defense, Department of Energy, U.S. Environmental Protection Agency, and Nuclear Regulatory Commission as detailed in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DOD2000). MARSSIM "provides guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk based regulation" (DOD 2000). The data being generated as a result of this plan will follow appropriate MARSSIM guidance. "MARSSIM provides a nationally consistent approach to conducting radiation surveys and investigations at potentially contaminated sites" (DOD 2000). "MARSSIM may serve to guide or monitor remediation efforts whether or not a release criterion is applied.... MARSSIM describes generally acceptable approaches for: planning and designing scoping, characterization, remediation-support, and final status surveys, but with a specific focus on the final status surveys" (DOD 2000).

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2.0 BACKGROUND

The SSFL was established in 1947 as a field test laboratory for static-fire testing of large rocket engines. Area IV of the SSFL was established in 1953 and was slated as a nuclear reactor test facility. A broad range of energy-related research, including nuclear-related operations, were conducted in Area IV of SSFL between 1953 until 1988. Prior to the termination of research activities in 1998, there were three primary types of operations conducted at Area IV:

- Development and testing of nuclear reactors
    - By 1960 there were eight major programs focusing on the development and testing of nuclear reactors in Area IV. All programs were terminated by 1980.
- Nuclear support operations
    - Starting in 1956, programs for manufacturing, management and disassembly of fuel for reactor operations and the operation of waste management facilities for off-site disposal were conducted. All operations were terminated by 1988 with the exception of the Radioactive Materials Handling Facility (RMHF), Fuel Storage Facility and the Radiation Instrument Calibration Laboratory.
- Non-nuclear energy research and development
    - Liquid metal processes and the development of liquid metal components and weld testing. The non-nuclear energy research and development programs were not sources of potential radiological contamination.

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3.0 HISTORICAL SITE ASSESSMENT

The *Historical Site Assessment of Area IV Santa Susana Field Laboratory Ventura County, California* (Sapere 2005) was developed to determine which of the 272 sites in Area IV were "impacted" as defined in MARSSIM. *The Data Gap Analysis Report* (CDM 2008) built on the Historical Site Assessment (HSA) to determine which of these impacted areas require the collection of additional data to support the risk-based calculations. The U.S. Environmental Protection Agency subsequently issued "*Draft Technical Memorandum, Subarea HSA-5A Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study, Ventura County, California, in January, 2011 (*EPA 2011a*);* "*Draft Technical Memorandum, Subarea HSA-5B, Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study, Ventura County, California*" in October, 2010 (EPA 2010b); "*Revised Draft Technical Memorandum, Subarea HSA-5C, Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study, Ventura County, California*" in August, 2010 (EPA 2010a); *Draft Technical Memorandum, Subarea HSA-5D Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study, Ventura County, California, in April, 2011 (*EPA 2011c*); Draft Technical Memorandum, Subarea HSA-6 Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study, Ventura County, California, in June, 2011 (*EPA 2011d*;)*and *Draft Technical Memorandum, Subarea HSA-8 Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study, Ventura County, California, in March, 2011 (*EPA 2011b*).* Conclusions stated in these technical memoranda are incorporated herein.

As noted in Section 2.2 of MARSSIM, areas that have no reasonable potential for residual contamination (as a result of site activities) are classified as non-impacted areas (DOD 2000). As noted in Section 1.2 of the EPA revised draft technical memorandum for Subarea 5C, "All of the sites at the Area IV Study Area are considered to have a "reasonable potential for residual contamination" (DOD 2000), so none is classified as "non-impacted"" (EPA 2010a). As such, buildings and consolidated materials within Area IV are subject to confirmatory radiological surveys as MARSSIM Class 1, 2 or 3 areas. Section 1.2 of the EPA revised draft technical memorandum for Subarea 5C also notes that Class 1, 2 and 3 Areas are defined as follows:

- Class 1 Areas: Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological investigations) above the derived concentration guideline level for average concentration over a wide area, used with statistical tests (i.e., derived concentration guidance level, wide-area ($DCGL_W$))."
- "Class 2 areas: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$.
- Class 3 Areas: Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on site operating history and previous radiation investigations.

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4.0 RADIOLOGICAL POTENTIAL CONTAMINANTS OF CONCERN

The radiological PCOCs in the impacted portions of Area IV consist mainly of materials associated with reactor fuel and fission and activation products. Specific radiological activities in Area IV included:

- The operation of ten nuclear reactor facilities
- The operation of seven criticality test facilities
- The manufacturing of reactor fuel assemblies
- The disassembly and inspection of reactors and used reactor fuel assemblies
- The on-site storage of nuclear material

Contamination could also have resulted from smaller scale laboratory work in Area IV including:

- The fabrication, use and storage of radioactive sources
- Research on reprocessing used reactor fuel
- The operation of particle accelerators
- Research using radioisotopes
- Miscellaneous operations

Radionuclides Related to Historical Operations at the Santa Susana Field Laboratory Area IV (SAIC 2009) lists some applicable PCOCs for Area IV of the SSFL. EPA has also listed "Radionuclides of Concern" in the HSA for the applicable subarea. The HSAs have identified additional radionuclides as PCOCs including K-40, and Sb-125. Ni-59 and Ni-63 were also identified as ROCs for a few specific buildings.

Many radionuclides, especially those in naturally occurring series, have radioactive daughter products. As an example, although Th-232 emits one alpha particle, when in equilibrium with its daughter products, total emissions consist of six (6) alpha particles and four (4) beta particles. The Th-232 decay products grow into equilibrium relatively quickly such that all the members of that decay chain would be expected to be present at the same relative activity concentration. Such a situation is encountered as a result of both thorium processing operations and with regard to background. These progeny will not be measured separately unless detected by gamma spectroscopy, but must be taken into account when performing surveys involving these materials because the additional emissions associated with the daughters will be measured also. With regard to the naturally occurring uranium (U-238) decay series, by contrast, daughters beyond U-234 will not be present in measureable quantities from ingrowth from processed uranium due to the long half-life of U-234. Therefore, they are not process related and would generally only be encountered at background levels. One potential exception may be the use of such radionuclides as calibration sources (Ra-226, Pb-210/Po-210) for instrumentation. Such radionuclides have been specifically added to the PCOC list for the applicable buildings involved. The PCOCs are listed in Table 4-1.

Table 4-1. Radiological Potential Contaminants of Concern for the SSFL[1]

Element (Atomic Mass)	Isotope	Half-Life (Years)	Radiation[2]	Particle Energies (MeV)[3]	Abundance (%)[4]
Americium (241)	Am-241	4.32×10^{2}	alpha	5.43	13
				5.49	86
Antimony (125)	Sb-125	2.77×10^{0}	beta	0.4457	100
Barium (133)	Ba-133	1.07×10^{1}	electron capture	NA	NA
Beryllium (10)	Be-10	2.5×10^{6}	beta	0.5558	100

Table 4-1. Radiological Potential Contaminants of Concern for the SSFL[1] (Continued)

Element (Atomic Mass)	Isotope	Half-Life (Years)	Radiation[2]	Particle Energies (MeV)[3]	Abundance (%)[4]
Cadmium (113)	Cd-113m	1.41×10^{1}	beta	0.585	100
Curium (244)	Cm-244	3.0×10^{1}	alpha	5.76	24
				5.8	76
Cobalt (60)	Co-60	5.26×10^{1}	beta	0.3179	100
Cesium (137)	Cs-137	3.0×10^{1}	beta	0.511	95
				1.17	5
Europium (152)	Eu-152	1.27×10^{1}	electron capture (72%) beta (28%)	NA	NA
				1.48	100
Europium (154)	Eu-154	8.8×10^{0}	beta	0.87	100
Europium (155)	Eu-155	5.0×10^{0}	beta	0.19	100
Hydrogen (3)	H-3	1.23×10^{1}	beta	0.018	100
Lead-Polonium (210)	Pb-Po-210	2.23×10^{1}	beta	0.063 0.016	20 80
			Alpha	5.305	100
Neptunium (237)	Np-237	2.14×10^{6}	alpha	4.79	47
				4.77	25
Nickel (59) [4022, 4034,4044 only]	Ni-59	7.5×10^{4}	electron capture	NA	NA
Nickel (63) [4022, 4034, 4044 only]	Ni-63	1.00×10^{2}	beta	.066	100
Promethium (147)	Pm-147	2.6×10^{0}	beta	0.225	100
Plutonium (238)	Pu-238	8.64×10^{1}	alpha	5.46	28
				5.5	72
Plutonium (239)	Pu-239	2.44×10^{4}	alpha	5.10	12
				5.14	15
				5.15	73
Plutonium (240)	Pu-240	6.6×10^{3}	alpha	5.12	26
				5.16	74
Plutonium (241)	Pu-241	1.4×10^{1}	beta	0.015	100
Potassium (40)	K-40	1.28×10^{9}	beta	1.312	89
Radium (226) [4011, 4029 only]	Ra-226	1.6×10^{3}	alpha	4.78	100
Strontium-Yttrium (90)	Sr-Y-90	2.8×10^{1}	beta	2.28	99
Thorium (228)	Th-228	1.9×10^{0}	alpha	5.34	27
				5.42	72
Thorium (230)	Th-230	8.0×10^{4}	alpha	4.621	23
				4.688	76
Thorium (232)	Th-232	1.41×10^{10}	alpha	3.95	23
				4.01	77
Uranium (233)	U-233	1.59×10^{5}	alpha	4.78	13
				4.825	84
Uranium (234)	U-234	2.47×10^{5}	alpha	4.72	27
				4.77	72
Uranium (235)/Uranium (236)	U-235/ U-236	7.1×10^{8}	alpha	4.2-4.32	10
				4.366	18
				4.398	56
				4.5-4.6	11

Table 4-1. Radiological Potential Contaminants of Concern for the SSFL[1] (Continued)

Element (Atomic Mass)	Isotope	Half-Life (Years)	Radiation[2]	Particle Energies (MeV)[3]	Abundance (%)[4]
Uranium (238)	U-238	4.49×10^{9}	alpha	4.15	23
				4.2	77

[1] Radiological characteristics were obtained from *The Health Physics and Radiological Health Handbook,* Revised Edition (Bernard Shleien 1992), The Radiological Health Handbook, U.S. Army, 1971 (U.S. Army 1971) , or Radiological and Chemical Fact Sheets to Support Human Health Risk Analyses for Contaminated Areas, Argonne National Laboratory, March 2007.
[2] Primary means of decay. Many COPCs also emit one or more gamma rays in addition to particle emissions.
[3] Maximum energies are listed for beta particles.
[4] Abundance refers to the percentage of disintegrations of the nuclide at the specified energy (Shleien 1992).
MeV – million electron Volts
y – year

4.1 SCREENING LEVEL DERIVED CONCENTRATION GUIDELINE LEVELS

As radiological PCOCs at Area IV of the SSFL consist of a range of radionuclides, surveys must be designed such that they can detect the radionuclide(s) used within that structure consistent with the most limiting screening level Derived Concentration Guideline Levels (DCGLs). The isotope-specific Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs) listed below are obtained from the EPA BPRG website for the exposure of indoor workers to surficial contamination. These BPRGs are based on 25 years of exposure at 2,000 hours per year and a risk of 1×10^{-6}. The D&D worker scenario uses these BPRGs to develop screening level DCGLs for a D&D worker. The D&D worker scenario is based on 500 hours over a 90 day period for a single year (NUREG/CR-5512, Volume 1, Section 6.7.1). The D&D worker scenario is selected as the most appropriate scenario for design of the survey as the buildings represented within this plan are slated to be demolished. The calculated DCGLs at Area IV of the SSFL are listed in Table 4-2.

Table 4-2. Screening Level Derived Concentration Guideline Levels

Element (Atomic Number)	Isotope	3-D Residential Ground Plane (dpm/100cm^2)	BPRGs Indoor Worker Settled Dust (dpm/100cm^2)	BPRGs 3-D Indoor Worker[1] Ground Plane (dpm/100cm^2)	D&D Worker [2] (DCGLs*) (dpm/100cm^2)[3]
Americium (95)	Am-241	1.96×10^{6}	7.35×10^{0}	9.90×10^{6}	7.00×10^{2}
Barium (56)	Ba-133	6.79×10^{6}	1.30×10^{2}	1.33×10^{8}	1.30×10^{4}
Beryllium (4)	Be-10	8.84×10^{3}	2.21×10^{2}	4.46×10^{4}	2.20×10^{4}
Cadmium (48)	Cd-113m	3.06×10^{4}	6.26×10^{0}	5.99×10^{5}	3.00×10^{3}
Curium (96)	Cm-244	1.50×10^{4}	1.49×10^{1}	6.99×10^{4}	1.50×10^{3}
Cobalt (27)	Co-60	1.17×10^{1}	5.08×10^{1}	5.00×10^{1}	5.00×10^{3}
Cesium (55)	Cs-137+D	1.68×10^{1}	2.15×10^{1}	8.04×10^{1}	2.20×10^{3}
Europium (63)	Eu-152	1.16×10^{1}	2.58×10^{3}	5.28×10^{1}	5.30×10^{3}
Europium (63)	Eu-154	1.40×10^{1}	3.10×10^{3}	6.19×10^{1}	6.20×10^{3}
Europium (63)	Eu-155	5.08×10^{2}	1.46×10^{3}	2.17×10^{3}	1.50×10^{5}
Hydrogen (1)	H-3	N/A	N/A	N/A	2.1×10^{7c}
Neptunium (93)	Np-237+D	N/A	1.25×10^{1}	N/A	1.30×10^{3}
Promethium (61)	Pm-147	2.03×10^{6}	6.28×10^{3}	8.52×10^{6}	6.30×10^{5}
Plutonium (94)	Pu-238	9.79×10^{3}	6.19×10^{0}	4.84×100^{4}	6.00×10^{2}
Plutonium (94)	Pu-239	1.77×10^{4}	5.44×10^{0}	8.95×100^{4}	5.00×10^{2}
Plutonium (94)	Pu-240	9.08×10^{3}	5.44×10^{0}	4.57×10^{4}	5.00×10^{2}
Plutonium (94)	Pu-241+D	2.84×10^{6}	1.57×10^{7}	1.30×10^{7}	1.30×10^{9}
Strontium (38)	Sr-90+D	2.69×10^{2}	1.47×10^{1}	1.28×10^{3}	1.50×10^{3}
Thorium (90)	Th-228+D	5.13×10^{1}	3.24×10^{1}	2.15×10^{2}	3.20×10^{3}

Table 4-2. Screening Level Derived Concentration Guideline Levels (Continued)

Element (Atomic Number)	Isotope	3-D Residential Ground Plane (dpm/100cm^2)	BPRGs Indoor Worker Settled Dust (dpm/100cm^2)	BPRGs 3-D Indoor Worker[1] Ground Plane (dpm/100cm^2)	D&D Worker [2] (DCGLs*) (dpm/100cm^2)[3]
Thorium (90)	Th-230	6.17×10^3	8.50×10^0	3.11×10^4	8.00×10^2
Thorium (90)	Th-232	9.24×10^3	7.77×10^0	4.66×10^4	8.00×10^2
Uranium (92)	U-233	7.04×10^3	1.26×10^1	3.55×10^4	1.20×10^3
Uranium (92)	U-234	8.24×10^3	1.29×10^1	4.15×10^4	1.30×10^3
Uranium (92)	U-235+D	N/A	1.31×10^1	N/A	1.30×10^3
Uranium (92)	U-238+D	1.16×10^2	1.16×10^1	5.82×10^2	1.20×10^3

The more limiting scenario of the "Building PRGs Indoor Worker Settle Dust" or "Building PRGs 3-D Indoor Worker Ground Plane" is highlighted in gray

* DCGLs have been rounded to two significant digits.

dpm/100 cm^2 = disintegrations per minute per 100 square centimeters

D = daughter

[1] BPRGs listed are obtained from the EPA BPRG website for exposure of the stated receptor to surficial contamination. BPRGs are provided for comparison only. These BPRGs are based upon 25 years of exposure at 2,000 hours per year and a risk of 1×10^{-6}. The limiting surficial contamination BPRG is highlighted.

[2] The D&D Worker scenario is based upon 500 hours over a 90 day period for a single year (NUREG/CR-5512, Volume 1, Section 6.7.1). D&D Worker BPRGs are calculated by multiplying the limiting EPA Indoor Worker (IW) BPRG by a value of 100 (IW BPRG in dpm/100cm^2 * 25 y/1 y * 2000 hour/500 hour).

[3] This value was calculated using RESRAD-Build and the input parameters found in Appendix A. It can also be compared to the 25 mrem/y DCGL listed in Table B.1 of U.S. Nuclear Regulatory Commission Regulation (NUREG) 1757 of 1.2×10^8 dpm/100 cm^2.

The limiting radionuclides for each building are the PCOCs with the lowest screening level DCGL for each applicable mode of decay. Radiological surveys will include the evaluation of gamma, low-energy beta, and gross alpha and gross beta emissions. Low-energy beta emitters (e.g., H-3, Ni-63, Pu-241) are not generally detectable using field instruments. As such, evaluation of the presence of low energy beta emitters (e.g., H-3) will be accomplished by collecting smears from randomly selected areas using filter paper dampened with demineralized or dead water and analyzing these smears by liquid scintillation counting. To the extent practicable, samples subjected to total activity screen by liquid scintillation counting (LSC) that exhibit elevated radioactivity upon initial counting, will be recounted with isotope-specific energy windows to quantify the isotope-specific activity present. Other analytical procedures such as chemical separation may also be required if recounting does not appropriately allocate activity to the applicable constituents. Samples of radiologically-elevated media will be collected if practicable and submitted for laboratory analysis and used to scale the survey data to the appropriate radionuclide for the subsequent risk assessment.

The precise identification of the PCOCs for most buildings is not known with certainty. In addition, the isotopic ratios of any contamination that may exist in these areas are not known. As such, it is reasonable to use the most limiting DCGLs for each category of radionuclide pending confirmation of the radioisotopic mix. The most limiting of DCGLs for site radiological PCOCs are:

- Low-Energy Beta emitting radionuclides (e.g., H-3, Ni-63 and Pu-241): 2.1×10^7 disintegrations per minute per 100 square centimeters (dpm/100 cm^2)
- Beta-Gamma emitting radionuclides other than the above stated low energy beta emitters: 1,500 dpm/100 cm^2.
- Alpha emitting radionuclides: 500 dpm/100 cm^2 for alpha emitting radionuclides (Pu-239 and Pu-240) (Note: Use of this DCGL indirectly assumes that all alpha activity detected

is Pu-239/Pu-240 pending confirmation of the specific isotopic content. This approach is appropriately protective for other radionuclides.)

4.2 DERIVATION OF INVESTIGATION LEVELS

General. Although gamma emissions provide a valuable searching tool to identify areas with radioactivity that is elevated with respect to background, alpha and beta emissions will provide the primary bases for demonstrating compliance with DCGLs with beta serving as the preferred basis when both alpha and beta radiation is present from a given PCOC.

For purposes of defining the investigation levels representative building materials, not potentially impacted by site operations, are unavailable to establish site specific background reference levels. As such background will not include the contribution associated with building materials.

For Class 1 and Class 2 areas an investigation level equal to the stated DCGLs will be used. For Class 3 areas an investigation level of 50% of the DCGL will be utilized.

Identification of activity levels in excess of 100% of the DCGL for Class 2 areas will generally require reclassification of the affected area to Class 1 with the appropriate changes in sample density. Reclassification of only part of an area will only be performed when additional data or newly discovered process knowledge provide a sound basis for redefining the survey units and sizes (i.e., additional data are obtained to define the size of the elevated area). The data used must be in addition to the data obtained from the number of samples prescribed by the initial survey; otherwise, the entire survey unit will be reclassified.

Strontium – The limiting DCGL and investigation level for Class 1 and Class 2 areas for gross beta is 1,500 dpm/100 cm^2 for Sr-90. However, Sr-90 will provide twice the gross beta activity as it is in equilibrium with its Y-90 daughter. Therefore, the most limiting beta emitting radionuclide to compare with the gross beta result will be Cs-137. Given a Cs-137 DCGL of 2,200 dpm/100 cm^2, the beta investigation level will not exceed the greater of 1,100 dpm/100 cm^2 (i.e., 50% of the DCGL) for Class 3 areas or the actual instrument minimum detectable concentration (MDC) as computed without a site specific instrument background. This approach is consistent with MARSSIM Table 5 which uses the greater of the Derived Concentration Guideline Levels used for statistical tests (Wilcoxon Rank Sum) ($DCGL_W$) or the MDC as the investigation level.

Plutonium – The limiting DCGL and investigation level for Class 1 and Class 2 areas for gross alpha is 500 dpm/100 cm^2 for Pu-239 and Pu-240. As such, the investigation level will not exceed 250 dpm/100 cm^2 for Class 3 areas or the actual instrument MDC as computed without site-specific instrument reference area background.

Tritium (H-3) – Accurate measurement of very low energy beta emitters such as tritium necessitates special consideration of survey methods. As an example, given that tritium emits a low energy beta and no gamma, the presence of tritium on surfaces cannot generally be measured directly thus they are not addressed by scan or routine fixed point surveys and must be assessed using special procedures such as the collection and liquid scintillation counting of smears. The DCGL and investigation level for Class 1 and Class 2 areas for tritium is 2.1×10^7 dpm/100 cm^2. As such, the investigation level for Class 3 areas will be 1.0×10^7 dpm/100 cm^2 or the site specific MDC.

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5.0 DATA QUALITY OBJECTIVES

This Data Quality Objective (DQO) process follows the 7-step EPA process. The DQOs developed here pertain to the building radionuclide data that are required to complete a risk assessment consistent with CERCLA for current conditions. The process used herein focuses on data needs for the CERCLA risk assessments, which depend on adequate knowledge of the nature and extent of contamination.

DOE is collecting additional data pursuant to planning efforts for the completion of building D&D and remediation of Area IV in full compliance with applicable regulations. Data are needed to evaluate risk to D&D workers, the community during transport and the environment in general. Environmental data used in the worker and community risk assessments must be of known quality and adequate for the purpose of risk assessment.

5.1 STEP 1 – STATE THE PROBLEM

This first step in the DQO process is to state the problem clearly and concisely.

Problem Statement: As noted in Section 1 and consistent with EPA HSAs (see Section 3.0), additional radiological building data are required to:

1. Determine the current radiological status of remaining structures;
2. Evaluate risks to workers as a result of building D&D activities;
3. Assess the risk to workers and to members of the public associated with transportation of building debris; and
4. Evaluate risk to the general environment

In addition to meeting the above stated data needs, the information obtained as a result of these surveys will also be integrated with existing data and augmented as required to characterize wastes and develop waste disposal profiles.

5.2 STEP 2 – IDENTIFY THE DECISION

The second step in the DQO process is to identify the principal study question and define alternative actions to make decision statements.

A data gap analysis (CDM 2008) was performed to assess the adequacy of radiological contamination information for existing structures (i.e., those that have not been demolished) for the purposes of risk assessment and off-site release estimates, evaluation of transportation impacts, and final disposition of wastes. The principal study question for the data gap analysis was whether existing chemical and radionuclide data related to Area IV were adequate to support risk assessments and cleanup remedy evaluations. The central decision relates to the evaluation of a risk associated with building D&D and the associated transportation of building debris. .

The decisions needed to determine the adequacy of the data include:

Are existing building survey data adequate to assess risks from building D&D and debris transport in the D&D plan?

- If current building surveys are adequate to analyze impacts for the D&D plan, then no further data collection is required;

- If current building surveys are inadequate, collect additional building survey data for the D&D plan.

For a number of the buildings within Area IV of the SSFL, the answer to this decision statement was that insufficient information was available such that collection of additional data is necessary. The goal of this survey and sampling effort is to fill the data gap. The results of the data gap analysis are used to define the type of additional data needed in the next step.

5.3 STEP 3 – IDENTIFY THE INPUTS TO THE DECISION

The objective of the third step in the DQO process is to identify the information needed to resolve the decision statements identified in Step 2. To perform human health risk assessment and delineate the extent of contamination the following data and information needs have been identified for Area IV buildings:

- Building surface survey data adequate to evaluate the risks of building demolition and debris transport.

  The gap analysis assessed the adequacy of radiological building survey data quantity and quality both for the on-site risk assessment and off-site release estimates for the D&D plan and transportation and final disposition planning. Table 5-1 presents the results of this analysis including the referenced site name, the projected MARSSIM classification, (CDM 2008), a summary of historical data and the specific data gap to be addressed. This comparison indicates that limited data gaps exist. The existing data gaps consist of the lack of building surface contamination data (i.e., fixed point measurements, radiological scan surveys, and removable contamination data) for 10 buildings/areas or limited portions thereof.

  MARSSIM survey protocols are used for classification purposes which, in turn, will dictate the percentage of each structure or consolidated area to be surveyed and the numbers of fixed point and low-energy beta measurements for each survey unit. EPA's draft historical site assessments have been reviewed pursuant to assignment of MARSSIM classifications.

- Isotopic ratios to be applied to contaminant levels for human health risk assessments.

  The gap analysis assessed the adequacy of radiological building isotopic data quantity and quality. Table 5-1 also incorporates the results of this analysis. Isotopic ratios to be applied to contaminant levels as an integral part of the preparation of human health risk assessments are not generally available for remaining buildings.

- Industrial and Residential Preliminary Remediation Goals (PRGs)/screening levels for building surfaces for radionuclide PCOCs

- Default EPA BPRGs are referenced for worker and residential radiological human health screening. Inputs used to develop these PRGs are carried forward in the development of D&D worker DCGLs as appropriate.

  A D&D worker scenario has been derived from the EPA BPRGs based on adjusted exposure parameters and is selected as the most appropriate scenario for design of the survey since the buildings represented within this plan are slated to be demolished and given the limit of sensitivity of available radiation monitoring instrumentation. Subsequent to demolition, wastes would be disposed of off-site at a properly permitted disposal site. Based upon these considerations, the D&D worker scenario will be utilized

in determining the target instrument sensitivity for each survey. The most restrictive gross alpha and gross beta BPRGs for site PCOCs for D&D worker will be used as the target sensitivity for alpha and beta surface surveys, respectively.

- Conceptual site model defining exposure pathways from building contamination for potential receptors that will be evaluated during the risk assessments.

  The conceptual site model provided in *The Data Gap Analysis Report* (CDM 2008) will be utilized for this work.

Table 5-1. Area IV Buildings Requiring Additional Information

Building[1,2]	MARSSIM Class	Summary of Historical Radiological Survey Information	Data Gap
RMHF General	Class 1	Survey data characterizing the existing concrete foundations data are necessary to evaluate potential future use but are not currently available. In addition, floors in some RMHF buildings (e.g., 4022) require additional survey data.	Characterize RMHF building concrete foundations; building floors; exterior surfaces; and roofs for which comprehensive data is not available.
4006 (Includes 4616)	Class 2	Detailed final status survey data exists for Building 4006. Radionuclide ratio sampling of elevated activity is required for risk assessment if such activity is detected.	Radionuclide ratio samples will be obtained if elevated activity is detected.
4009 Critical Experiments Building	Class 1	Rockwell International performed a 1988 survey collecting total and removable beta and alpha measurements plus external gamma radiation levels, and performed gamma spec on some radionuclide ratio samples. These data are supplemented by follow up surveys in 1990 and 1995, again including beta, alpha, and gamma spectroscopy analysis. Speciation for non-gamma-emitting radionuclides (e.g., H-3, Sr-90, Pu-241) was not performed.	Quantification of non-gamma emitting radionuclides is a data gap. Existing data are adequate for risk analysis of identified contaminants but may necessitate transfer of hard-copy results to a useable format.
4011 Radiation Instrument Calibration Laboratory	Class 1	Rockwell International performed a 1998 survey collecting total and removable beta and alpha measurements plus external gamma radiation levels, and performed gamma spectroscopy on some radionuclide ratio samples. Speciation for non-gamma-emitting radionuclides was not performed. Although additional information was derived from EPA Final Oversight Verification and Confirmation Radiological Survey Report dated December 20, 2002, this survey was limited to specific portions of the building.	Quantification of non-gamma emitting radionuclides is a data gap. Existing data are adequate for risk analysis of identified contaminants but may necessitate transfer of hard-copy results to a useable format.

Table 5-1. Area IV Buildings Requiring Additional Information (Continued)

Building[1,2]	MARSSIM Class	Summary of Historical Radiological Survey Information	Data Gap
4015	Class 1[3]	This facility was thought to have already been removed in the Data Gap Analysis. Given the nature of the activities performed in the building, very limited data currently exists.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4019 SNAP System Nuclear Qualification Test Facility	Class 1	The 1999 report by Boeing summarizes finding of prior investigations and documents results of total and removable beta and alpha measurements plus external gamma radiation levels. Neither speciation of non-gamma emitting radionuclides nor isotopic gamma spectroscopy analyses were performed. The lack of such information constitutes a data gap. Additional information was derived from EPA Final Oversight Verification and Confirmation Radiological Survey Report dated December 20, 2002.	A data gap exists with regard to the outside of the building and roof as well as with respect to the need for radionuclide ratio sampling if scan surveys reveal the presence of elevated radioactivity. In addition to the need for gamma spectroscopy to identify the radionuclide content and speciation of non-gamma-emitting radionuclides, transfer of hard-copy results to useable format may be necessary.
4021 (RMHF); Laundry and Hot and Cold Change Room	Class 1	Data is currently not available to support risk analysis. (This structure is to be surveyed and decontaminated at the time of RMHF closure.) Additional information was derived from Boeing "Current Radiological Status, Radioactive Materials Handling Facility, dated March 16, 2007.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4029	Class 1	This facility was thought to have already been removed in the Data Gap Analysis. A report on the comprehensive radiological survey of Building T029, performed in 1988, concluded that no residual radioactive contamination existed on the T029 floor or surrounding area, but recommended decontamination of a contaminated, below-floor-level, Ra-226 source well. Accordingly, the source well and other equipment were removed from the facility and follow-up surveys were performed. However, only dose rates from 1988 and soil sampling data from 1999 are available.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4034	Class 3	This facility was initially categorized as "non-impacted" given the nature of the activities performed in the building thus very limited data currently exists. Additional surveys prior to release are consistent with Boeing "Current Radiological Status, Radioactive Materials Handling Facility, dated March 16, 2007.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.

Table 5-1. Area IV Buildings Requiring Additional Information (Continued)

Building[1,2]	MARSSIM Class	Summary of Historical Radiological Survey Information	Data Gap
4038	Class 1[3]	This facility was initially categorized as "non-impacted" given the nature of the activities performed in the building thus very limited data currently exists.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces, Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4044 (RMHF) Clean shop and support lab	Class 3	Served various roles including that of a clean shop, a health physics office, and a break room. The health physics office has been used as a counting area for removable contamination measurements and storage and use of calibration sources. Although no other regulated radiological materials were managed specifically in this building it is considered radiologically impacted (contamination potential considered low). Swipe data available from routine health physics operations. Additional surveys prior to release are consistent with Boeing "Current Radiological Status, Radioactive Materials Handling Facility, dated March 16, 2007.	Perform scoping and characterization surveys to include scan and fixed point surveys. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4055 Nuclear Material Development Facility	Class 1	Fixed and removable verification data for comparison to NRC license requirements has been collected. Radionuclide ratio data were collected from paint and soils adjacent to the building but were evaluated for limited analytes. Additional information was derived from EPA Final Oversight Verification and Confirmation Radiological Survey Report dated December 20, 2002.	Quantitative isotopic data is necessary given limited analytical information available and the associated uncertainty for risk analysis. Surveys are also needed to evaluate exterior building surfaces and roofs. Radionuclide ratio samples will be obtained if elevated activity is detected.
4057	Class 1[3]	This facility was initially categorized as "non-impacted" given the nature of the activities performed in the building thus very limited data currently exists.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces, Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4093 (floor slab and walls of L-93)	Class 1	Only the concrete slab remains for this building and it was not addressed in the Data Gap Analysis. No survey data is available since before this building was demolished in 1995.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.

Table 5-1. Area IV Buildings Requiring Additional Information (Continued)

Building[1,2]	MARSSIM Class	Summary of Historical Radiological Survey Information	Data Gap
4100 Fast Critical Experiment Laboratory	Class 1	Systematic fixed and removable activity for beta and alpha radiation and gamma radiation measurements identified no contamination, as summarized in the 1980 Rockwell International report. Subsequent quarterly surveys supplement this dataset. Building reuse necessitated resurvey. Additional information was derived from EPA Final Oversight Verification and Confirmation Radiological Survey Report dated December 20, 2002.	Perform scoping and characterization surveys to include scan and fixed point surveys of exterior surfaces and roofs, Radionuclide ratio samples will be obtained if elevated activity is detected.
4133	Class 3	This facility was initially categorized as "non-impacted" given the nature of the activities performed in the building thus very limited data currently exists.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4462 Sodium Pump Test Facility (SPTF)	Class 1[3]	This facility was initially categorized as "non-impacted" given the nature of the activities performed in the building thus very limited data currently exists.	Perform scoping and characterization surveys to include scan and fixed point surveys of interior and exterior surfaces. Also collect dose rate data and survey ductwork. Radionuclide ratio samples will be obtained if elevated activity is detected.
4688 (RMHF); Open-walled Cleaning Station and Radioactive Materials Storage	Class 1	A limited number of fixed point measurements identified significant beta activity. Removable contamination data was not collected except on metal sample obtained from the roof (results in Cabrera 2007). The limited dataset represents a data gap for risk analysis. Limited surveys were performed in 2007 due to the presence of elevated background and significant levels of beta-emitting residual radioactivity.	Perform scoping and characterization surveys to include scan and fixed point surveys. Radionuclide ratio samples required to characterize isotopic content of beta activity.

[1] MARSSIM classifications listed within this table and survey plan are based on classifications provided in *The Data Gap Analysis Report* (CDM 2008). A comprehensive list of all remaining buildings in Area IV of the SSFL can be found in *The Data Gap Analysis Report* (CDM 2008).

[2] Although additional buildings (e.g., Buildings 4022, 4024, 4075, 4563, 4621, 4658, and 4665) exist within Area IV, available information for these structures is suitable for the purposes of risk assessment. As such, and given that these buildings were subjected to relatively recent and comprehensive surveys, they are not being subjected to additional investigation as part of this survey effort.

[3] Interiors of buildings 4015, 4038, 4057, and 4462 will be surveyed as MARSSIM Class 3 with the exterior portions of these buildings being surveyed as MARSSIM Class 1.

The RMHF was designed and constructed in 1959 for the storage and handling of new and irradiated nuclear fuel and other radioactive materials. There are ten numbered structures at the RMHF that currently remain. These consist of Buildings 4021, 4022, 4621 (and the adjacent storage yard), 4075, 4044, 4563, 4665, 4688, 4034, and 4658.

Building 4021 is included as part of the RMHF and was originally constructed in 1959. Building 4021 is a 3,000 square-foot single-story metal building consisting of a decontamination room, packaging room, hot and cold change rooms and an office area. Building 4021 was used during

decommissioning programs to process waste materials from the Sodium Reactor Experiment (SRE), Southwest Experimental Fast Oxide Reactor (SEFOR), Experimental Breeder Reactor (EBR), Fermi Reactor, Systems for Nuclear Auxiliary Power (SNAP) and other on-site programs (Sapere 2005). Radioactive materials located within this building are primarily from fission products and fuels.

Building 4044 is included as part of the RMHF and was originally constructed in the mid 1960s. Building 4044 is approximately 1,000 square feet (ft^2) in size and has been utilized as a clean shop and health physics office. The health physics portion of this building has been used as a counting station for removable contamination smears and the storage/use of calibration sources.

Building 4688 is included as part of the RMHF and was built in 1962. Building 4688 is a 630 square-foot building with no walls. It was utilized as a shed-like storage facility and sodium cleaning facility, radiological materials may have been stored in this area.

Building 4055 was constructed in 1967. Building 4055 was utilized as a Fast Flux Test Facility, for fission research and to fabricate mixed uranium-plutonium oxide pellets for irradiation tests (Sapere 2005).

Building 4100 was originally constructed in 1960. The Advanced Epithermal Thorium Reactor (AETR) was housed in Building 4100. It was used to study twenty different nuclear reactor core configurations.

Building 4006 is approximately 13,000 ft^2 in size. A portion of this building was operated as a non-nuclear sodium laboratory with other areas for office space and laboratory space (Sapere 2005).

Building 4009 was originally constructed in 1958. From 1958 to 1967 the building housed the Organic Moderated Reactor (OMR) Critical Facility and the Sodium Graphite Reactor (SGR) Critical Facility. In the 1980s, Building 4009 was utilized as a Radioactive Material Storage Site.

Building 4011 was constructed in 1958. Building 4011 is approximately 15,000 ft^2 in size. Prior to 1984 this building was utilized for non-nuclear programs. From 1984 to 1996, the north section of this building was used for calibration and repair of radiation instrumentation (Sapere 2005).

Building 4019 was constructed in 1962. Building 4019 was built to perform criticality acceptance tests of SNAP reactors before they were delivered for launch. Three reactors were assembled and tested in this building from 1964 to 1965 (Sapere 2005).

Building 4015 was Construction Staging Storage and includes Building 4707, Substation. It was constructed in 1974 in the same place as Parking Lot 4573, was used to store construction materials and was demolished in 2004.

Building 4059, Radioactive Measurement Facility, storage radioactive materials (Ra-226, Co-60, Po-Be, Pu-Be, and Cs-137) for instrument calibration; later was used as non-radioactive hazardous materials storage building for alkali metals (Na, NaK, Li, LiH_2) and alkali metal contaminated components. All below-grade enclosures were removed and disposed of as low level waste; excavations were backfilled to allow for continued use of the facility.

Building 4038 was the Systems for Nuclear Auxiliary Power (SNAP) Office Building No. 2. It includes the ETEC Headquarters/Doe Site Office, Liquid Metal Engineering Center (LMEC) Administration and Information, ETEC Administration, and is serviced by Substation 4757.

Building 4057 has housed Launch Handling and Mobile Equipment Development, LMEC Laboratory, Static Sodium Test Facility, ETEC General Test, and is serviced by Substation 4757. Building 4057 housed two sodium test rigs. Building 2057 was decommissioned for use in 1998 at which point it became a records room. In 2003, air sample media (filter papers) was discovered in a folder of records. Although some of these filters had low levels of residual contamination, surveys of the drawer contents confirmed that none of the contamination had escaped from the envelope containing the filters.

Building 4093, L-85 Reactor, Neutron Radiography Building, AE-6 Reactor, includes Site 4893, Pad (AE-6). Building 4093 was constructed to house the AE-6 Reactor. The AE- 6 Reactor was originally called the Water Boiler Neutron Source reactor. In 1972, the reactor was renamed L-85. Demolition began in 1982 with remove of uranyl sulfate. The rest of the building, excluding the foundation, was demolished in 1995. The sanitary leach field for Building 4903 was removed in 1999. There have been three incidents associated with Building 4093 that may have resulted in a release to the environment. On March 25, 1959, fission gas was released into the air, contaminating part of the high bay and employees. On July 30, 1982, rinse water contaminated with 5 milliliters of U-235 was spilled during the fuel draining operation, contaminating an employee and an area of the high bay floor. The area was partially decontaminated at the time and fully decontaminated during facility decommissioning. ON May 24, 1995, a radioactively contaminated high efficiency particulate air filter was found in a pile of debris.

Building 4133, Hazardous Waste Treatment /Management Facility, was physically transferred to its present location in 1977. It was previously labeled as Building 4724, Contaminated Sodium Facility. Prior to its move, it was surveyed for radiological contamination and released for unrestricted use.

Building 4462, SPTF Building, includes Building 4760, Substation. Constructed in 1974, Building 4462 was used to test sodium pumps. There are no Radiological Use Authorizations associated with Building 4462.

5.4 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

The fourth step in the DQO process is to specify the study boundaries. The objective of this fourth step is to define the spatial and temporal boundaries that limit the scope of the analysis.

5.4.1 Spatial Boundary

For the purpose of this survey plan, the spatial boundary includes all building surfaces of existing buildings of Area IV, focusing on the buildings of Area IV that require the collection of additional data to support the risk-based calculations. The specific buildings are listed above in Table 4-3. The spatial boundary also includes all consolidated materials (e.g., asphalt and concrete road surfaces, parking lots etc.)

5.4.2 Temporal Boundary

Current conditions of the buildings located within Area IV of the SSFL were used as characterization data for the purposes of the data gap analysis. Data that were available by January 28, 2008 were used in this assessment. Other, more recent, data were also reviewed during the document development process.

5.5 STEP 5 – DEVELOP THE ANALYTICAL APPROACH

The fifth step in the DQO process is to define the decision rules and develop an analytic approach that will guide analysis of the study results and drawing conclusions from the data.

5.5.1 General

The data being generated as a result of this plan will follow appropriate MARSSIM guidance such that a risk assessment for the evaluation of D&D worker and transport can be performed. "MARSSIM provides a nationally consistent approach to conducting radiation surveys and investigations at potentially contaminated sites." (DOD 2000). "MARSSIM may serve to guide or monitor remediation efforts whether or not a release criterion is applied.... MARSSIM describes generally acceptable approaches for: planning and designing scoping, characterization, remediation-support, and final status surveys, but with a specific focus on the final status surveys." (DOD 2000).

Impacted areas are classified as Class 1, 2 or 3 based on the following MARSSIM (DOD 2000) criteria:

- Class 1 Areas are those "Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation surveys) above the $DCGL_W$."
- Class 2 Areas are "Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$."
- Class 3 Areas are "Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on site operating history and previous radiation surveys."

Once classified, impacted areas are subdivided into survey units based on the corresponding area classification. Table 5-2 reflects the "suggested survey unit areas" as stated in MARSSIM (DOD 2000).

Table 5-2. MARSSIM "Suggested Survey Unit Areas"

Classification	Suggested Area
Class 1	Structure: up to 100 square meters (m^2) Land Area: up to 2,000 m^2
Class 2	Structure: 100 to 1,000 m^2 Land Area: 2,000 to 10,000 m^2
Class 3	Structure: No Limit Land Area: No Limit

The MARSSIM classification of each building requiring the collection of additional data, as listed in Table 4-3, are as follows with some various portions of buildings being different MARSSIM classes. The limiting MARSSIM classifications are as follows:

Class 1 – RMHF concrete foundations, Buildings 4009, 4011, 4015, 4019, 4021, 4029, 4038, 4055, 4057, 4093, 4100, 4462, and 4688.

Class 2 – Building 4006, (includes 4016).

Class 3 – Buildings 4034, 4044, and 4133.

Survey requirements for impacted areas are derived based on the area classification of each area. Table 5-3 lists the MARSSIM "Recommended Survey Coverage for Structures."

Table 5-3. MARSSIM "Recommended Survey Coverage for Structures"

Area Classification	Surface Scans	Surface Activity Measurements
1	100%	Number of data points from statistical tests; additional fixed point measurements and samples may be necessary for small areas of elevated activity
2	10 to 100% (10 to 50% for upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests
3	Judgmental	Number of data points from statistical tests

MARSSIM also notes that "Any measurement that is equal to or greater than the investigation level indicates an area of relatively higher concentration and is investigated, regardless of the outcome of the nonparametric statistical tests." MARSSIM investigation levels are stated in Table 5-4.

Table 5-4. MARSSIM "Summary of Investigation Levels"

Survey Unit Classification	Flag Fixed Point Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> $DCGL_{EMC}$[a] or > $DCGL_W$[b] and > a statistical-based parameter value	> $DCGL_{EMC}$
Class 2	> $DCGL_W$	> $DCGL_W$ or > MDC
Class 3	> fraction of $DCGL_W$	> $DCGL_W$ or > MDC

[a] $DCGL_{EMC}$ - The DCGL used for elevated measurement comparison.
[b] $DCGL_W$ – The DCGL used for statistical tests.

5.5.2 Survey Protocol for Class 3 Facility Areas

The survey protocol for MARSSIM Class 3 Areas is intended to collect data for offices and other areas that have been maintained as clean or free of radiological contamination. These areas are not expected to contain residual levels of radioactivity. The survey provides assurance that these areas do not have residual activity. The survey measurements for surface activity will consist of a combination of qualitative surface scans with gamma detectors; quantitative surface scans and fixed point measurements of gross alpha and gross beta; measurements of removable activity from areas exhibiting elevated radioactivity; isotopic fractionation of elevated radioactivity to determine the applicable constituents; and dose measurements if previous data are insufficient. Table 5-5 summarizes the survey requirements for Class 3 areas.

Table 5-5. Class 3 Survey Requirements Summary

Up to 10% of the floor, walls, and work surfaces will be subjected to scan surveys.
A fixed point measurement will be made at the highest scan location or in the center of each room if no elevated areas are found during the scan.
A number of additional fixed point measurements will be made at random locations. The number is statistically derived in accordance with MARSSIM Section. 5.5.2.
Removable contamination (smear) surveys for low-energy beta emitting radionuclides.

5.5.3 Survey Protocol for Class 2 Facility Areas

The purpose of this type of survey is to collect data for facilities and areas that have known or suspected residual levels of radioactivity that do not exceed the DCGL. The survey measurements for surface activity will consist of a combination of surface scans, fixed point

measurements, measurements of removable activity, and dose measurements, if previous data are insufficient. Table 5-6 summarizes the survey requirements for Class 2 areas.

Table 5-6. Class 2 Survey Requirements Summary

One hundred percent (100%) of the floor area in each survey unit will be scanned.
Ten percent (10%) to 100%* scanning will be performed on interior and exterior wall surfaces, ceilings, roofs, and other overhead surfaces.
Smears and fixed point readings (timed count) will be obtained from locations of the highest contamination. The background associated with various construction materials is assumed unavailable and is not being subtracted from readings and areas are being initially evaluated based on the most restrictive DCGL for building PCOCs. As such, all areas with results greater than 50% of the DCGL as indicated by the scanning surveys will be investigated for each horizontal and vertical surface.
An additional number of fixed point measurements will be made at systematic points defined by a grid starting at a random location as well as in appropriate judgmental locations. The number of samples is determined based on historical data and the statistical tables found in MARSSIM Sect. 5.5.2.
Removable contamination (smear) surveys for low-energy beta emitting radionuclides.

* The actual percentage will be based on operating history, visual observation, and the previous survey results as a function of the derived concentration guideline level.

5.5.4 Survey Protocol for Class 1 Facility Areas

The purpose of this type of survey is to collect data for facilities that have historical or expected residual levels of radioactivity above the DCGL. The survey measurements for surface activity will consist of a combination of surface scans, fixed point measurements, measurements of removable activity, and dose measurements if previous data are insufficient. Table 5-7 summarizes the survey requirements for Class 1 areas.

Table 5-7. Class 1 Survey Requirements Summary

One hundred percent (100%) of the floor area in each survey unit and walls to six feet above the floor will be scanned.
Walls, ceilings, horizontal surfaces (e.g., I-beams and window sills) and roofs will be classified independent of floor classifications based on historical or scoping survey results.
Smears and fixed point measurements (timed count) will be obtained from areas with levels of contamination greater than the DCGL that are detected by the scanning surveys. Additional fixed point measurements and samples may also be necessary for small areas of elevated activity.
An additional number of fixed point measurements are made at systematic points defined by a grid starting at a random location. The number of samples is determined based on historical data and the statistical tables found in MARSSIM Sect. 5.5.2.
Removable contamination (smear) surveys for low-energy beta emitting radionuclides.

5.5.5 Sampling Grids for Fixed Point Measurements

The probability sampling (less than 100%) performed by fixed point field measurements will be systematic sampling on a triangular grid with a random start for Class 1 and Class 2 areas and simple random sampling for Class 3 areas. It is anticipated that only these measurements will be used in conducting statistical analysis. However, results from scanning, fixed point field measurements, and laboratory analysis of samples will assist in determining the nature and extent of contamination within each building.

5.5.6 Sampling for Determination of Radionuclide Ratios

If it is determined that sampling and analyses are necessary to reliably determine the radionuclide ratios, biased sampling will be conducted. The sampling will be biased toward areas of higher contamination to enable the activity of the radionuclides present within a given area to

be fractionated to the applicable constituents. Accurate ratios necessarily mandate collection of sufficient activity to accurately determine the radionuclide ratios.

Scanning surveys with alpha, beta and gamma survey instruments will be utilized to identify areas with the highest contamination. Identification of areas of total contamination greater than 1000 dpm/100 cm^2 is desired so as to increase the quantity of activity such that error associated with the fractionation of isotopic activity is minimized.

Once the areas of elevated activity are identified, the Project Health Physicist will determine the best approach for determining the isotopic activity of each radionuclide present. Options include: collection of one or more samples of dust, floor sweepings, scrapings, or other media; collection of radiologically-elevated building materials and/or collecting and compositing smear samples of removable activity from elevated areas. If smears are used they will be collected from elevated areas and counted in the field with both the alpha and beta/gamma survey instruments to identify and quantify areas of significant removable contamination. Smears used for activity fractionation will be composited for the given building or portion thereof being evaluated.

The sampled area will be recorded on a map. Samples may be collected by scooping or scraping collected dirt and dust into a sample container. The sampled media may include dust, floor sweepings, grease, rubble, or any other removable material. Enough sample should be collected (based on survey results) so that the laboratory will be able to analyze a sample aliquot that would contain at least 100 dpm and preferably 1000 dpm total activity to minimize statistical error.

A large area wipe may be used to collect samples from floors or other surfaces. These samples can be collected using large area smears (e.g., Masslin cloth) to obtain a sample of removable activity from the surface of interest. The smear will be evaluated with alpha, beta and gamma survey instruments to identify areas of significant removable contamination. It is preferred that samples including Masslin cloth samples to be submitted for laboratory analysis have at least 1000 dpm/100cm^2 of activity.

The samples will be analyzed for the suite of radionuclides that have been evaluated to have the potential to contribute greater than 99% of the remaining activity, dose, and/or risk as identified in *Radionuclides Related to Historical Operations at the Santa Susana Field Laboratory Area IV,* (SAIC 2009). These radionuclides are listed in Table 4-1.

5.6 STEP 6 – DETERMINE SPECIFIC ACCEPTANCE CRITERIA

The sixth step in the DQO process is to specify error tolerances. The objective of this step is to evaluate the error tolerances that will be built into the design of characterization programs so that decision uncertainty is within tolerable limits. For purposes of the use of data for risk assessments, hypothesis statistical tests will not be performed. However, measurement quality objectives are driven by the use of the BPRGs as the DCGLs. Specific requirements with regard to analytical methods and detection requirements are contained in Table 5-8, *Parameters, Analytical Methods, and Required Detection Limits* and in the referenced MQOs contained in the QAPP attached as Appendix D.

5.6.1 Measurement Quality Objectives

The overall quality assurance (QA) objective for the surveying and sampling activities at Area IV of the SSFL is to develop and implement procedures for laboratory analyses that will provide data of known quality consistent with its intended use. The sample set, laboratory analysis results, and

interpretations must be based on data that meet or exceed QA objectives established for the project. QA objectives for the field measurement systems are also an important aspect of the building investigations.

Evaluation of Precision, Accuracy, Representativeness, Comparability and Completeness (PARCC parameters) and sensitivity (blanks) is necessary to assure quality of the data. For the constituent of interest (COI) screening and data gap analysis, an abbreviated screening assessment of only data representativeness and sensitivity was applied.

Data representativeness is the extent to which available data characterize potential exposure conditions for applicable receptors. Proper selection of sampling locations, consideration of potential hot spots, assessment of background concentrations, and collection of a sufficient number of samples help maximize data representativeness.

Types of data needed:

- Surface contamination total and removable (smear) measurement results and critical levels and dose rate measurements.
- Radionuclide analytical results and uncertainties for samples.
- Detection limits.

Standard Quality Assurance Project Plan (QAPP) PARCC parameters requirements will be applied as Measurement Quality Objectives (MQOs) for any new data that is collected. The *Santa Susana Field Laboratory Radiological Investigation Quality Assurance Project Plan* can be found in Appendix D.

Required analytical methods and detection limits for samples are listed below in Table 5-8. Results shall be reported as pCi/sample and shall be reported with the measurement uncertainty.

Table 5-8. Parameters, Analytical Methods, and Required Detection Limits

	Isotope	Method	Required Detection Limit (pCi/sample)
Americium (241)	Am-241	Chemical Separation and Alpha Spectroscopy	50
Barium (133)	Ba-133	Gamma Spectroscopy	50
Beryllium (10)	Be-10	Chemical Separation and Liquid Scintillation Counting	50
Cadmium (113)	Cd-113m	Chemical Separation and Liquid Scintillation Counting	50
Curium (244)	Cm-244	Chemical Separation and Alpha Spectroscopy	50
Cobalt (60)	Co-60	Gamma Spectroscopy	50
Cesium (137)	Cs-137	Gamma Spectroscopy	50
Europium (152)	Eu-152	Gamma Spectroscopy	50
Europium (154)	Eu-154	Gamma Spectroscopy	50
Europium (155)	Eu-155	Gamma Spectroscopy	50
Hydrogen (3)	H-3	Liquid Scintillation Counting	10,000
Neptunium (237)	Np-237	Chemical Separation and Alpha Spectroscopy	50
Promethium (147)	Pm-147	Chemical Separation and Liquid Scintillation Counting	50
Plutonium (238)	Pu-238	Chemical Separation and Alpha Spectroscopy	50
Plutonium (239/240)	Pu-239/240	Chemical Separation and Alpha Spectroscopy	50

Table 5-8. Parameters, Analytical Methods, and Required Detection Limits (Continued)

	Isotope	Method	Required Detection Limit (pCi/sample)
Plutonium (241)	Pu-241	Chemical Separation and Liquid Scintillation Counting	50
Strontium (90)	Sr-90	Chemical Separation and Gas Flow Proportional Counting	50
Thorium (228)	Th-228	Chemical Separation and Alpha Spectroscopy	50
Thorium (230)	Th-230	Chemical Separation and Alpha Spectroscopy	50
Thorium (232)	Th-232	Chemical Separation and Alpha Spectroscopy	50
Uranium (233/234)	U-233/234	Chemical Separation and Alpha Spectroscopy	50
Uranium (235)	U-235	Chemical Separation and Alpha Spectroscopy	50
Uranium (238)	U-238	Chemical Separation and Alpha Spectroscopy	50

New data will be verified at 100% and validated at a Level IV for a minimum of 10% of samples collected. Problems identified in the 10% Level IV validation may require further review and validation of the remaining 90% to evaluate the extent of the problems.

5.7 STEP 7 – OPTIMIZING THE DESIGN

The presence of activity exceeding 50% of the DCGL for Class 3 areas or 100% of the DCGL for Class 2 areas will require reclassification of all or part of the area as Class 2 or Class 1, as appropriate, and the implementation of more comprehensive surveys. Reclassification of a limited portion of an area will be accomplished only when additional data or newly discovered process knowledge provide a sound basis for redefining the survey units and sizes (i.e., additional data are obtained to define the size of the elevated area).

5.8 OVERVIEW OF SURVEY APPROACH

The radiological evaluations of the impacted buildings at Area IV of the SSFL will consist of:

- Performing walkthrough surveys with gamma detectors to qualitatively identify and investigate areas with gamma emissions that are elevated with respect to background. Since there are naturally occurring radionuclides found in many building materials (e.g., concrete, brick, block, etc.), elevation with respect to background will be evaluated by comparison to ambient background and to average readings of uncontaminated areas. Reference to backgrounds listed for these materials in the NRC NUREG 1507 may also be made.
- Gamma survey data will also be used to quantify the activity of radionuclides such as Ba-133 that decay by methods such as electron capture which do not involve the emission of alpha or beta particles. Instrumentation for such surveys will specifically include standard thallium-activated sodium iodide [NaI(Tl)] detectors as well as field instruments for the detection of low-energy radiation (FIDLER) detectors. In addition, gamma surveys may require the collection and laboratory analysis of areas of elevated activity to identify the specific constituents present.
- Performing scan surveys biased toward the areas with the greatest likelihood of having residual radioactivity. For MARSSIM Class 1 and 2 areas, 100% of accessible surfaces will be subjected to scan surveys with up to 10% of Class 3 areas being surveyed. (Such areas would include but are not limited to cracks and crevices in concrete floor, window

ledges, tops of I-beams and related structural members and drains and traps of potentially impacted sewer lines.);

- Fixed point measurements will be collected from systematic locations for Class 1 and 2 areas and from random locations for Class 3 areas. Random fixed point measurements will concentrate on areas most likely to exhibit elevated radioactivity. Fixed point measurements will also be collected from biased locations. Biased locations, as used herein, are areas of elevated activity identified by scan surveys;
- Smears for low-energy beta-emitting radionuclides (e.g., tritium).
- Measurement of external gamma dose rates.
- The collection and laboratory analysis of samples of contamination to identify and quantify the nature of constituent(s) contributing to elevated radioactivity. Laboratory samples may consist of large area smears, multiple small smears or collection of volumetric media.
- Initial scan surveys will be performed with a portable detector such as gas flow proportional or scintillation detector system. Results of initial scoping surveys will be used in conjunction with existing data to determine the detailed survey requirements for a given area. Investigation levels as defined in MARSSIM are "media-specific, radionuclide-specific concentration or activity level of radioactivity that: 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded" (DOD 2000). MARSSIM notes that "In Class 2 or Class 3 areas, neither measurements above the $DCGL_W$ nor areas of elevated activity are expected. Any measurement at a discrete location exceeding the $DCGL_W$ in these areas should be flagged for further investigation. Because the survey design for Class 2 and Class 3 survey units is not driven by the elevated measurements comparison, the scanning MDC might exceed the $DCGL_W$. In this case, any indication of residual radioactivity during the scan would warrant further investigation" (DOD 2000).
- In Class 1 and Class 2 areas the investigation level will be the greater of the minimum detectable activity or the most restrictive DCGL for site radiological PCOCs for a given analytical method (e.g., gross alpha and beta). Given that investigation levels are radionuclide-specific, if residual radioactivity exceeding the most restrictive DCGLs is encountered, the isotopic activity will be determined and investigation levels may be adjusted upward such that they will not exceed 50% of the DCGL for the isotopes (or mixture) determined to be present.

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6.0 SURVEYS TO BE PERFORMED

Additional radiological building data are required for conducting worker D&D and debris transportation risk assessments for use in developing the D&D plan. The required data will be collected in full compliance with the Site Safety and Health Plan for Area IV of the SSFL which incorporates DOE Order 458.1, *Radiation Protection of the Public and Environment*, (DOE 2011). The SSHP is in Appendix C.

The following is an overview of minimum measurements to be performed for the specified impacted buildings. Measurements as used herein are inclusive of collection of samples of and laboratory analysis pursuant ot radionuclide ratio sampling, dose rate measurements, fixed point and scan surveys as well as smears to assess the magnitude of removable contamination. Further, smears include measurements for low-energy beta emissions (e.g. tritium) which require analysis using instrumentation such as liquid scintillation counters as well as more common smears counted with other radiation counting equipment. Fixed point and smear measurements will be augmented by scan surveys of up to 100% of the surface area as specified for each building.

All sample locations will be numbered and clearly marked on a scaled map of the structure for the project file and future reference or comparable information recorded to assure that sample locations are appropriately captured.

The scope of this survey effort consists of 18 impacted buildings/areas within Area IV of the SSFL (see Table 5-1). Specific surveys to be performed in each of these buildings are stated in sections 6.2 through 6.19 and are listed in Table 6-1.

Table 6-1. Surveys to be Performed at SSFL

Building	Fixed Point Measurements	Scan Surveys	Dose Rate Measurements	Removable Contamination (Smears)	Removable Low-Energy Beta Emitters including Tritium	Radionuclide Ratio Sampling
RMHF Concrete Foundations	Yes	Yes	Yes	Yes	Yes	Yes
Building 4006 (Includes 4016)	No	Yes	No	Smears will be collected if necessary for radionuclide ratio determination	No	To be performed if elevated activity is located
Building 4009 (Critical Experiments Building)	Yes	Yes	Yes	Smears will be collected if necessary for radionuclide ratio determination	Yes	To be performed if elevated activity is located
Building 4011 Radiation Instrument Calibration Laboratory	Yes	Yes	Yes	Smears will be collected if necessary for radionuclide ratio determination	Yes	To be performed if elevated activity is located

Table 6-1. Surveys to be Performed at SSFL (Continued)

Building	Fixed Point Measurements	Scan Surveys	Dose Rate Measurements	Removable Contamination (Smears)	Removable Low-Energy Beta Emitters including Tritium	Radionuclide Ratio Sampling
Building 4015	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4019 (SNAP System Nuclear Qualification Test Facility)	Yes	Yes	Yes	Smears will be collected if necessary for radionuclide ratio determination	Yes	To be performed if elevated activity is located
Building 4021 (RMHF Laundry and Hot and Cold Change Rooms)	Yes	Yes	Yes	Yes	Yes	To be performed if elevated activity is located
Building 4029	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4034	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4038	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4044 (RMHF) Clean shop and support Lab	Yes	Yes	Yes	Yes	Yes	To be performed if elevated activity is located
Building 4055	Yes	Yes	Yes	Smears will be collected if necessary for radionuclide ratio determination	No	To be performed if elevated activity is located

Table 6-1. Surveys to be Performed at SSFL (Continued)

Building	Fixed Point Measurements	Scan Surveys	Dose Rate Measurements	Removable Contamination (Smears)	Removable Low-Energy Beta Emitters including Tritium	Radionuclide Ratio Sampling
Building 4057	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4093 (Floor slab and walls of L-83)	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4100	Yes	Yes	Yes	Yes	Yes	To be performed if elevated activity is located
Building 4133	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4462 (SPTF)	Yes	Yes	Yes	Yes	No	To be performed if elevated activity is located
Building 4688 (RMHF) Open-walled cleaning Station and Radioactive Materials Storage	Yes	Yes Yes	Yes Yes	Yes	Yes	Yes

Note: Determination of the relative isotopic distribution (i.e., fractionation of gross alpha and beta results to specific radionuclides) may be accomplished using one or more surface contamination smears, samples of residuals such as dusts or floor sweepings, portable single or multi-channel analyzers (e.g., the Exploranium), or samples of building materials such as concrete corings, as appropriate. (See Section *5.1.6 Sampling for Determination of Radionuclide Ratios).* Confirmatory dose rate data will be obtained for each building.

6.1 SURVEY PARAMETERS

The building areas to be surveyed will vary with the specific impacted area based on potential contamination but will generally include dose rate surveys of representative areas, scan and fixed point measurements and radionuclide ratio sampling if elevated activity is detected, as appropriate, for the following areas:

- Floors – Floors will be surveyed within each impacted building.

- Walls – Walls within potentially impacted areas to a height of 6 ft above the floor. Horizontal surfaces – Overhead structural supports and other horizontal areas such as window sills will be surveyed
- Duct work and ventilation exhaust – If the exhaust ducts exhibit contamination, the scope of the survey will be expanded to include evaluation of areas immediately adjacent to the ventilation system exhaust. Roof surveys will place special emphasis on areas such as cracks, crevices, and porous materials in which contamination could be deposited and retained.
- Ceilings – Ceilings will be investigated if walls exhibit levels of radioactivity exceeding DCGLs.
- Building exterior (e.g., outside walls)
- Roofs

MARSSIM is used in classifying areas with classifications dictating the density of fixed and removable measurements and scanning percentage for each building. The MARSSIM based classifications listed in the following sections are based on data from *The Data Gap Analysis Report* (CDM 2008) and can be found in Table 4-3 of this plan. EPA's ongoing historical site assessment may impact final classification of areas and buildings.

A pre-survey evaluation has been performed to determine the number of measurements required per MARSSIM. Surveys will consist of 11 fixed and removable measurements for each area. Investigation of buildings exhibiting elevated radioactivity will be adjusted as appropriate and may be reclassified to a lower MARSSIM class. Sample (survey) locations within Class 3 areas will be randomly generated. Special emphasis will be provided to assuring that locations most likely to exhibit elevated radioactivity are thoroughly investigated.

6.1.1 Fixed Point and Removable Measurements

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. (Removable contamination as used herein is the amount of activity obtained within a 100 cm^2 area with a filter and applying moderate pressure.) Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building Exterior
- Roof – if elevated measurements are found within the ventilation system

Eleven fixed point and removable measurements (smears) will be collected within each building or within each independent area of the building to account for variability of radionuclides. These measurements will be collected utilizing randomly generated sample locations. The fixed point measurement will be collected prior to the smear. Fixed point and removable sample densities are defined based on MARSSIM classification. At least 11 sample locations per 100 m^2 for Class 1 buildings, per 1000 m^2 for Class 2 buildings, or per 10,000 m^2 acres for Class 3 buildings will be collected. (Eleven (11) was determined using the Sign Test; see Section 5.0 for calculations and additional information).

6.1.2 Dose Rate Measurements

Dose rate measurements will be performed at 3.3 ft (1 meter) above the floor surface at 11 locations in each survey unit. These measurements shall be taken at areas where the highest dose rate is expected (i.e., exits, entrances and travel pathways).

6.1.3 Radionuclide Ratio Measurements

Scanning surveys in conjunction with fixed point measurements using both alpha and beta/gamma survey instruments will be utilized to identify areas with the highest contamination. Analytical laboratory results will augment instrument surveys and enable gross alpha, gross beta and low-energy beta results to be fractionated to the applicable radionuclides. Sampling to fractionate activity will be accomplished as specified in Section 5.5.6 *Sampling for Determination of Radionuclide Ratios*.

All sample locations will be numbered and clearly marked on a scaled map (or dimensions provided) of the structure for the project file and future reference.

6.2 THE RADIOACTIVE MATERIAL HANDLING FACILITY CONCRETE FOUNDATIONS

The building concrete foundations in the RMHF have been classified as MARSSIM Class 1 areas. The following surveys are required pursuant to radiological surface characterization of concrete foundations in the RMHF:

Tritium. Low-energy beta emitters are not generally detectable using field instruments. As such, 11 smears will be collected from each concrete pad and analyzed for low-energy beta emitters including tritium. Smears will be obtained from areas most likely to be contaminated (e.g., areas adjacent to known soil contamination, former floor drains).

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of concrete foundations with special emphasis on areas such as cracks and crevices that commonly collect such contaminants. Scan surveys will be performed for 100% of each concrete pad in its current configuration

Fixed point and removable contamination surveys will include the collection of 11 fixed point and 11 removable samples per 100 m^2 of each concrete pad in addition to measurements of any elevated areas detected by scan surveys. Fixed point measurements will be collected utilizing a systematic grid and a random starting point.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

6.3 BUILDING 4006 – INCLUDES BUILDING 4616

Surveys of Building 4006 will be limited to MARSSIM Class 2 scan surveys to identify elevated radioactivity for radionuclide ratio sampling. Elevated radioactivity that is encountered both inside and on the exterior surface of the building will be sampled for determination of radionuclide ratios if such activity is detected.

6.4 BUILDING 4009 – CRITICAL EXPERIMENTS BUILDING

Building 4009 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4009 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate.

Other Radiological PCOCs. Surveys for these radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor
- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements will be obtained from representative areas within Building 4009 at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.5 BUILDING 4011 – RADIATION INSTRUMENT CALIBRATION LABORATORY

Building 4011 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4011 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate.

Other Radiological PCOCs. Surveys for these radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. Fixed point measurements will be obtained from biased areas identified by scan surveys as being potentially elevated as well as at Class 2 survey locations. Scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor

- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements will be obtained from representative areas within Building 4011 at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.6 BUILDING 4015

Building 4015 has been classified such that exterior portions of the building will be surveyed as MARSSIM Class 1 areas with interior portions of the building being surveyed as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4015 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys of interior surfaces will consist of:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Exterior wall surfaces to a height of at least 6 ft above ground level will be subjected to scan surveys of 100% of the accessible surface. Areas more than 6 ft above ground level will be subjected to scoping surveys with scan surveys based on information derived from the scoping surveys. A minimum of 10% of accessible surface areas above 6 ft will be surveyed.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include accessible areas of the:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements will be obtained from representative areas within Building 4015 at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.7 BUILDING 4019 – SNAP SYSTEM NUCLEAR QUALIFICATION TEST FACILITY

Building 4019 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4019 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor
- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements will be obtained from representative areas within Building 4019 at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.8 BUILDING 4021 – PACKAGING AND DECON ROOMS

Building 4021 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4021 and analyzed for

low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate.

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor
- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof – if elevated measurements are found within the ventilation system

Eleven (11) fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing a systematic grid.

Dose Rate Measurements. Dose rate measurements in Building 4021 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations in each Class 1 survey unit. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

6.9 BUILDING 4029

Building 4029 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4029 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor
- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing systematic sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4029 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (i.e., exits, entrances and travel pathways).

6.10 BUILDING 4034

Building 4034 has been classified as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4034 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4034 will be performed at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.11 BUILDING 4038

Building 4015 has been classified such that exterior portions of the building will be surveyed as MARSSIM Class 1 areas with interior portions of the building being surveyed as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4038 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, interior scan surveys will consist of:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Exterior wall surfaces to a height of at least 6 ft above ground level will be subjected to scan surveys of 100% of the accessible surface. Areas more than 6 ft above ground level will be subjected to scoping surveys with scan surveys based on information derived from the scoping surveys. A minimum of 10% of accessible surface areas above 6 ft will be surveyed.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include accessible areas of the :

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4038 will be performed at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.12 BUILDING 4044 – CLEAN SHOP AND SUPPORT LAB

Building 4044 has been classified as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4044 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof – if elevated measurements are found within the ventilation system

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4044 will be performed at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.13 BUILDING 4055 – NUCLEAR MATERIAL DEVELOPMENT FACILITY

The exterior portion of Building 4055 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of the exterior of this building is required to be performed. Data collected in this area will be limited to scan and fixed point surveys of the exterior portion of the building and sampling of elevated areas on the outside of the building for radionuclide ratio sampling if elevated activity is encountered.

6.14 BUILDING 4057

Building 4057 has been classified such that exterior portions of the building will be surveyed as MARSSIM Class 1 areas with interior portions of the building being surveyed as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4057 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys of interior surfaces will consist of:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Exterior wall surfaces to a height of at least 6 ft above ground level will be subjected to scan surveys of 100% of the accessible surface. Areas more than 6 ft above ground level will be subjected to scoping surveys with scan surveys based on information derived from the scoping surveys. A minimum of 10% of accessible surface areas above 6 ft will be surveyed.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include accessible areas of the:

- Floors
- Walls
- Elevated support structures
- Ventilation System

- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4057 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.15 BUILDING 4093

Building 4093 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4093 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor
- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include remaining portions of the structure.

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing systematic sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4093 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.16 BUILDING 4100 – FAST CRITICAL EXPERIMENT LABORATORY

The exterior portion of Building 4100 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will be limited to surveys to evaluate the potential presence of elevated radioactivity on exterior building surfaces including the roof. Samples obtained from the exterior portion of the building will also be collected for radionuclide ratio sampling if elevated activity is encountered.

6.17 BUILDING 4133

Building 4133 has been classified as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4133 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4133 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.18 BUILDING 4462 (SPTF)

Building 4462 has been classified such that exterior portions of the building will be surveyed as MARSSIM Class 1 areas with interior portions of the building being surveyed as a MARSSIM Class 3 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4462 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys of interior surfaces will consist of:

- 10 – 50% of the floor area in its current configuration
- 10 – 50% of wall areas to 6 ft above the floor
- 10 – 50% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Exterior wall surfaces to a height of at least 6 ft above ground level will be subjected to scan surveys of 100% of the accessible surface. Areas more than 6 ft above ground level will be subjected to scoping surveys with scan surveys based on information derived from the scoping surveys. A minimum of 10% of accessible surface areas above 6 ft will be surveyed.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include accessible areas of the:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing randomly generated sample locations.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4462 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

6.19 BUILDING 4688 – OPEN-WALLED CLEANING STATION AND RADIOACTIVE MATERIALS STORAGE

Building 4688 has been classified as a MARSSIM Class 1 area. Radiological surface characterization of this building is required to be performed. Data collected in this area will include:

Tritium. Given that low-energy beta emitters are not generally detectable using field instruments and the absence of such data, 11 smears will be collected from Building 4688 and analyzed for low-energy beta emitters including tritium. Smears will be obtained from the exhaust system and drains, traps, or other areas in which tritium would be expected to concentrate

Other Radiological PCOCs. Surveys for other radiological PCOCs will include scans of walls, floors and horizontal surfaces such as window ledges and structural support members as well as investigation of the duct work, where accessible. Special emphasis will be placed on areas such as cracks, crevices and duct work which commonly collect such contaminants. As such, scan surveys will consist of up to:

- 100% of the floor area in its current configuration
- 100% of wall areas to 6 ft above the floor
- 100% of the surface area of the air intakes and adjacent reasonably accessible interior portions of ventilation ducts; and
- The covers of any floor drains identified in the area and traps of drain lines.

Total residual surface activity (i.e., fixed point measurement results) and removable contamination (smear surveys) will include evaluations of any radiologically elevated areas detected by scan surveys. Surveys will include:

- Floors
- Walls
- Elevated support structures
- Ventilation System
- Building exterior
- Roof

Eleven fixed point and removable measurements will be collected within each survey unit. These measurements will be collected utilizing a systematic grid.

Radionuclide Ratio Sampling. Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Elevated radioactivity will be sampled for determination of radionuclide ratios if such activity is detected.

Dose Rate Measurements. Dose rate measurements in Building 4688 will be obtained at 1 m (3.3 ft) above the floor surface at 11 locations. These measurements shall be taken at areas where the highest dose rate is expected (e.g., exits, entrances and travel pathways).

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7.0 NUMBER OF SAMPLES PER AREA

Surveys are to be performed for specific buildings as noted in Table 4-3 to obtain information for CERCLA risk assessment. The number of samples required for such surveys are calculated using the procedures defined in this section. (See MARSSIM Section 5.5.2 for additional detail.)

MARSSIM provides for evaluation of areas in which the contaminant is present in background as well as for areas in which contaminants are not present in background. Since representative building materials, not potentially impacted by site operations, are unavailable for establishing site specific and medium-specific background levels, only instrument backgrounds will be utilized and survey units will be evaluated using the Sign Test thus estimation of only the contaminant variability is required rather than both the contaminant and background variability.

7.1 SPECIFY THE DECISION ERROR

In order to calculate the required number of samples to be collected in each survey unit, a decision error rate must be utilized. These error rates do not translate to understating or overstating the risk. These assumed error rates are being used as if the data were to be used for final status survey.

The Type I (false negative) error for Area IV of SSFL radiological surveys has been set at 0.05 and the Type II (false positive) error has been set at 0.10. This means that there is a 5% probability of erroneously releasing a survey unit whose true mean is greater than the DCGL and a 10% probability of not releasing a site that has attained the DCGL.

7.2 RELATIVE SHIFT

The relative shift is defined as the Δ/σ where Δ is the DCGL - LBGR (lower bound of the gray region) and σ is the standard deviation of the contaminant distribution. MARSSIM recommends that the LBGR initially be set one half of the DCGL, but should be adjusted if necessary to provide a Δ/σ value between the recommended range of 1 to 3.

The value for σ can be estimated in a number of ways. Sometimes there is data from the site that is sufficient to calculate the standard deviation within the survey unit, σ_s (note that for Class 1 units σ represents the standard deviation just prior to release and after material above the criterion is thought to be removed). Data may also be available from a reference or background area. (Although reference area data can be used to estimate a standard deviation, σ_r, if the contaminant is present in background, as noted above, it is conservatively assumed that contaminants are not present in background.) As such, the σ_s is used when calculating Δ/σ.

7.2.1 Calculate the Relative Shift

A relative shift of 3.0 will be utilized for determining the number of radionuclide ratio samples required to be collected. This assumes a low variability of contamination relative to the DCGLs. Low variability is assumed given many of the target buildings have already been released, though some characterization is still required in order to complete dose calculations.

7.3 NUMBER OF SAMPLES PER AREA

The calculated value for Δ/σ can be used to obtain the minimum number of samples/measurements necessary to satisfy requirements using the MARSSIM equation presented below:

$$N = \frac{(z_{1-\alpha}+z_{1-\beta})^2}{4(Sign\ p - 0.5)^2}$$

The calculated value, N, is the number of samples/measurements required from each survey unit. $Z_{1-\alpha}$ and $Z_{1-\beta}$ are critical values that can be found in MARSSIM, EPA 1989, or statistics textbooks and handbooks, and *Sign p* is a measure of probability available from MARSSIM Table 5.4.

A 20% increase in this number is recommended to account for lost or unusable samples/measurements. The calculated values apply to each survey unit.

7.3.1 Determining the Number of Samples per Survey Unit

Using the Sign Test the number of data points, N, for each survey unit is calculated using Equation 5-2 and Table 5.4 in MARSSIM, given 5% Type I error and 10% Type II error and a default relative shift of 3.0.

$$N = \frac{(z_{1-\alpha}+z_{1-\beta})^2}{4(Sign\ p - 0.5)^2}$$

$$N = \frac{(1.645+1.282)^2}{4(0.99865-0.5)^2} = 8.61 = 9 \text{ Samples}$$

The uncertainty associated with the calculation, N, should be accounted for during survey planning thus the number of data points is increased by 20% and rounded up. This is in order to ensure there are sufficient data points to allow for any possible lost or unusable data.

$$N = 9 + 0.2(9) = 11\ Samples$$

It is noted that 10 samples have been used as the minimum requirement for producing an upper 95% confidence level on the mean concentration (EPA 2007). This is relevant because the objective is to collect data sufficient to calculate the dose to future site workers and members of the public exposed to materials during transport. For the purposes of this survey the number of measurements (N) has been calculated to be 11 per survey unit.

8.0 SURVEY IMPLEMENTATION

8.1 INSTRUMENTATION

Survey instruments (Section 6.2) used for radiological measurements:

- have been selected based on the survey instrument's detection capability for the site radiological PCOCs.
- will have been calibrated in accordance with American National Standards Institute (ANSI) N323A, Radiation Protection Instrumentation Test and Calibration – Portable Survey Instruments (ANSI, 1997).
- calibration will utilize a National Institute of Standards and Testing (NIST) source to obtain a quantitative measurement.
- will be operated and maintained by qualified personnel, in accordance with Health Physics Program procedures (e.g., physical inspection, background checks, response/operational checks).
- will be subject to background count rate determination using the mean value of 10 each one-minute background counts.
- will be subjected to daily QA checks before use, at the conclusion of the work day and at anytime that an instrument provides questionable results. QA checks will specifically include confirmation that their fixed point response is within ±20% of a known reference source.
- will be subjected to background checks at the same location in a reproducible geometry at the beginning and end of each survey day at any time that instrument response is questionable. The acceptance criterion for background will be a background count rate within three standard deviations of the mean background value. (Background count rates exceeding the mean by more than two standard deviations will result in recounting of background to assure that the initial result is due to statistics rather than instrument serviceability.)

Radiological field instrumentation used for these building surveys will have been calibrated in accordance with ANSI N323A within the past 12 months (or more frequently if recommended by the manufacturer). Daily quality control checks will be conducted on each instrument prior to use, at the end of the day and anytime that results appear questionable. Instruments will be operated by fully qualified radiological staff in full compliance with established Health Physics Procedures. Only data obtained using instruments that satisfy these performance requirements will be accepted for use during this survey.

Site radiological PCOCs emit alpha, beta and gamma radiations which can be used to identify and quantify the radioactive constituents present. Gamma walkthrough surveys are performed initially to qualitatively identify areas for more comprehensive evaluation as well as to quantify isotopic activity for radionuclides that do not emit alpha or beta particles." Surface scans for gross alpha and gross beta radiation will be performed to identify areas of elevated residual radiological contamination. Both alpha and beta scans are being used because some of the PCOCs emit alpha radiation while other constituents emit beta particles. Given the greater attenuation of alpha particles compared to beta, beta surveys will be performed when emissions include beta particles of sufficient energy to be reasonably detectable are present. Technical assessment on use of alpha or beta for a given set of circumstances will be made by the Project Radiation

Control Manager/Certified Health Physicist. Instrument response will be continuously monitored during scanning through use of the audible instrument signal using earphones/head phones as appropriate. Scanning results will be recorded in counts per minute (cpm) which along with the appropriate instrument geometry and calibration information will be used to convert the data to dpm/100 cm^2 for comparison to cleanup criteria.

One hundred percent of reasonably accessible areas will be scanned in Class 1 and Class 2 survey units while up to 10% coverage is targeted for Class 3 survey units. For the purposes of this plan "accessible areas" are those where safety considerations or other restrictions do not prevent access for normal scanning activities (e.g., overhead areas immediately adjacent to high voltage power lines). As a conservative measure the level of scanning effort in Class 2 areas will be 100%. Class 3 scan surveys will be biased to areas with the highest potential for contamination based on the professional judgment of the on-site Project Health Physicist.

In accordance with Section 5.5.2.6 of MARSSIM, locations identified during the surface scans that exceed the investigation levels as stated below will be investigated by taking further measurements to confirm and/or quantify contaminant levels in the area of elevated activity. (Investigation levels were defined in Section 4.2.) Audible responses of the instrument will be monitored, and locations of elevated response above the investigation levels listed below will be measured with a fixed point measurement. In Class 1 and Class 2 areas an investigation level equal to the stated DCGLs will be used while for Class 3 areas the investigation levels will consist of 50% of the most restrictive DCGL or the MDC whichever is greater. These levels will be recalculated and converted to counts per minute (cpm) based upon site specific conditions as required to correlate with instrument response and actual instrument background at the site.

There may be locations where safety considerations or other restrictions prevent access for normal scanning activities in overhead areas or under equipment. Reasonable efforts to scan such locations will be made. Alternative and innovative approaches (e.g., use of extension poles, detectors mounted on platforms with wheels or skids, placing detectors in protective sleeves, etc.) will be evaluated and implemented, as appropriate.

All sample locations will be numbered and clearly marked on a scaled map (or dimensions provided) of the structure for the project file and future reference.

8.2 MINIMUM DETECTABLE CONCENTRATIONS

The MDC is an activity level, calculated a priori "before-the-fact," that a specific instrument and measurement technique can be expected to detect 95% of the time. Site specific detection sensitivities (scan and fixed point MDCs) for Area IV of SSFL have been calculated based on Sr-Y-90 in accordance with the approach detailed in NUREG-1507. These calculations are provided in Appendix B of this document and the calculated MDCs are listed below in Table 9-1.

Table 9-1. Evaluation of Instruments for Use at SSFL[1,2]

Description	Application	Scan MDC (dpm/100 cm^2)[3,4]	Fixed Point Count MDC (dpm/100 cm^2)[3,4,5] 2 minute count time[5]	Fixed Point Count MDC (dpm/100cm^2)[3,4] 4 minute count time[5]
Ludlum Model 2929 coupled with a Ludlum 43-10-1 (dual phosphor alpha / beta scintillator)[5]	Smear counter	N/A	6 dpm/100 cm^2 Alpha 35 dpm/100 cm^2 Beta	4 dpm/100 cm^2 Alpha 26 dpm/100 cm^2 Beta

Table 9-1. Evaluation of Instruments for Use at SSFL[1,2] (Continued)

Description	Application	Scan MDC (dpm/100 cm^2)[3,4]	Fixed Point Count MDC (dpm/100 cm^2)[3,4,5] 2 minute count time[5]	Fixed Point Count MDC (dpm/100cm^2)[3,4] 4 minute count time[5]
Ludlum Model 2224-1 coupled with a Ludlum 43-89 (ZnS plastic scintillator). Effective area 126 cm^2.	Alpha / Beta surface scan	99 dpm/100 cm^2 @ 1 in/s Alpha 456 dpm/100 cm^2 @ 1 in/s Beta	67 dpm/100 cm^2 Alpha 204 dpm/100 cm^2 Beta	43 dpm/100 cm^2 Alpha 143 dpm/100 cm^2 Beta
Ludlum Model 2221 coupled with a Ludlum 43-37 (floor monitor). Effective area 545 cm^2	Alpha / Beta surface scan	64 dpm/100 cm^2 @ 1 in/s Alpha 184 dpm/100 cm^2 @ 1 in/s Beta	40 dpm/100 cm^2 Alpha 101 dpm/100 cm^2 Beta	27 dpm/100 cm^2 Alpha 71 dpm/100 cm^2 Beta

[1] Other equivalent or similar instruments may be selected for use. If other instruments are used, scan rates and counting durations will be adjusted as necessary to achieve data quality objectives.
[2] The derivation of these scan MDCs are presented in Appendix B and C.
[3] Scan and fixed point MDCs are rounded to two significant digits.
[4] Background levels used in these calculations are instrument background, scan MDCs are for comparative use only and will be reevaluated based on site background as appropriate. For more information see Appendix B and C.
[5] These numbers are based upon a background count rate of 10 minutes and a sample count rate of 2 minutes, alternatives are calculated in Appendix B.
[5] Detectability of radiation depends in part on the instrument count time such that increasing the count time from 2 minutes to 4 minutes reduces Fixed Point Count MDCs. See Appendix B for calculations.

The Ludlum Model-3 or equivalent will be utilized for collecting dose rate measurements.

For the purpose of this plan, representative building materials not potentially impacted by site operations are not available with which to establish a site-specific and medium-specific background dataset. Instrument backgrounds will be subtracted, however, to produce net detector responses. These MDCs will be recalculated upon arrival at SSFL and upon available of site-specific background reference areas. Low energy beta activity (e.g., tritium) will be measured by liquid scintillation counting in a qualified laboratory. MDC achieved for total activity screen by LSC are commonly on the order of less than 5 dpm/100 cm^2.

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APPENDIX A

Parameters for RESRAD-BUILD Building D&D Scenario (D&D Worker)

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PARAMETERS FOR RESRAD-BUILD BUILDING D&D SCENARIO (D&D WORKER)

Parameter	Description	Value	Justification
Time Parameter			
Exposure Duration	Amount of time that exposure occurs	365 days	NUREG/CR-5512, Volume 1, Section 3.2.1
Indoor Fraction	Fraction of the exposure duration that is spent inside the building	0.057	500 hours over a 90 day period once/year NUREG/CR-5512, Volume 1, Section 6.7.1
Evaluation Time	Times at which doses are calculated	0 year	RESRAD-BUILD Default
Building Parameters			
Number of Rooms	Number of compartments in the building	1	RESRAD-BUILD Default
Deposition Velocity	Velocity at which airborne particles are deposited onto the floor surfaces	0.01 m/sec	RESRAD-BUILD Default (A sensitivity test resulted in no significant difference between the default value and the min. and max values listed in NUREG/CR-6697)
Resuspension Rate	Rate at which deposited material is resuspended into the air	1.0 E-06 sec^{-1}	Twice the value of Building Occupancy Scenario (NUREG/CR-5512, Volume 1, Section 6.3.1)
Building Exchange Rate	Total volume of air going out of the building per unit time divided by the total volume of the building	0.8 hr^{-1}	RESRAD-BUILD Default Consistent with value of 0.75 hr^{-1} for conditioned spaces (cited by American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.)
Room Area	Floor Area of the room	225 m^2	EPA BPRG Calculator – Room = 50' x 50' x 10'
Room Height	Height of the room	3 m	EPA BPRG Calculator – Room = 50' x 50' x 10'
Room Exchange Rate	Total volume of air going out of the room per unit time divided by the total vol. of the room	0.8 hr^{-1}	RESRAD-BUILD Default Same as building exchange rate due to single room
In/Out Flow Rate	Flow rates of air into and out of the room	540 m^3/hr	Room volume (675 m^3) * Room exchange rate (0.8 hr^{-1})
Receptor Parameters			
Number of Receptors		1	RESRAD-BUILD Default
Room # Location	Room in which the receptor is located	1	RESRAD-BUILD Default
Time Fraction	Fraction of time within the building that the exposed individual spends at his receptor location	1	RESRAD-BUILD Default
Breathing Rate	Inhalation rate of airborne material at this location	38.4 m^3/day	EFH Table 5-23 (Adult – Moderate Activity) (Breathing rate = 1.6 m^3/hr)

PARAMETERS FOR RESRAD-BUILD BUILDING D&D SCENARIO (D&D WORKER) (CONTINUED)

Parameter	Description	Value	Justification
Ingestion Rate	Ingestion rate of deposited dust for this location	2.25 E-04 m^2/hr	EPA BPRG Calculator – Indoor Worker Exposure to Settled Dust on Surfaces [IR_d (dust ingestion rate - worker) 54 cm^2/day equivalent]
Receptor Location	Coordinates of the receptor	7.5m, 7.5m, 1m	Located in center of room at height of 1m
Parameter	**Description**	**Value**	**Justification**
Shielding Parameters			
Thickness	Thickness of the shielding between the contamination source and the receptor location	0	RESRAD-BUILD Default
Density	Density of the shielding material	Not Applicable	
Material	Identification of the shielding material	Not Applicable	
Source Parameters			
Number of Sources		1	Floor and four walls
Room # location	All sources are located in Room # 1	1	
Source Type		Area	Surface contamination only; volume source is not likely due to historical assessment of SSFL buildings. (No processing of materials or activation of building materials.)
Direction	Axis perpendicular to the exposed area	Floor (z), Ceiling (z), 4 walls (x,y,x,y)	NUREG/CR-5512, Volume 1, Section 6.2.1
Location	Center point of the source in the x, y, z direction	Floor: 7.5m, 7.5m, 0m;	Entire floor is uniformly contaminated.
Geometry: Area	Area of the exposed surface over which the contamination is evenly distributed	225 m^2	
Air Release Fraction	Fraction of the eroded material that is released into the air	0.1	Most likely value. NUREG/CR-6697
Direct Ingestion	Direct Ingestion rate of the source by any receptor in the room	0 /hr	RESRAD-BUILD Default
Removable Fraction	Fraction of the source that can be linearly removed between t =0 and lifetime	0.2	Most likely value. NUREG/CR-6697
Lifetime	Amount of time in which all of the removable fraction of the source is linearly eroded	365 days	RESRAD-BUILD Default
Radionuclides Concentration	Unit concentration is initially run; results are normalized to 15 mrem/yr to determine each isotopic BPRG	1 pCi/m^2	

NON-DEFAULT PARAMETERS

As stated in section 2.1, a hierarchical system was used to derive the RESRAD-BUILD parameters for the industrial worker scenario. Justification for each non-RESRAD-BUILD default parameter used is given as follows:

- The **Indoor Fraction** was set at 0.057. This equates to a D&D worker working 500 hours over a 90 day period once in a single year in the contaminated structure as discussed in NUREG/CR-5512 Section 3.2.1.
- The **Room Area** was set at 225 m^2. This is equivalent to the second smallest room (50 feet by 50 feet by 10 feet) in the EPA BPRG Calculator.
- The **Resuspension Rate** was set at 1E-06 sec^{-1}. This is equivalent to Twice the value used for the Building Occupancy Scenario (NUREG/CR-5512, Volume 1, Section 6.3.1).
- The **Breathing Rate** was set at 38.4 m^3/day. This value is more conservative than the default value and is listed in EPA's Exposure Factors Handbook Table 5-23 (Adult – Moderate Activity Breathing Rate = 1.6 m^3/hr).
- The **Ingestion Rate** was set at 2.25E-04 m^2/hour. This value is equivalent to the EPA BPRG Calculator dust ingestion rate of 54 cm^2/day [IR_d – Indoor Worker Exposure to Settled Dust on Surfaces]
- The **Receptor** and **Source Locations** were set to place the receptor 1 meter (m) above the floor in the middle of a 15 m by 15 m room with 3 m walls. The floor is uniformly contaminated.
- The **Removal Fraction** was set at 0.2. This value assumes that 20 % of the contamination is removable at any given time. This value also corresponds to the maximum allowable removable contamination fraction (or percentage) for both the DOE and NRC and is the most likely value as listed in NUREG/CR-6697. This is also a conservative value when compared to the newer NRC guidance most likely value of 0.1 listed in NUREG/CR-6755.

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APPENDIX B

Scan MDCs for Radiological Contaminants of Concern at the Santa Susana Field Laboratory

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MDCS FOR RADIOLOGICAL CONTAMINANTS OF CONCERN AT THE SANTA SUSANA FIELD LABORATORY

NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998), and NUREG 1575, MARSSIM (DoD 2000) provide methodology for calculation of MDCs. The following details the approach for calculating site specific MDCs for Th-232 for use in the scoping survey process at the SSFL.

The steps utilized for calculating MDCs for the SSFL follow the approach detailed in NUREG 1507. The steps include:

1. Calculating the minimum detectable count rate (MDCR) by selecting a given level of performance, scan speed, and background level of the detector; and
2. Selecting a surveyor efficiency, if applicable.

The observation interval (i) is defined as the width of the probe divided by the time that 25% of the probe is over a 4"×4" area of interest (a function of scan speed).

$$i = \text{(probe width)} / \text{(scan speed)}$$

The observable background counts (b_i) is defined as is the number of background counts that occur during an observation interval.

$$B = \text{background count rate (cpm)}$$
$$b_i = B \times (i/60)$$

The minimum detectable number of net source counts in the interval is given by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the delectability value associated with the desired performance (d') as shown below:

$$s_i = d' \sqrt{b_i}$$

or

$$s_i = d' \sqrt{B\left(\frac{i}{60}\right)}$$

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, d', is defined as the index of sensitivity and is dependent on the selected decision errors for Type I (alpha) and Type II (beta) errors. A true positive error ($1-\beta$) of 95% and a false positive error (alpha) of 60% were selected to be consistent with NUREG 1507. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

$$MDCR = s_i \times (60/i) = X \text{ cpm}$$

Finally, the scan MDCs for structure surfaces may be calculated:

$$Scan\ MDC = \frac{MDCR}{(\sqrt{p})(\varepsilon_s)(\varepsilon_i)\left(\frac{probe\ area}{100\ cm^2}\right)}$$

MCDR = minimum detectable count rate
ε_s = surface efficiency
ε_i = instrument efficiency
p = surveyor efficiency

The static MDC for structure surfaces may be calculated as follows:

$$Static\ MDC = \frac{\left(3 + 3.29\sqrt{(R_{b)}(T_g)(1+\frac{T_g}{T_b})}\right)}{(\varepsilon_s)(\varepsilon_i)\left(\frac{probe\ area}{100\ cm^2}\right)(T_g)}$$

R_b or B^* = background count rate (cpm)
ε_s = surface efficiency
ε_i = instrument efficiency
T_g = sample count time (min)
T_b = background count time (min)

* Representative building materials not potentially impacted by site operations are assumed unavailable for establishing a site-specific and medium-specific background dataset. Instrument backgrounds will be utilized to produce net detector responses. If site-specific background levels are obtained the instrument MDCs will be re-calculated.

For alpha survey instrumentation with a background of approximately one to three counts per minute, a single count will give a surveyor sufficient cause to stop and investigate further. Assuming this to be true, the probability of detecting given levels of alpha emitting radionuclides can be calculated by use of Poisson summation statistics. Derivation of this equation can be found in Appendix J of MARSSIM.

The alpha scan probability for structure surfaces may be calculated as follows:

$$P\ (n\ \geq 1) = 1 - e^{\frac{(-G)(\varepsilon_i)(d)}{(60)(v)}}$$

$P(n \geq 1)$ = probability of getting greater than or equal to 1 count during the time interval t
G = Investigation Level (dpm/100cm^2)
ε_i = instrument efficiency (cpm/dpm)
v = scan speed (in/sec)
d = Probe width (in)

The MDC results are presented in dpm/100cm^2 for comparison purposes. Thus the MDC calculation was corrected using total efficiency and probe area. For determining the SSFL MDCs, average background values were not used, these numbers were determined from instrument background levels determined from a similar site. If site-specific background levels are determined upon arrival at SSFL the MDCs will be re-calculated.

COMPUTATION OF DETECTION LIMITS FOR A LUDLUM MODEL 2224-1 SCALER AND LUDLUM MODEL 43-89 DETECTOR WITH A 2 MINUTE COUNT TIME

The alpha static MDC for the 43-89 can be calculated as follows:

R_b = 1 cpm
T_b = 2 minutes
T_g = 2 minutes
ε_s = 0.25
ε_i = 0.228 cpm/dpm
probe area = 125 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(1(2)(1+\frac{2}{2})}\right)}{(2)(0.25)(0.228)\left(\frac{125}{100\ cm^2}\right)} = 67\ dpm/100\ cm^2$$

The alpha scan probability for the 43-89 can be calculated as follows:

G = 250 dpm/100cm^2
ε_i = 0.228 cpm/dpm
v = 1 in/sec
d = 4 in

$$P\ (n\ \geq 1) = 1 - e^{\frac{(-250)(0.228)(4)}{(60)(1)}} = 1.0$$

The alpha scan MDC for the 43-89 can be calculated as follows:

w = 4 in
s = 1 in/sec

$$i = \frac{4}{1} = 4\ \text{sec}$$

d'= 1.38
B = 1 cpm
i = 4 sec

$$MDCR = 1.38\left(\sqrt{(1)\frac{4}{60}}\right)(\frac{60}{4}) = 5\ \text{cpm}$$

MCDR = 5 cpm
ε_s = 0.25
ε_i = 0.228
p = 0.5
probe area = 125 cm^2

$$MDC = \frac{5}{\left(\sqrt{0.5}\right)(0.25)(0.228)\left(\frac{125}{100\ cm^2}\right)} = 99\ dpm/100\ cm^2$$

The beta static MDC for the 43-89 can be calculated as follows:

R_b = 200 cpm
T_b = 2 minutes
T_g = 2 minutes
ε_s = 0.5
ε_i = 0.377 cpm/dpm
probe area = 125 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(200(2)(1+\frac{2}{2})}\right)}{(2)(0.5)(0.377)\left(\frac{125}{100\ cm^2}\right)} = 204\ dpm/100\ cm^2$$

The beta scan MDC for the 43-89 can be calculated as follows:

w = 4 in
s = 1 in/sec

$$i = \frac{4}{1} = 4\ \text{sec}$$

d'= 1.38
B = 200 cpm
i = 4 sec

$$MDCR = 1.38\ (\sqrt{200\ x\ \frac{4}{60}})(\frac{60}{4}) = 76\ \text{cpm}$$

MCDR = 76 cpm
ε_s = 0.5
ε_i = 0.377
p = 0.5
probe area = 125 cm^2

$$MDC = \frac{76}{\left(\sqrt{0.5}\right)(0.5)(0.377)\left(\frac{125}{100\ cm^2}\right)} = 456\ dpm/100\ cm^2$$

COMPUTATION OF DETECTION LIMITS FOR A LUDLUM MODEL 2224-1 SCALER AND LUDLUM MODEL 43-89 DETECTOR WITH A 4 MINUTE COUNT TIME

The alpha static MDC for the 43-89 can be calculated as follows:

R_b = 1 cpm
T_b = 4 minutes
T_g = 4 minutes
ε_s = 0.25
ε_i = 0.228 cpm/dpm
probe area = 125 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(1(4)(1+\frac{4}{4})}\right)}{(4)(0.25)(0.228)\left(\frac{125}{100\ cm^2}\right)} = 43\ dpm/100\ cm^2$$

The alpha scan probability for the 43-89 can be calculated as follows:

G = 250 dpm/100cm^2
ε_i = 0.228 cpm/dpm
v = 1 in/sec
d = 4 in

$$P\ (n \geq 1) = 1 - e^{\frac{(-250)(0.228)(4)}{(60)(1)}} = 1.0$$

The alpha scan MDC for the 43-89 can be calculated as follows:

w = 4 in
s = 1 in/sec

$$i = \frac{4}{1} = 4\ \text{sec}$$

$d' = 1.38$
B = 1 cpm
i = 4 sec

$$MDCR = 1.38\left(\sqrt{(1)\frac{4}{60}}\right)(\frac{60}{4}) = 5\ \text{cpm}$$

MCDR = 5 cpm
ε_s = 0.25
ε_i = 0.228 cpm/dpm
p = 0.5
probe area = 125 cm^2

$$MDC = \frac{5}{\left(\sqrt{0.5}\right)(0.25)(0.228)\left(\frac{125}{100\ cm^2}\right)} = 99\ dpm/100\ cm^2$$

The beta static MDC for the 43-89 can be calculated as follows:

R_b = 200 cpm
T_b = 4 minutes
T_g = 4 minutes
ε_s = 0.5
ε_i = 0.377 cpm/dpm
probe area = 125 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(200(4)(1+\frac{4}{4})}\right)}{(4)(0.5)(0.377)\left(\frac{125}{100\ cm^2}\right)} = 143\ dpm/100\ cm^2$$

The beta scan MDC for the 43-89 can be calculated as follows:

w = 4 in
s = 1 in/sec

$$i = \frac{4}{1} = 4\ \text{sec}$$

d'= 1.38
B = 200 cpm
i = 4 sec

$$MDCR = 1.38\ (\sqrt{200\ x\ \frac{4}{60}})(\frac{60}{4}) = 76\ \text{cpm}$$

MCDR = 76 cpm
ε_s = 0.5
ε_i = 0.377
p = 0.5
probe area = 125 cm^2

$$MDC = \frac{76}{\left(\sqrt{0.5}\right)(0.5)(0.377)\left(\frac{125}{100\ cm^2}\right)} = 456\ dpm/100\ cm^2$$

COMPUTATION OF DETECTION LIMITS FOR A LUDLUM MODEL 2221 SCALER AND LUDLUM MODEL 43-37 DETECTOR WITH A 2 MINUTE COUNT TIME

The Alpha Static MDC for the 43-37 can be calculated as follows:

R_b = 5 cpm
T_b = 2 minutes
T_g = 2 minutes
ε_s = 0.25
ε_i = 0.162 cpm/dpm
probe area = 545 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(5(2)(1+\frac{2}{2})}\right)}{(2)(0.25)(0.162)\left(\frac{545}{100\ cm^2}\right)} = 40\ dpm/100\ cm^2$$

The Alpha Scan Probability for the 43-37 can be calculated as follows:

G = 250 dpm/100 cm^2
ε_i = 0.162 cpm/dpm
v = 1 in/sec
d = 6.26 in

$$P\ (n\ \geq 1) = 1 - e^{\frac{(-250)(0.162)(6.26)}{(60)(1)}} = 0.99$$

The Alpha Scan MDC for the 43-37 can be calculated as follows:

w = 6.26 in
s = 1 in/sec

$$i = \frac{6.26}{1} = 6.3 \text{ sec}$$

$d' = 1.38$
B = 5 cpm
i = 6.3 sec

$$MDCR = 1.38\left(\sqrt{(5)\frac{6.3}{60}}\right)(\frac{60}{6.3}) = 10 \text{ cpm}$$

MCDR = 10 cpm
ε_s = 0.25
ε_i = 0.162
p = 0.5
probe area = 545 cm^2

$$MDC = \frac{10}{\left(\sqrt{0.5}\right)(0.25)(0.162)\left(\frac{545}{100\ cm^2}\right)} = 64\ dpm/100\ cm^2$$

The Beta Static MDC for the 43-37 can be calculated as follows:

R_b = 950 cpm
T_b = 2 minutes
T_g = 2 minutes
ε_s = 0.5
ε_i = 0.373 cpm/dpm
probe area = 545 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(950(2)(1+\frac{2}{2})}\right)}{(2)(0.5)(0.373)\left(\frac{545}{100\ cm^2}\right)} = 101\ dpm/100\ cm^2$$

The Beta Scan MDC for the 43-37 can be calculated as follows:

w = 6.26 in
s = 1 in/sec

$$i = \frac{6.26}{1} = 6.3\ \text{sec}$$

d' = 1.38
B = 950 cpm
i = 6.3 sec

$$MDCR = 1.38\left(\sqrt{(950)\frac{6.3}{60}}\right)(\frac{60}{6.3}) = 132\ \text{cpm}$$

MCDR = 132 cpm
ε_s = 0.5
ε_i = 0.373
p = 0.5
probe area = 545 cm^2

$$MDC = \frac{132}{\left(\sqrt{0.5}\right)(0.5)(0.373)\left(\frac{545}{100\ cm^2}\right)} = 184\ dpm/100\ cm^2$$

COMPUTATION OF DETECTION LIMITS FOR A LUDLUM MODEL 2221 SCALER AND LUDLUM MODEL 43-37 DETECTOR WITH A 4 MINUTE COUNT TIME

The Alpha Static MDC for the 43-37 can be calculated as follows:

R_b = 5 cpm
T_b = 4 minutes
T_g = 4 minutes
ε_s = 0.25
ε_i = 0.162 cpm/dpm
probe area = 545 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(5(4)(1+\frac{4}{4})}\right)}{(4)(0.25)(0.162)\left(\frac{545}{100\ cm^2}\right)} = 27\ dpm/100\ cm^2$$

The Alpha Scan Probability for the 43-37 can be calculated as follows:

G = 250 dpm/100 cm^2
ε_i = 0.162 cpm/dpm
v = 1 in/sec
d = 6.26 in

$$P\ (n\ \geq 1) = 1 - e^{\frac{(-250)(0.162)(6.26)}{(60)(1)}} = 0.99$$

The Alpha Scan MDC for the 43-37 can be calculated as follows:

w = 6.26 in
s = 1 in/sec

$$i = \frac{6.26}{1} = 6.3 \text{ sec}$$

$d' = 1.38$
B = 5 cpm
i = 6.3 sec

$$MDCR = 1.38\left(\sqrt{(5)\frac{6.3}{60}}\right)(\frac{60}{6.3}) = 10 \text{ cpm}$$

MCDR = 10 cpm
ε_s = 0.25
ε_i = 0.162
p = 0.5
probe area = 545 cm^2

$$MDC = \frac{10}{\left(\sqrt{0.5}\right)(0.25)(0.162)\left(\frac{545}{100\ cm^2}\right)} = 64\ dpm/100\ cm^2$$

The Beta Static MDC for the 43-37 can be calculated as follows:

R_b = 950 cpm
T_b = 4 minutes
T_g = 4 minutes
ε_s = 0.5
ε_i = 0.373 cpm/dpm
probe area = 545 cm^2

$$MDC = \frac{\left(3 + 3.29\sqrt{(950(4)(1+\frac{4}{4})}\right)}{(4)(0.5)(0.373)\left(\frac{545}{100\ cm^2}\right)} = 71\ dpm/100\ cm^2$$

The Beta Scan MDC for the 43-37 can be calculated as follows:

w = 6.26 in
s = 1 in/sec

$$i = \frac{6.26}{1} = 6.3 \text{ sec}$$

$d' = 1.38$
B = 950 cpm
i = 6.3 sec

$$MDCR = 1.38\left(\sqrt{(950)\frac{6.3}{60}}\right)(\frac{60}{6.3}) = 132 \text{ cpm}$$

MCDR = 132 cpm
ε_s = 0.5
ε_i = 0.373
p = 0.5
probe area = 545 cm^2

$$MDC = \frac{132}{\left(\sqrt{0.5}\right)(0.5)(0.373)\left(\frac{545}{100\ cm^2}\right)} = 184\ dpm/100\ cm^2$$

Liquid scintillation counters will achieve an MDC of 100 dpm/100 cm^2. This concentration is less than the lower bound of the CERCLA risk range for tritium exposure to the D&D worker.

COMPUTATION OF SMEAR DETECTION LIMITS WITH A LUDLUM MODEL 2929 SCALER AND LUDLUM MODEL 43-10-1 DETECTOR

$$Static\ MDC = \frac{\left(3 + 3.29\sqrt{(R_{b)}(T_g)(1 + \frac{T_g}{T_b})}\right)}{(\varepsilon_i)\left(\frac{probe\ area}{100\ cm^2}\right)(T_g)}$$

ε_i = 0.601 (beta) 0.74 (alpha)
probe area = 100 cm^2
R_b = 60 cpm (beta) 1 cpm (alpha)
T_g = 2 minutes
T_b = 10 minutes, 5 minutes, 2 minute

Beta count, 10 minute background count time:

$$MDC = \frac{\left(3 + 3.29\sqrt{(60(2)(1 + \frac{2}{10})}\right)}{(2)(0.601)\left(\frac{100}{100\ cm^2}\right)} = 35.3\ dpm/100\ cm^2$$

Beta count, 5 minute background count time:

$$MDC = \frac{\left(3 + 3.29\sqrt{(60(2)(1 + \frac{2}{5})}\right)}{(2)(0.601)\left(\frac{100}{100\ cm^2}\right)} = 38.0\ dpm/100\ cm^2$$

Beta count, 2 minute background count time:

$$MDC = \frac{\left(3 + 3.29\sqrt{(60(2)(1 + \frac{2}{2})}\right)}{(2)(0.601)\left(\frac{100}{100\ cm^2}\right)} = 44.9\ dpm/100\ cm^2$$

Alpha count, 10 minute background count time:

$$MDC = \frac{\left(3 + 3.29\sqrt{(1(2)(1 + \frac{2}{10})}\right)}{(2)(0.74)\left(\frac{100}{100\ cm^2}\right)} = 5.5\ dpm/100\ cm^2$$

Alpha count, 5 minute background count time:

$$MDC = \frac{\left(3 + 3.29\sqrt{(1(2)(1+\frac{2}{5})}\right)}{(2)(0.74)\left(\frac{100}{100\ cm^2}\right)} = 5.7\ dpm/100\ cm^2$$

Alpha count, 2 minute background count time:

$$MDC = \frac{\left(3 + 3.29\sqrt{(1(2)(1+\frac{2}{2})}\right)}{(2)(0.74)\left(\frac{100}{100\ cm^2}\right)} = 6.5\ dpm/100\ cm^2$$

The Ludlum 2929 Dual Channel Scaler is most commonly used with the Ludlum 43-10-1 detector, thus MDCs were calculated using this detector model. If other detectors are chosen calculations will be re-performed. The use of 60 cpm (beta) and 1 cpm (alpha) are being used due to lack of site specific background data from the Santa Susana Field Laboratory. These numbers have been conservatively chosen from technical manual data and comparative site data.

APPENDIX C

Site Safety and Health Plan for SSFL

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SITE SAFETY AND HEALTH PLAN FOR THE RADIOLOGICAL SURVEY PLAN FOR BUILDINGS AND CONSOLIDATED MATERIALS WITHIN AREA IV OF THE SANTA SUSANA FIELD LABORATORY

JUNE 2011

prepared for

U.S. Department of Energy (DOE)

prepared by

CDM with support from Science Applications International Corporation (SAIC)

COMMITMENT TO IMPLEMENT THE ABOVE
SITE SAFETY AND HEALTH PLAN

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ACRONYMS AND ABBREVIATIONS

AHA	activity hazard analysis
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ATV	all terrain vehicles
CDE	committed dose equivalent
CEDE	committed effective dose equivalent
CFR	Code of Federal Regulations
cm^2	square centimeters
CPR	cardiopulmonary resuscitation
D&D	decontamination and decommissioning
DAC	derived air concentration
dBA	decibels
DDE	deep dose equivalent
DOE	Department of Energy
dpm	disintegrations per minute
EC&HS	Environmental Compliance and Health and Safety (program)
F	Fahrenheit
FM	field manager
FP	flash point
HAZWOPER	Hazardous Waste Operations and Emergency Response
HP	health physics
HSWP	health and safety work permit
IDLH	immediately dangerous to life and health
IDW	investigative-derived waste
mrem/yr	millirem per year
MSDS	Material Safety Data Sheets
NIOSH	National Institute of Occupational Safety and Health
NRC	Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OJT	on-the-job training
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
RCT	Radiation Control Technician
RME	radiation-monitoring equipment
RPM	Radiation Protection Manager
RPP	Radiation Protection Plan
SAIC	Science Applications International Corporation
SDE	shallow dose equivalent
SSFL	Santa Susana Field Laboratory
SSHO	Site Safety and Health Officer

ACRONYMS AND ABBREVIATIONS (Continued)

SSHP	Site Safety and Health Plan
TEDE	total effective dose equivalent
TES	task evaluation standard
TODE	total organ dose equivalent
TLV	threshold limit value
TWA	time-weighted average

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1.0 INTRODUCTION

1.1 OBJECTIVE

The scope of this Site Safety and Health Plan (SSHP) is limited to building surveys, pavement coring and hand auguring performed at Santa Susana Field Laboratory (SSFL) Area IV as part of the Radiological Survey Plan for Buildings and Consolidated Materials within Area IV of the Santa Susana Field Laboratory. The purpose of this SSHP is:

- to provide a written assessment of potential safety and health hazards associated with performance of work,
- to specify minimum acceptable protective equipment that will be used, and
- to provide procedures that shall be followed during the performance of work.

The requirements of this plan are applicable to all CDM Team personnel working at or on the site. In cases where another contractor is responsible for access and control of a particular area of the site where CDM personnel are required to work, the SSHP requirements of that contractor will be implemented in addition to the requirements of this SSHP (e.g., building access requires permission of Boeing. Personnel entering buildings will comply with all Boeing safety requirements). In the event that there are conflicts between SSHP requirements, the more restrictive of the two will be implemented.

1.2 POLICY STATEMENT

It is the policy of the CDM Team to require its employees to take every reasonable precaution to protect the health and safety of employees, the public, and the environment. All CDM organizational components must not only comply with applicable local, state, and federal environmental, health and safety regulations but shall do so in a proactive fashion. Responsibility for compliance with Environmental Compliance & Health and Safety (EC&HS) requirements lies with each individual and their line management.

The operating philosophy of the CDM Team is that no job is too important or too small that we cannot devote the time and resources to protect its most important asset, the employee. CDM Team line managers are responsible for the health and safety of their employees. Any CDM Team employee found not in compliance with this document, the EC&HS program requirements, or other safety documents, shall be subject to disciplinary action up to and including termination.

All CDM Team employees shall promptly report any environmental, health, and safety concerns to their line management. Management of the CDM Team shall not reprimand or otherwise take disciplinary action against their employees for reporting such concerns.

1.3 HEALTH AND SAFETY PROGRAM / RADIATION PROTECTION PROGRAM

The CDM Team's health and safety program is comprised of individual EC&HS Program procedures. SAIC is responsible for the team's Radiation Protection Plan (RPP) which is comprised of individual Health Physics (HP) procedures. The written EC&HS and RPP are compliant with the U.S. Department of Energy's (DOE) "Worker Safety and Health Program" and "Occupational Radiation Protection" regulations, 10 CFR 851 and 10 CFR 835, respectively, as well as with DOE Order 458.1, Radiation Protection of the Public and the Environment . The EC&HS and RPP procedures that are applicable to this SSHP are those that are specifically referenced within this document. CDM Team personnel are required to be trained on applicable

EC&HS and RPP procedures and the contents of this plan prior to on-site project participation. Applicable EC&HS and HP procedures (as determined by this SSHP), together with this SSHP, provide the requirements for safely performing fieldwork at the SSFL. These documents also establish practices to protect the public and the immediate environment from hazards caused by on-site work.

This SSHP must be on site during field work and accessible to employees and subcontractors.

1.4 SITE DESCRIPTION/HISTORY

The SSFL is located atop an east-west ridge of the Simi Hills, south of the community of Simi Valley, west of the San Fernando Valley, and approximately 40 miles north of downtown Los Angeles, California (See Survey Plan Figure 1-1; Location of SSFL). Area IV is the western-most of four administrative areas within the SSFL site.

From the mid-1950s until the mid-1990s, the DOE and its predecessor agencies were engaged in and sponsored nuclear operations within Area IV of the SSFL. These operations resulted in the radiological contamination of soil and structures in portions of Area IV. Decontamination and decommissioning (D&D) activities were conducted in Area IV from 1998 until 2007 when it was suspended pursuant to direction from the U.S. District Court of Northern California. Subsequent assessments identified the need for building surveys to augment surveys previously performed. This SSHP addresses the health and safety requirements for performance of these building surveys and radiological investigations of potentially contaminated concrete and asphalt surfaces.

2.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

This section presents the lines of authority, responsibilities, and communication procedures concerning site safety and health and emergency response. All fieldwork will be under the supervision of the Field Manager (FM), Site Safety and Health Officer (SSHO), or designee. The FM will oversee normal and emergency work and will perform any required emergency notification.

2.1 PROGRAM MANAGER

The Program Manager is responsible for ensuring conformance with policies and procedures. Specific responsibilities of the Program Manager include:

- Ensuring that project managers satisfy health and safety requirements;
- Ensuring that project staff implement the project SSHPs;
- Ensuring that projects have the necessary resources to operate safely;
- Ensuring an approved SSHP is issued prior to commencement of field activities; and
- Ensuring that a qualified SSHO is designated.

2.2 THE RADIATION CONTROL MANAGER

The Radiation Control Manager (RCM) will address radiological hazards associated with the project. Specific responsibilities include:

- Providing or reviewing the radiation sections of the SSHP;
- Assuring compliance with survey plan requirements to include applicable health and safety requirement;
- Assessing radiological exposure measurements; and
- Oversight of the Health and Safety Work Permits (HSWPs) process.

2.3 FIELD RADIATION PROTECTION MANAGER

The Field Radiation Protection Manager (RPM) will oversee the field activities associated with the project and will be responsible for site accessibility, safety, and radiological controls. He/she is responsible for enforcing the field requirements of this SSHP. Specific responsibilities of the Field Manager are listed below:

- The Field RPM will serve as project Radiation Safety Officer, providing on-site health physics support. In this capacity the Field RPM will implement the SAIC Health Physics Program and associated procedures except as specifically excluded in Section 6.4, HP-04.
- Conducting site training and surveillances as needed;
- Assessing radiological exposure measurements;
- Supervising health physics technicians; and
- Reviewing and approving Health and Safety Work Permits (HSWPs) on an as-needed basis.
- Coordinating on-site operations;

- Conducting and recording worksite inspections;
- Stopping work or upgrading protective measures (including protective clothing) if adverse health and safety conditions are encountered;
- Ensuring that at least one person currently certified in first aid and/or cardiopulmonary resuscitation (CPR) are on staff;
- Conducting and recording daily "tailgate" safety briefings;
- Controlling visitor access to the exclusion zone; and
- Maintaining a copy of Boeing's *Service Provider Manual* and ensuring appropriate implementation.

NOTE: Indications of adverse health and safety conditions include monitoring instrument readings in excess of the established action limits, etc. The FM must also authorize resumption of work following correction of the adverse condition(s).

2.4 SITE SAFETY AND HEALTH OFFICER (SSHO)

The SSHO is responsible for making health and safety decisions for health and safety activities, and for verifying the effectiveness of the health and safety program. The SSHO has primary responsibility for the following:

- Maintaining current copies of the project SSHP, and applicable SAIC EC&HS policies and procedures;
- Stopping work if uncontrolled health and safety hazards are encountered,
- Ensuring compliance with the project SSHP;
- Documenting deficiencies identified in inspections, designating responsible parties, procedures, and timetables for correction,
- Stopping work or upgrading protective measures (including protective clothing) if adverse health and safety conditions are encountered;
- Approving upgrades and downgrades of personal protective equipment (PPE);
- Ensuring that a site-specific pre-entry health and safety briefing covering potential chemical and physical hazards, safe work practices, and emergency procedures is conducted and documented for site workers;
- Maintaining on-site auditable documentation of all required records, including:
  - Material Safety Data Sheets (MSDSs) for applicable materials utilized at the site,
  - Training for site workers and visitors,
  - Calibration/maintenance of field instruments such as radiation monitoring equipment, etc.,
  - Environmental and personal exposure monitoring results,
  - Notification of accidents/incidents,
  - Reports of any chemical overexposure or excessive levels,

  - Notification of employees of chemical exposure data, and
  - Medical surveillance;

- Confirming that all on-site personnel have received the training listed in the Training Requirements section (Section 4.0) of this SSHP;
- Verifying that the project SSHPs emergency points of contact are correct;
- Ensuring monitoring for potential on-site exposures is conducted in accordance with this SSHP;
- Performing periodic worksite safety inspections;
- Ensuring that worksite safety inspections are conducted by the Field Manager or qualified technicians;
- Updating the project SSHP (field changes) to ensure that it adequately identifies all tasks and significant hazards at the site and notifying project personnel of changes;
- Investigating accidents and near accidents and reporting to the Program Manager and Corporate Health and Safety Manager as applicable;
- Coordinating with Site Safety personnel, including reporting accidents and incidents immediately and submitting written reports;
- Reviewing industrial hygiene and radiological exposure monitoring data;
- Recommending changes to engineering controls, work practices, and PPE;
- Coordinating and controlling any emergency response actions; and
- Ensuring that all monitoring equipment is operating according to the manufacturer's specifications and performing field checks of instrument calibration.

2.5 RADIATION CONTROL (HEALTH PHYSICS) TECHNICIANS (RCT)

RCTs will be used to conduct the building surveys. RCTs are also responsible for assessing radiological conditions, verifying that radiological control practices are being implemented, and stopping work if controls are insufficient. Specific duties include:

2.5.1 Senior Radiation Control (Health Physics) Technicians

The responsibilities of the senior RCTs are described below:

- Conducting routine radiation, contamination and airborne radioactivity surveys;
- Establishing protective barriers and posting appropriate radiological signs;
- Implementing the personal protective equipment program for the purposes of keeping radiation exposure ALARA;
- Performing operability checks of radiation monitors and survey meters;
- Performing unconditional release surveys of materials from the restricted area;
- Evaluating the results of routine radiation, contamination, and airborne radioactivity surveys;

- Evaluating airborne concentrations and determining DAC-hr (derived air concentration-hour) exposures for individuals;
- Performing shipping and receipt surveys of radioactive material;
- Performing job coverage surveys and directing activities to ensure compliance with applicable regulations;
- Performing and documenting personnel decontamination;
- Implementing the radiation protection program;
- Ensuring compliance with this SSHP and applicable HP procedures; and
- Developing and issuing HSWPs.

2.5.2 Junior Radiation Control (Health Physics) Technicians

The responsibilities of the junior RCTs are described below:

- Conducting routine radiation, contamination and airborne radioactivity surveys;
- Establishing protective barriers and posting appropriate radiological signs;
- Implementing the personal protective equipment program for the purposes of keeping radiation exposure ALARA;
- Performing operability checks of radiation monitors and survey meters; and
- Performing unconditional release surveys of materials from the restricted area under the direction and guidance of fully qualified RCT or Health Physicists.

2.6 EMPLOYEES

Each employee is responsible for:

- Complying with the requirements of this SSHP;
- Completing his or her work assignment in a safe and effective manner;
- Accepting an assignment or beginning a task only after understanding the risks and hazards associated with that activity;
- Completing the applicable training, medical evaluations, respirator fit testing, wearing protective clothing, etc., as specified in the SSHP, before beginning any job;
- Implementing the buddy system in field locations (i.e., verbal or visual contact);
- Having thorough knowledge of specific emergency response procedures for the site;
- Immediately reporting any occupational illness or injury to the appropriate supervisor/field manager, including any potential exposure to hazardous substances for which protection was not provided;
- Wearing and maintaining personal protective equipment, as specified in the SSHP;
- Reporting to the SSHO any hazards not documented in the SSHP or inadequately controlled by procedures contained in the SSHP;

- Implementing assigned responsibilities in accordance with the SSHP;
- Observing work in controlled areas to verify compliance with radiological controls;
- Stopping work when adverse safety conditions arise; and
- Reporting all adverse safety conditions to the FM and/or SSHO.

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3.0 CONTAMINANT AND HAZARD DESCRIPTION

Planned site tasks present a number of different hazards and contaminants including physical hazards and exposure to radiological contaminants. Examples of hazards that may be encountered in the performance of this work are provided in Table 3-1.

Table 3-1. Hazards Inventory

Biological hazards	Inclement weather
Operation of power tools or equipment	Noise
Radiation or radioactive contamination	Slips, trips, and falls
Fire	Temperature extremes
Vehicle traffic hazards	

3.1 ACTIVITY HAZARD ANALYSES

Potential hazards associated with work at the SSFL were considered when generating an Activity Hazard Analysis (AHA) for the building survey, pavement coring and associated soil sampling. In developing the building survey AHA, the SSHO drew upon the knowledge and experience of employees who had previously performed that activity. The AHA defines the activities being performed, identify the specific hazards anticipated, and list the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not begin until the SSHO, or designee has briefed the work crew on the hazard analysis.

Building radiological surveying are non-intrusive tasks that pose a very limited potential for external radiation exposure or radiological contamination as much of Area IV has previously been remediated with the intent to release without restrictions. Irrespective of the reduced hazard each area will be subjected to dose rate surveys concurrent with initial entry to preclude the possibility of unidentified hazards. Access to buildings in Area IV is still controlled by Boeing, as site owner. Several of these buildings are still posted radiological facilities. Boeing permission is required prior to building entry. Project personnel who enter radiologically controlled areas of the site will follow established site requirements and/or the RPP, whichever is more restrictive. Physical hazards for the building survey will be minor since the tasks will not involve heavy equipment, power tools, or other physical hazards beyond slip/trip/fall hazards.

Intrusive activities such as pavement coring and associated soil sampling will take place in radiologically unrestricted access areas. Therefore, it is not anticipated that radiological contamination would be encountered. The AHAs that have been developed for the pavement coring and soil sampling activities do address hazards that may be encountered if radiological or chemical contamination is encountered as does the AHA for hand decontamination should it become necessary.

There is a very limited potential for encountering chemical hazards during the building survey. It is unlikely that personnel will be exposed to chemical contaminants associated with previous site activities due to the nature of how building surveys are performed (i.e., non-intrusive activities).

There is potential for exposure to biological hazards during work at SSFL. Such hazards include animal/snake bites or insect stings, toxic plants, animal feces, and bloodborne pathogens while traveling between buildings.

Animal bites or insect stings are usually nuisances that can be handled by minimal first-aid treatment. Mosquitoes may carry West Nile Virus and if fever, headaches and nausea occur from a mosquito bite, contact your physician immediately. Ticks can carry Lyme disease and if fever,

rash, or vomiting occurs, you should also contact your physician immediately. The best way to prevent insect bites is to use repellent containing DEET on exposed skin. Bees, wasps and yellow jacket stings can also be dangerous especially if you are allergic. Africanized bees have arrived in California and are very aggressive. If you see a bee swarm the best action is to run as fast you can, cover your face and close your mouth, and try to find someplace dark and cold to hide (e.g., in an enclosed vehicle). The biggest hazard and most common cause of fatalities from an animal bite or sting, particularly from bees, wasps and spiders, is a sensitivity reaction. Individuals who are aware of a personal sensitivity or allergy shall make their supervisor aware of the sensitivity or allergy, so that a record may be kept on file in the event of a reaction or exposure.

Snakes live everywhere in California and while most are not poisonous, the rattlesnake is. To protect against rattlesnake bites, look carefully where you step. If bitten by a rattlesnake, call 9-1-1 immediately.

AHAs for the building radiological survey activities and equipment usage are provided in Attachment 3. AHAs for the pavement coring and associated soil sampling are provided in Attachment 3. When a task not described in this document is encountered, the SSHO will conduct a task-specific AHA to evaluate the requirements necessary to perform the task safely. The task-specific AHA will be documented in a format similar to the AHA form provided in Attachment 3.

The HSWP for this radiological survey plan will comply with Boeing site requirements for entry into the respective areas being surveyed as described herein and will be consistent with SAIC procedure HP-21.

3.2 POTENTIAL EXPOSURES

3.2.1 Site Contaminants

The areas of SSFL Area IV where the building surveys will occur are not expected to have chemical contaminants.

3.2.2 Radiological Hazards

The primary radionuclide at SSFL is Cs-137. Additional potential contaminants of concern include those radionuclides listed in Table 3-2. Personnel conducting building surveys will follow HSWP requirements while in radiologically controlled areas and will conduct periodic radiological dose rate and contamination monitoring to ensure anticipated conditions do not change.

Table 3-2. Radiological COPCs at SSFL

Element (Atomic Number)	Isotope	Element (Atomic Number)	Isotope
Americium (95)	Am-241	Plutonium (94)	Pu-238
Barium (56)	Ba-133	Plutonium (94)	Pu-239
Beryllium (4)	Be-10	Plutonium (94)	Pu-240
Cadmium (48)	Cd-113	Plutonium (94)	Pu-241+D
Curium (96)	Cm-244	Strontium (38)	Sr-90+D
Cobalt (27)	Co-60	Thorium (90)	Th-228+D

Table 3-2. Radiological COPCs at SSFL (Continued)

Element (Atomic Number)	Isotope	Element (Atomic Number)	Isotope
Cesium (55)	Cs-137+D	Thorium (90)	Th-230
Europium (63)	Eu-152	Thorium (90)	Th-232
Europium (63)	Eu-154	Uranium (92)	U-233
Europium (63)	Eu-155	Uranium (92)	U-234
Hydrogen (1)	H-3	Uranium (92)	U-235+D
Neptunium (93)	Np-237+D	Uranium (92)	U-238+D
Promethium (61)	Pm-147		

Personnel involved with the tasks defined by this SSHP are likely to be exposed to external radiation at levels well below the DOE 5,000 mrem/y radiation worker limit and well below Boeing's 2,000 mrem/y administrative limit. Building 4024 (SETF) and the RMHF are posted radiological facilities and require Boeing issued dosimetry for entry. DOE requires dosimetry for anyone entering a radiation area (> 5 mrem/hr) or anyone expected to exceed 100 mrem/y.

3.2.2.1 Airborne Radioactive Contamination

It is unlikely that personnel will be exposed to airborne radioactive contamination above site limits based on the nature of building surveys (i.e., non-intrusive activities). Also, with the exception of ventilation ducting in Building 4021, there are currently no airborne radioactive contamination areas inside buildings within Area IV. Air monitoring will be conducted by CDM and if airborne radioactive contamination exceeds 10% of the DAC, personnel will be assigned CDM-issued respirators. The project RPM will coordinate required support with Boeing to provide bioassay services for those entering airborne contamination areas.

3.2.2.2 Health Effects Associated with Radiation Exposure

Neither internal nor external radiation exposure above limits is expected to be a concern at SSFL. However, inhalation of radioactive airborne particulates, if radiation exposure were a concern, would likely present the greatest concern because radioactive material may be deposited inside the body where tissues are more sensitive to the types of radiation emitted by site contaminants. In addition, internal radiation exposure continues until the material has been eliminated from the body. Chronic exposure to radiation may also be associated with an increased lifetime risk of cancer.

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4.0 TRAINING

Personnel who participate in field activities associated with this project who are exposed to hazardous substances and health hazards as defined in 29 CFR 1910.120 are subject to the training requirements presented in Table 4-1. Filling out paperwork, attending meetings, or similar activities inside routinely occupied buildings or office trailers are not field activities and are not subject to these training requirements. Visitors or other personnel who will be on site but will not be exposed to hazardous substances and health hazards as defined in 29 CFR 1910.120 are not required to have the training listed in Table 4-1. Delivery, service/repair, and administration personnel who do not access controlled areas of the site are not subject to these training requirements. All personnel entering SSFL controlled areas of the site will require specific SSFL training based upon the area of the site they will be accessing and the need for a site escort.

Table 4-1. Training Requirements

Training	Worker	Supervisor	Site visitor
Hazardous Waste Operations (40 hour and OJT)	√	√	---
Hazardous Waste Operations Annual Refresher (8 hour)	√	√	---
Radiation Worker Annual Training (or RPM approved equivalent)	√	√	---
Hazardous Waste Operations Supervisors Training (8 hour)	---	√	---
General Hazard Communication Training (Contained in 40-hour and 8-hour courses)	√	√	---
Hearing Conservation Training (for workers in hearing conservation program; contained in 40-hour and 8-hour courses)	√	√	---
SSFL Site-specific safety training (Boeing training)	√	√	√
Site Specific Hazard Communication	√	√	---
Safety Briefing (daily when field work is being conducted)	√	√	---
First Aid/CPR (if medical services >5 min. away)	√*	---	---

√ = Required
--- = Not required
OJT = on-the-job training may be conducted on the SSFL site
* At least one worker is required to be trained in First Aid/CPR

4.1 HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE TRAINING REQUIREMENTS

All personnel working at SSFL who are exposed to hazardous substances or health hazards are required to have 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training as well as a current 8-hr Annual HAZWOPER Refresher training prior to being permitted to engage in hazardous waste operations that could expose them to these hazards. In addition to this training, three days of relevant field experience (i.e., on-the-job training (OJT)) is required and must be documented by the SSHO or Field Manager. The field experience may be documented on site after an individual has been approved to work on site or the SSHO may approve OJT documented at other sites.

The 8-hour HAZWOPER Refresher course is required annually for applicable personnel. An extension may be granted for up to 90 days by the SSHO if the refresher course has not been taken but has been scheduled to be completed within the extension period.

The HAZWOPER Manager/Supervisor Training is required for personnel who directly supervise hazardous waste site workers. This is an 8-hour course that must be taken once. Note that the initial 40-hour HAZWOPER course is a prerequisite.

The radiation worker training is required annually for personnel who are likely to exceed an occupational radiation dose of 100 mrem/yr total effective dose equivalent (TEDE). The content of the radiation worker training includes, at a minimum; risks of exposure to radiation and radioactive materials, including prenatal radiation exposure; basic radiological fundamentals and radiation protection concepts; physical design features, administrative controls, limits, policies, procedures, alarms, and other measures implemented at the facility to manage doses and maintain doses ALARA, including both routine and emergency actions; individual rights and responsibilities as related to implementation of the facility radiation protection program; individual responsibilities for implementing ALARA measures; use of dosimetry and instruments; site contaminants and probability of exposure; required monitoring; exposure control methods; and individual exposure reports that may be requested. The RPM will ensure that radiation worker training certification is on file for applicable personnel.

General hazard communication training is required for all site workers. This training must communicate the risks and protective measures for chemicals that employees may encounter. This requirement is met by taking the 40-hour HAZWOPER course, annual refreshers, or the site-specific training.

Hearing conservation training is required on an annual basis by 29 *CFR* 1910.95 for all employees enrolled in a hearing conservation program. This will include all employees exposed to occupational noise in excess of 85 decibels (dBA) for an 8-hour time-weighted average (TWA). This annual training is provided as part of the 40-hour HAZWOPER course, annual refreshers, or site-specific training. Occupational noise levels for work covered by this SSHP are not expected to exceed 85 dBA for an 8-hour TWA.

4.2 SITE WORKER TRAINING

Personnel on site must receive site-specific safety training. Signatures of those attending the training must be entered into project documentation prior to the individual performing field work. The site-specific training will include the following site-specific information, as appropriate:

- SSFL applicable training (Boeing);
- Names of site health and safety personnel and alternates;
- Contents of the project SSHP;
- Hazards and symptoms of contaminant exposure (chemical and radiological)
  - Names of contaminants
  - Exposure limits
  - Monitoring
  - Pregnancy concerns;

- Hazards and symptoms of chemicals used on site;
- Physical hazards in the workplace;
- Location and availability of hazard communication material (MSDSs);
- Site and task specific PPE including purpose, donning, doffing, and proper use;
- Safe work practices to minimize risks;
- Safe use of engineering controls and equipment;
- Medical surveillance requirements;
- Site control measures,
- Reporting requirements for spills and emergencies;
- Decontamination procedures to prevent the spread of chemical and radiological contamination;
- Contingency plans (e.g., communications, phone numbers, emergency exits, assembly point, etc.);
- Spill containment procedures (e.g., reporting, clean-up methods, etc.);
- Emergency equipment locations and use (e.g., fire extinguishers, spill kits, etc.); and
- Access to Medical and exposure records

Safety briefings will be held daily when field work is performed. These briefings will usually be conducted by the SSHO, the Field Manager, or a designee and will be attended by all applicable site workers and supervisors. These briefings will address site-specific safety issues and will be used as an opportunity to refresh workers on specific procedures and to address new hazards and controls. Safety briefings will be documented in logbooks or other appropriate format.

Understanding and awareness of applicable CDM Team HP and EC&HS procedures is accomplished through required reading of applicable documents and procedures. Program and procedural required reading is assigned by the SSHO and RPM in coordination with the Field Manager and is documented electronically.

4.3 SITE VISITOR TRAINING

All site visitors who will perform inspections or surveillance activities will receive a briefing specific to hazards and controls associated with their intended site tasks. The visitor briefing shall include, at a minimum:

- A review of site specific hazards and controls applicable to their intended task;
- Procedures applicable to the task; and
- The applicable requirements of this SSHP.

A site visitor requiring access to a controlled area must be escorted while in the controlled area. Specific training requirements outlined in Sections 4.0 to 4.2 may be waived if the visitor's task does not involve hands-on work (i.e., the task is an inspection or surveillance) and is no greater than 8 hours in duration.

Any site visitor requiring access to controlled areas to conduct hands on work or requiring greater than 8 hours access will be required to complete Site Worker Training and other applicable training as outlined in Sections 4.1 and 4.2. Site visitors are not allowed to enter Radiation Areas or Airborne Radioactivity Areas under any circumstance.

4.4 RADIATION CONTROL TECHNICIAN TRAINING

RCTs are required to complete appropriate radiation safety training prior to assuming responsibility for radiation safety activities. RCTs qualify to perform specific tasks through performance based training (Task Evaluation Standards [TES]) that is evaluated by a qualified trainer/evaluator for the task.

4.5 DOCUMENTATION

Documentation of the required training will be maintained by the SSHO. This documentation will include copies of 40-hour and 3-day OJT, 8-hour refresher, and supervisor training certificates, radiation worker training records, RCT training records, and copies of first aid/CPR certificates, as applicable. Electronic documentation of training certificates may be maintained on site in lieu of hard copies.

5.0 MEDICAL SURVEILLANCE

All employees performing on-site work who meet the requirements of 29 *CFR* 1910.120(f) or 1910.134(e) will be enrolled in a medical surveillance program as appropriate to assess and monitor the workers' health and fitness. Applicable employees are provided with summaries of medical examination results following each examination and are provided more detailed information upon written request. Documentation of medical clearance will be maintained by the SSHO. Electronic documentation of medical clearances may be maintained on site in lieu of hard copies.

The frequency of applicable employee medical exams shall be as follows:

- Prior to assignment;
- Once every 12 months for each employee covered unless the attending physician believes a shorter or longer interval (not to exceed 2 years) is appropriate;
- At termination of employment or reassignment to an area where the employee would not be covered, if the employee has performed field work since his/her last examination and has not had an examination within the last 6 months; and
- As soon as possible upon notification by an employee that he/she has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the permissible exposure limit (PEL) or published exposure levels in an emergency situation.

It is not likely that personnel involved with the tasks defined by this SSHP will be exposed to hazardous substances or health hazards at or above the established permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more per year. Therefore, it is not expected that personnel will require medical surveillance in accordance with 29 CFR 1910.120 or 1910.134.

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6.0 EXPOSURE MONITORING

Assessment of employee exposures will be performed, as appropriate, to ensure that exposures do not exceed acceptable levels. Action levels have been established for this monitoring. Exposure monitoring will depend on the activities being conducted and the potential exposures. Table 6-1 establishes minimum monitoring requirements for on-site work. Exposure monitoring requirements will be communicated through HSWPs and the SSHO or Field Manager.

Monitoring for radiological contamination will be conducted using radiation-monitoring equipment (RME). RME will be used in accordance with SAIC St. Louis Procedures:

HP-11, *Radiological Monitoring*, and
HP-30, *Radiological Instrumentation*

Air sampling will be conducted to determine the exposures of representative employees if direct-reading monitoring or other indicators suggest the potential for exposures greater than 10 percent of a derived air concentration (DAC). Entry into airborne contamination areas will require CDM-issued respirators. Bioassays will be taken if personnel enter contamination areas or airborne contamination areas. Exposure assessments will be reported as required in 10 CFR 835 and 29 CFR 1910.

Personnel involved with the tasks defined by this SSHP are likely to be exposed to external radiation at levels well below the DOE 5,000 mrem/y radiation worker limit and well below Boeing's 2,000 mrem/y administrative limit. Building 4024 (SETF) and the RMHF are posted radiological facilities and require Boeing issued dosimetry for entry. DOE requires dosimetry for anyone entering a radiation area (> 5 mrem/hr) or anyone expected to exceed 100 mrem/y.

The CDM Team has conducted noise monitoring of standard types of site equipment at previous projects and has established basic hearing protection requirements. It is not expected that hearing protection will be required.

Table 6-1. Monitoring Requirements and Action Limits

Hazard or Measured Parameter	Area	Interval	Limit	Action	Tasks
External ionizing radiation with TLDs or OSLDs.	Worn between waist and neck of employee	Boeing requires dosimetry when entering 4024 and the RMHF	When individuals are likely to receive 100 mrem /yr (external).	Notify RPM and SSHO. Additional controls may include engineering or administrative controls	Entry into radiological restricted areas when required.
External ionizing radiation with survey instrument.	Clean areas on a routine basis to verify background levels	Boeing requires dosimetry when entering 4024 and the RMHF	>2 mrem per hour (external).	Notify RPM and SSHO. Additional controls may include engineering or administrative controls	All on-site tasks as required by the RPM.
Radiological contamination with survey instrument. alpha & beta sensitive plastic scintillation /count rate system, or equivalent.	When personnel leave contaminated areas, when equipment is removed from contaminated areas, clean areas on a routine basis to verify non-contamination	Upon exit from contamination or potentially contaminated areas as determined by the RPM on HSWPs. At other intervals as determined by the RPM in accordance with procedures HP-11 and HP-12.	Radionuclide specific Surface Radioactivity Limits as determined by the RPM in accordance with procedure HP-03 "Radiological Limits" and Table 8-2.	Notify SSHO and RPM. Additional controls may include changes to PPE, decontamination procedures, or engineering controls	All on-site tasks as required by the RPM.
Sampling for airborne radionuclides	Breathing zone in areas of intrusive work.	Representative personnel and areas at job start and intermittently thereafter for personnel working in areas where air concentrations may exceed 10% of the DAC.	10 percent of DAC	Variables may include engineering, administrative, or personal protective measures. Known or suspected intakes may require bioassay sampling.	As required by the RPM on HSWPs.
Temperature	In or near work area	Periodic measurements when protective clothing is required in areas greater than 85 degrees	>85°F <40°F	Administrative controls (See Section 8.17)	All tasks
Removable surface contamination determined by smearing surface of 100cm^2.	All equipment and items removed from the restricted area and contaminated area.	Each exit	Surface Radioactivity Limits as outlined in Table 8-2 of this SSHP.	Remove by decontamination and resurvey. If contamination cannot be removed, control as radioactive material or dispose as radioactive waste.	Survey all equipment removed from contaminated and restricted areas

7.0 PERSONAL PROTECTIVE EQUIPMENT

PPE for site tasks is based on potential site-specific physical, radiological, and chemical hazards. In cases where multiple hazards are present, a combination of protective equipment will be selected so that adequate protection is provided for each hazard. This section emphasizes the programmatic requirements for PPE. Task-specific equipment is listed on the task specific HSWP. For more information on HSWPs see Section 8.3 of this SSHP.

7.1 PPE PROGRAM

The CDM Team's PPE program is controlled by EC&HS Procedure 13, HP Procedure 5, and 29 *CFR* 1910, Subpart I, Personal Protective Equipment. The level of protection and types of materials selected for a particular task are based on the following:

- Potential for exposure due to activity;
- Activity duration;
- Route of exposure;
- Measured or anticipated concentration in the medium of concern;
- Toxicity, reactivity, or other measure of adverse effect; and
- Potential for physical hazards such as falling objects, flying projectiles, etc.

In situations where the type of contaminant and probability of contact are not known, the appropriate protection is selected based on the professional judgment of the SSHO until the hazards are further evaluated.

The SSHO may raise or lower the level of PPE worn by the teams, depending upon the site-specific hazards encountered in the field. If site conditions are such that the level of PPE is insufficient or work must be stopped, the Field Manager will take appropriate action immediately. Criteria indicating a possible need for reassessment of the PPE selection include the following:

- Commencement of an unplanned (hazard not previously assessed) work phase;
- Working in unplanned temperature extremes;
- Evidence of contamination such as discolored soil or unexpected elevated instrument readings near the soil;
- Exceeding the action limits of chemical or radiological hazards; or
- Changing the work scope so that the degree of contact with contaminants changes.

Use of respiratory protection is not anticipated. However, should respiratory protection (Level C) become necessary, EC&HS Procedure 9, Respiratory Protection, and HP Procedure 6 will be implemented. As a minimum, this will require that respirator users have current training, fit tests and medical clearance for respirator use. Workers will wear only the type and size respirator for which they have been fit tested. The SSHO will provide site-specific respirator training to ensure that workers understand proper respirator use.

7.2 TYPES OF EQUIPMENT

This section presents the types of protective clothing that may be used for the project. Requirements for task-specific levels of protective clothing are presented in the Activity Hazard

Analysis located in Section 3.1 of this SSHP and/or the task specific HSWP. At a minimum, all building survey activities will require Level D protective equipment. Levels of protection that may be used to protect against chemical, radiological and physical hazards at this site include:

- Level C Protective Equipment
  - Full-face respirator and air purifying cartridges capable of filtering out organic vapors, acid gases, and radionuclides
  - Hooded chemical-resistant clothing (Polyethylene-coated Tyvek® or equivalent) with all openings taped
  - Two pair chemical-resistant gloves (nitrile and non-latex exam gloves)
  - Safety boots (ANSI Z41)
  - Shoe covers
  - Hard hat (ANSI Z89.1) if dropping or overhead hazards are present
- Modified Level D Protective Equipment (may vary depending on activity specific hazards)
  - Tyvek® or equivalent coveralls with openings taped closed, as applicable
  - Nitrile or polyvinyl chloride (PVC) gloves
  - Safety boots (ANSI Z41)
  - Disposable boot covers
  - Hard hat (ANSI Z89.1) if dropping or overhead hazards are present
  - Safety glasses with side shields (ANSI Z87.1)
  - Splash goggles or face shield (if splash hazard for eye or face/skin is present)
- Level D Protective Equipment
  - Coveralls/field clothes
  - Reflective safety vest (near active roadways/traffic)
  - Snake gaiters
  - Safety boots (ANSI Z41)
  - Safety glasses with side shields (ANSI Z87.1)
  - Hard hat (ANSI Z89.1) if dropping or overhead hazards are present
  - Leather or similar work gloves if sharp or abrasive materials are handled

7.3 CLEANING, STORAGE, AND PROGRAM VERIFICATION

If site tasks require the use of protective clothing, disposable clothing will be used in most cases. Disposable PPE that is determined to be contaminated will be properly disposed to preclude any reuse. Unused protective clothing will be stored in clean staging areas until needed. The SSHO will verify that the PPE in use is appropriate and is being used properly.

8.0 STANDARD OPERATING SAFETY PROCEDURES

This section presents the general safety rules that apply to all operations performed by the CDM team and its subcontractors. The provisions of the plan are mandatory for all on-site employees and visitors. This includes employees engaged in initial site reconnaissance, preliminary field investigations, mobilization, project operations, and demobilization.

8.1 SITE RULES

The following rules apply to all site activities:

- Personnel will follow site-specific requirements listed in Boeing's *Service Provider Manual*
- Daily safety briefings ("tailgate") will be conducted by the Field Manager, SSHO, or designee to inform personnel of new hazards or procedures;
- The SSHO, Field Manager, and project personnel are responsible to suspend/ stop work and require all personnel to evacuate the affected area if any of the following situations occur:
  - Inadequate health and safety precautions on the part of any on-site personnel, and
  - Potential significant exposure as a result of planned or unplanned activities;
- Personnel will perform only those tasks that they believe they can do safely;
- Personnel will notify the SSHO of any medical conditions (e.g., allergy to poison ivy or bee stings, diabetes, and pregnancy) that require special consideration;
- Personnel will maintain proper workplace housekeeping to minimize the potential for trips and other accidents;
- Contact with potentially contaminated substances will be avoided unless appropriate PPE is worn;
- Spills will be prevented to the greatest extent possible. In the event that a spill occurs, the spilled material will be contained to the extent possible;
- Eating, drinking, smoking, chewing gum or tobacco and other practices that increase the probability of hand-to-mouth transfer are prohibited in contaminated and potentially contaminated areas;
- Workers should wash their hands and faces upon leaving the work area and prior to eating or drinking;
- All injuries and accidents will be reported to the SSHO and/or Field Manager in accordance with EC&HS 4.1; and
- All fieldwork will be performed using the buddy system. Members of a buddy team will maintain verbal or visual contact. Verbal contact may be maintained by the use of a communication device.

8.2 PERMIT REQUIREMENTS

All permits necessary for the safe execution of this project will be obtained prior to performing the work requiring the permit. At a minimum, all intrusive activities will be preceded by an investigation to preclude encountering sub-surface utilities. Project personnel will coordinate with Boeing and comply with all site requirements for intrusive activities.

8.3 HEALTH AND SAFETY WORK PERMITS (HSWPS)

HSWPs will be generated and followed by all personnel entering radiologically restricted areas.

8.3.1 Development

The HSWP communicates the hazards and actions to be taken to mitigate the hazards for performance of specific work.

HSWPs are required and shall be used in accordance with Procedure HP-21. The HSWP shall follow the applicable provisions of this SSHP, applicable Occupational Safety and Health Administration (OSHA), applicable SSFL HASP and RPP, and any special safety, health, and environmental protective measures, based on chosen work methods. All HSWPs and their revisions shall be reviewed by the SSHO and approved by the RPM, or designees.

HSWPs can be designated as routine or special. A routine HSWP is used to control tasks and activities of a repetitive nature with general radiological, industrial, or occupational concerns that are reasonably expected to not change, and may be approved for up to one year. A special HSWP is used to control non-repetitive tasks with increased significance for industrial/occupational safety concerns or with the potential for significant exposure to radiation or radioactive material. Special HSWPs remain active only for the estimated duration of the job and are terminated at completion of the activity.

8.3.2 Implementation

The original approved HSWP shall be transmitted to the SSHO for retention in the HSWP package. A copy of the HSWP and all pre-job briefing forms shall be present on site.

In order to provide for safety awareness at the worker level, the Project SSHO or designee shall review the HSWP with the work crew prior to the start of work on the first day of the activity. The review meeting shall include the following topics, as applicable: (1) scope of work being performed; (2) hazardous conditions of the workplace and controls; (3) procedural and HSWP requirements; (4) limiting condition that may void the HSWP or attached permits; (5) hold points; (6) communication and coordination with other work groups; (7) provisions for housekeeping and final cleanup; and (8) emergency response and evacuation planning, as applicable. All workers and supervisors directly participating in the job shall attend the briefing. Following the review, all participants shall sign and date the pre-job briefing form or equivalent (e.g., logbook).

8.3.3 Revision

HSWPs may be revised in the field during work activities upon notification of, and approval from the Project RPM or designee in conjunction with the SSHO. Approval for a pen and ink changes will be written. Members of project work crews, subcontractor crews, and field supervisors shall re-sign the HSWP indicating that they have read, understand, and will comply with the HSWP revision.

Should conditions/concerns change while working under a HSWP, work shall stop until the conditions can be evaluated by the Field Manager and/or SSHO to determine if a revision to the HSWP is required to address the change. If the HSWP requires revision, then all personnel listed on the original HSWP shall be informed of the change and shall attend an HSWP review conducted by the Project SSHO or designee prior to the start of work on the first day that they conduct work under the revised HSWP.

8.3.4 Exemptions

Work activities that generally do not require an HSWP include:

- Office work, site tours outside restricted areas, administrative support, work area inspections/surveillances,
- General housekeeping when no PPE other than standard safety apparel (hard hat and safety glasses) is required, and
- Building surveys in unrestricted areas of SSFL.

All emergency response activities performed by project employees and off-site personnel may bypass HSWP requirements. These activities may include fire response, medical emergency response, or natural disaster response. After the immediate emergency response activities are completed, HSWP paperwork will be filled in for completion of the response.

8.4 DRUM/CONTAINER HANDLING

Sampling of drums is not expected.

8.5 CONFINED SPACE ENTRY

Entry into confined spaces is not expected. However, any confined space entry will be performed in conformance with the requirements of SAIC EC&HS Procedure 10, SSFL requirements, and *29 CFR 1910.146*.

8.6 HOT WORK, SOURCES OF IGNITION, FIRE PROTECTION

Hot work is not expected for this project. However, any hot work will be performed in conformance with SSFL requirements and *29 CFR 1910, Subpart J*.

- Sources of ignition will be kept at least 15 meters from flammable storage areas.
- Flammables storage areas will be posted with signs indicating “No smoking or open flame.”
- At least one fire extinguisher of appropriate size and type will be kept 8 to 23 meters from all flammables storage areas.
- An approved flammable cabinet will be used to store 25 gallons or more of flammable liquid.
- Flammable liquids (other than decontamination solvents) will be kept in an approved safety containers with flame arresters.

8.7 ELECTRICAL SAFETY

Working with electricity is not expected. However, working with electricity will be conducted in conformance with 29 *CFR* 1910, Subpart S.

8.8 EXCAVATION AND TRENCH SAFETY

Excavation and trenching are not expected as part of this project. However, if conducted, trench excavation will be conducted in conformance with 29 *CFR* 1926, Subpart P -Excavations.

8.9 MACHINE GUARDING

All equipment will be operated with all guards provided by the manufacturer and in compliance with *29 CFR 1910,* Subpart O. If any guarding must be removed for servicing, the equipment will be disabled and locked out, as appropriate, to preclude movement or release of energy.

8.10 LOCKOUT/TAGOUT

Servicing or maintenance on a system where the unexpected energizing, start-up, or release of kinetic or stored energy could cause injury or damage will be isolated in accordance with EC&HS Procedure 11, *Lock Out/Tag Out* and 29 *CFR* 1910.147. Authorized personnel shall perform Lockout/Tagout. All employees affected by a lockout/Tagout shall be notified before and upon completion of the Lockout/Tagout activity.

8.11 FALL PROTECTION

Work areas with the potential for a fall of 6 feet or more will be provided with fall protection in compliance with *29 CFR 1926,* Subpart M. This fall protection will consist of guardrails, personal fall protection, or equivalent. Personal fall protection will be used if it is necessary for personnel to access areas with the potential for a fall of 6 feet or more (e.g., sheer cliffs, etc.). If fall protection is required, a competent person will be designated to inspect the fall protection system and ensure the requirements of EC&HS 170, *Fall Protection* are implemented appropriately.

For the building survey, it is anticipated that personnel may need to access facility areas that are located overhead and may require the use of ladders. Therefore, personnel using ladders will be trained in the proper use and safety of ladders.

8.12 HAZARD COMMUNICATION

EC&HS Procedure 8, *Hazard Communication*, and *29 CFR 1910.1200* will govern the hazard communication program for the gamma walkover survey. At a minimum, the following steps will be taken.

- MSDS evaluations will be reviewed prior to bringing a new chemical on-site for personal protection and waste management issues. Copies of the MSDSs will be submitted to SSFL.
- All hazardous materials on site will be labeled to comply with the *29 CFR 1910.1200*. Labeling shall include;
  - Clear labeling as to the contents,

  - The appropriate hazard warning, and
  - The name and address of the manufacturer.

- MSDSs will be available on site for all hazardous materials that are present.
- A current inventory of hazardous chemicals on site will be maintained in locations where MSDSs are stored.
- Site-specific training will include the hazards posed by site contaminants and chemicals, methods and observations that may be used to detect the presence or release of a chemical, their location and concentrations, protective measures, work practices, PPE to be used, and emergency procedures.
- Copies of MSDSs for all hazardous chemicals (chemicals brought on site) will be maintained in the work area. MSDSs will be available to all employees for review.

8.13 ILLUMINATION

Site fieldwork will be conducted indoors. Temporary lighting will be used as necessary to ensure adequate illumination intensities in all work areas.

8.14 SANITATION

Sanitation requirements for drinking water, toilets, and washing facilities will be in conformance with 29 CFR 1926.51. Fieldwork that is conducted under temporary conditions will allow field workers to have transportation readily available to toilet facilities. Applicable requirements include:

- Means for washing hands and faces prior to eating will be provided at the work site.
- An adequate supply of drinking water will be provided in labeled, sanitary dispensers. Fluids shall be made readily available during hot weather in accordance with Section 8.17.1.

Temporary sleeping quarters and shower/change rooms are not anticipated for this project.

8.15 HOUSEKEEPING

Work areas and means of access shall be maintained safe and orderly. General housekeeping practices are noted below:

- Means for washing hands and faces prior to eating will be provided at the work site;
- Work areas shall be kept clean to the extent that the nature of work allows;
- Work and storage area floors should be kept dry and in good condition to the extent that the nature of the work allows (e.g. not slippery or cracked, no tripping hazards, etc.);
- All field equipment shall be picked up and organized upon completion of work and/or at the end of the day;
- Emergency information is posted at the work site;
- Fire extinguishers accessible, free from obstruction and easily visible;

- Lighting is adequate; and
- When tasks require it, keep emergency eyewash accessible, free from obstruction, and easily visible.

8.16 DRILL RIG OPERATIONS

Drill rig operations are not expected to be conducted as part of the pavement coring and any associated soil sampling. If drill rig operations become necessary then an addendum to the HASP will be developed to address associated hazards.

8.17 HEAT/COLD STRESS

8.17.1 Heat Stress

Important factors in preventing heat stress induced illnesses are acclimatization, consumption of copious quantities of fluids, and appropriate work/rest cycles. General controls will consist of making fluids readily available, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas as necessary. The following specific steps will be taken to reduce the potential for heat stress induced illness.

- If ambient temperatures are forecast to exceed 85^{o}F, heat stress topics will be covered in pre-job briefings that include heat stress control (shifting work schedules to avoid working in the hottest part of the day, shade and use of air conditioned vehicles or buildings for cooling), recognition of heat stress induced illness, first aid for heat stress and use of emergency response plan for heat induced illnesses;
- If ambient temperatures exceed 85^{o}F, a cool drink will be made conveniently available to site workers (field lead is to make sure that there is enough for 1 quart per employee per hour);
- If ambient temperatures exceed 85^{o}F, workers will be instructed to monitor their own and their buddy's condition relative to heat stress and to drink plenty of water throughout the day;
- Workers will be allowed to take unscheduled breaks, as needed; and
- Workers wearing Tyvek® or other impermeable clothing when ambient temperatures exceed 85^{o}F should be monitored for heat stress by taking their pulses at the beginning of each rest period. If any worker's heart rate exceeds 110 beats per minute and their body temperature exceeds 100.4°F after a rest period, further controls shall be implemented.

8.17.2 Cold Stress

Critical factors in preventing cold stress disorders are adequate clothing and staying dry. The SSHO will ensure the capability to quickly move individuals who become wet to a sheltered, warm area. The following specific steps will be taken:

- If ambient temperatures are less than 40°F, site training will include prevention of cold injury, cold injury symptoms, and cold injury first aid;
- A heated break area will be readily available during cold weather periods (<32°F). A heated vehicle may be used for this purpose;

- Workers will be allowed to take unscheduled breaks, if needed, in a warm area; and
- The SSHO will determine if outdoor work should be performed if the equivalent chill temperature (temperature combined with the effect of wind) is less than –29° F.

8.18 IONIZING RADIATION

All work involving ionizing radiation will be performed in compliance with applicable Health Physics procedures. The guiding philosophy will be to keep exposures as low as reasonably achievable (ALARA).

8.18.1 Exposure Limits

Table 8-1 presents exposure limits as they apply to this project.

Table 8-1. Radiation Exposure Limits

Effected Individual	Period	Effected Organ[b]	Control Levels (rem)	DOE Limits (rem)
Adult Radiation Worker	Annual	TEDE	1.5	5.0
Adult Radiation Worker	Annual	TODE	5.0	50
Adult Radiation Worker	Annual	Lens of the Eye	1.5	15
Adult Radiation Worker	Annual	SDE	5.0	50
Declared Pregnant Radiation Worker	Gestation Period	Fetus	0.5	0.5
Employee[a]/Public	Annual	TEDE	0.1	0.1
Public Access Areas	Hour	TEDE	0.002	0.002

[a] Applies to all employees not qualified as radiation workers.

[b] The abbreviations are summarized below:

TEDE: Total effective dose equivalent: The sum of the deep dose equivalent (DDE) and committed dose equivalent (CEDE)..

TODE: Total organ dose equivalent: The sum of the DDE and the committed dose equivalent (CDE) to any individual organ or tissue other than the lens of the eye.

SDE: Shallow-Dose Equivalent to the skin or any extremity.

It is not expected that any individual working on this project will exceed 500 mrem per year from radiation sources external to the body. The RPM will evaluate site dose rates to ensure this expectation does not change.

It is not expected that any individual working on this project will exceed 500 mrem per year from intakes of radioactive material into the body; therefore internal monitoring will not be required unless entry is made to contamination areas or airborne contamination areas. The RPM may choose to conduct monitoring to provide negative data.

Personnel working under this SSHP will be required to participate in SSFL's external monitoring program and may be required to participate in SSFL's internal monitoring programs.

8.18.2 Surface Radioactivity Limits

Building Preliminary Remediation Goals (BPRGs) have been established in the survey plan. Table 8-2 presents contamination limits for equipment and materials as they apply to this project.

Table 8-2. Surface Contamination Levels

Condition[a]	Alpha (dpm α/100 cm^2)			Beta (dpm α/100 cm^2)		
	Average[b,c]	Maximum[b,d]	Removable[b,e]	Average[b,c]	Maximum[b,d]	Removable[b,e]
Potentially contaminated materials / equipment requiring an unrestricted release survey.	100	300	20	5000	15,000	1000

[a] Values in this table were taken from 10 CFR 835 and DOE Order 5400.5 and apply specifically to the SSFL facility.

[b] As used in this table, dpm (disintegration's per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

8.18.3 General Requirements

Employees likely to exceed a radiation dose from external sources of 100 mrem/yr will wear thermo-luminescent dosimeters (TLDs) analyzed under a program meeting the National Voluntary Laboratory Accreditation Program (NVLAP) program. Boeing provides dosimetry support for entry to Building 4024 or RMHF.

Employees in contaminated areas will be monitored for contamination before leaving the controlled area. In areas where personnel contamination is unlikely, the employee may perform this monitoring (self-monitoring). Any detected personnel contamination will immediately be reported to an RCT. In areas where contamination is probable, this monitoring must be performed by an RCT. Any detectable contamination will require decontamination to levels indistinguishable from background following established procedures.

Instruments and equipment used inside radiological contaminated areas will be surveyed prior to release from the area. This survey will be performed by a qualified Senior RCT.

All radiation meters will be calibrated annually and will be checked against a known source prior to each day of use. The results of source checks will be maintained on site.

Radiological restricted areas will be identified and posted in accordance with DOE requirements as delineated in SAIC Procedure HP-20.

8.19 INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT

Regular trash will be disposed of in appropriate receptacles according to site rules. In the unlikely event that IDW is generated, it will be packaged, marked and stored in a Boeing designated area pending disposal. If coring is required it will be performed in accordance with a site-specific HSWP which will be coordinated with the Radiation Protection Manager and the Health and Safety Manager for concurrence prior to initiation of work.

8.20 BIOLOGICAL HAZARDS

Environmental biological hazards which may be present at the site include tickborne diseases, stinging and biting insects, vermin and wild animals, snakes, and poisonous plants. Tickborne diseases include Lyme Disease and Rocky Mountain Spotted Fever. Stinging and biting insects include spiders, mosquitoes, bees, and wasps. Poisonous plants include poison oak. Protection against biological hazards may include, as applicable, the following measures.

- PPE such as long sleeve shirts, gloves, leather safety boots, netting, snake gaiters, and masks (i.e. dust masks)
- Repellents (DEET containing)
- Barrier creams
- Instructions in recognition and identification of the harmful plants, animals, and insects

8.20.1 Ticks

For outdoor work, clothing should be inspected frequently when in a tick habitat. The head and body should be inspected thoroughly upon leaving the field. Not all ticks are infected with the bacterium which causes Lyme Disease and Rocky Mountain Spotted Fever. Removal of ticks is best accomplished using small tweezers. The ticks' body should not be squeezed. The tick should be saved in a jar labeled with the date, body location of the bite, and the place where it may have been acquired. The bite area should be cleaned with antiseptic and medical attention should be sought as soon as possible. Lyme disease typically occurs in the summer months and is characterized by a slowly expanding red rash, which develops a few days to a few weeks after the bite of an infected tick. This may be accompanied by flu-like symptoms along with headache, stiff neck, fever, muscle aches, and/or a general malaise. Medical treatment at this stage is critical, as these early symptoms may disappear and more serious problems may follow. Rocky Mountain Spotted Fever is transmitted by the Dog Tick which is larger than the Deer Tick which transmits Lyme Disease. Rocky Mountain Spotted Fever usually occurs in the spring or summer. Infection generally manifests itself several days after exposure. The onset of the illness is abrupt and often accompanied by high fever, headache, chills, and severe weakness. Early detection and treatment significantly reduces the severity of illness.

8.20.2 Stinging Insects

For minor bites and stings from insects, first swipe skin with credit card or similar to remove stinger, clean the area and then apply a cold pack to the affected area. Later apply soothing lotions such as calamine/caladryl. If a worker has a history of allergic reactions (anaphylaxis) to insect bites, the worker should consult with their physician and carry an "epi-pen" (epinephrine shot) with them in the field and instruct fellow workers to assist them in using it. The SSHO must be notified whenever a worker has a potential reaction to stinging insects and the location of their epi-pen or equivalent. If the victim is displaying signs of anaphylaxis or is subject to attacks of hay fever or asthma seek immediate medical assistance.

8.20.3 Vermin and Snakes

Contact with vermin and wild animals should be avoided. Be alert to the possible presence of vermin and wild animals particularly when working in brushy and wooded areas. Be observant to the possible presence of snakes in wooded and brushy areas. Most snakes will escape rather than

attack when confronted. A snake bite is usually characterized by extreme pain and swelling at the site of the bite. The manifestations of the bite include general weakness, rapid pulse, nausea and vomiting, shortness of breath, dimness of vision, tingling or numbness of the tongue, mouth and scalp, and shock. Medical assistance should be sought immediately. Due to the potential presence of rattlesnakes on site, all personnel will wear "Snake Gaiters". If bitten by a rattlesnake, call 911 from a site phone or 818-466-8911 from a cell phone immediately.

First aid measures involve calming the victim, immobilization in a horizontal position so that the bitten body part is at or below the heart level. The victim should not walk, run, or take alcoholic beverages or stimulants. The victim should not be given aspirin. If the snake can be killed or captured without risk or delay, it should be transported to the hospital for identification. The bitten area may be washed with soap and water and blotted dry with sterile gauze.

8.20.4 Poisonous Plants

The majority of reactions following contact with poisonous plants involve allergic reactions characterized by headache and fever, itching, redness, and a rash. The most distinctive feature of poison oak is its leaves which are composed of three leaflets each. Poison oak has greenish white flowers and berries that grow in clusters. Contact can result in a severe rash, characterized by redness, blisters, swelling, and intense burning and itching. The victim can also develop a high fever and become very ill. Usually the rash will begin a few hours after exposure, but it has been known to be delayed for 24 to 48 hours. Lack of a reaction to these plants upon contact does not guarantee that future contact will also result in no reaction. When working in areas with poison oak, workers should wear long sleeved shirts and pants, gloves and boots. When working with a weed eater or when facial contact is of a concern, the use of a clear plastic hooded shield should be considered.

Use of barrier creams are effective but require frequent application and may be rubbed and perspired off. Clothing which has come in contact with poisonous plants should be washed after each wearing with soap and water. Gloves, boots, and equipment should be sprayed with water and allowed to sit overnight. Water and air exposure breaks down the plant oil rendering it harmless. Employees should be careful when removing and donning contaminated gloves and clothing during the day and should be careful of wiping the face with contaminated gloves and clothing. Employees should wash their hands with soap and water after handling the outside of exposed clothes and gloves. If a rash develops, apply a soothing lotion such as calamine lotion. If a more severe reaction develops or if there is a known history of sensitivity, seek medical attention

8.21 NOISE

Noise levels greater than 85 dBA (8-hr TWA) are not expected for activities covered by this project. However, if required, an effective hearing conservation program as described in 29 CFR 1910.95 shall be administered to minimize potential exposures to loud noise. The hearing conservation program shall be administered in accordance with EC&HS 15 "Hearing Conservation and Noise Control". EC&HS 15 focuses on minimizing and monitoring employees exposure to noise using engineering controls, audiometric testing, training, and hearing protectors.

9.0 SITE CONTROL MEASURES

The Field Manager, SSHO, and/or RPM will be responsible for establishing the site control zones, as necessary, around project controlled areas that present physical, radiological, and/or chemical hazards. Implementation of the site control zones will help to minimize the number of employees potentially exposed and to minimize the potential for the spread of contamination. RCTs will monitor the implementation of the required site control work rules and will report any deviations from prescribed practice to the SSHO or stop work, as appropriate.

Due to the nature of building surveys, site control zones will normally move with the equipment/personnel. Personnel implementing building surveys will need to be aware of other site activities that are occurring and be in communication with those personnel to ensure that work zones are controlled appropriately. Project personnel will attempt to exclude all unauthorized personnel (members of the public, etc.) from work areas where there are radiological, health, or safety hazards. If unauthorized personnel enter a project controlled area and refuse to leave, work will be stopped and the contract coordinator will be notified.

Field personnel will be capable of contacting other field personnel and outside agencies. Hand-held radio or cell phones may be used for onsite communication. However, due to the limited size of the site, verbal and or visual communication may be used as well.

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10.0 PERSONAL HYGIENE AND DECONTAMINATION

If personnel or equipment are determined to be contaminated, the following sections will apply.

10.1 PERSONNEL DECONTAMINATION

SAIC HP procedures will be used to control the spread of contamination and to ensure that workers are free of contamination. PPE doffing and personnel decontamination are part of this system. The doffing of PPE will normally be the only decontamination effort necessary. Further decontamination will only be necessary if the results of contamination surveys indicate contamination on personnel skin or personal clothing. Radiological decontamination will be performed in accordance with Procedure HP-10, *Personnel and Equipment Decontamination*. The doffing of PPE will be conducted in accordance with RCT direction and/or the applicable HSWP.

10.2 EQUIPMENT DECONTAMINATION

All potentially contaminated equipment will be decontaminated in accordance with Procedure HP-10, *Personnel & Equipment Decontamination.* Specific decontamination requirements are outlined in task specific work-descriptions (e.g., Sampling and Analysis Plan, HSWP, etc.)

Following decontamination, all potentially radiologically contaminated equipment shall be surveyed by a Senior RCT if it is intended that the equipment is to be released for unrestricted use (decontamination between samples does not require a survey). If fixed or loose contamination is found, release of the equipment will be evaluated by the RPM. Equipment leaving the site for unrestricted use must have no contamination that exceeds the levels listed in Section 8.18.2. Results of contamination surveys shall be documented.

A decontamination area may need to be constructed to minimize the spread of contamination and to collect decontamination liquid/material.

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11.0 EMERGENCY PROCEDURES AND EQUIPMENT

All personnel will follow site requirements during emergency activities. The SSHO will also escort or assign an escort to off-site emergency responders as needed. In order to minimize the potential for accidents and injuries, project personnel will conduct worksite inspections in areas where CDM Team activities are being conducted. If an emergency occurs, the Field Manager and SSHO will participate in a post-emergency briefing to discuss the event, identify the causes, identify corrective measures, and evaluate the responses.

In the event of an accident or incident, the SSHO, Field Manager, or Program Manager will notify the contract coordinator.

All accidents will be investigated and reported in accordance with EC&HS Procedure 4.1, *Accident Reporting*. Drug screening may be performed as determined by SSHO.

All personnel working on site will be trained in the requirements of this section. This will include recognizing emergencies, reporting emergencies to the SSHO, and responding to emergencies. Employees will also be informed of any changes in potential emergencies or response plans.

Note: Project personnel are not trained to respond to emergencies other than fighting minor fires in their incipient stages, containment and cleanup of minor spills, and evacuation to a safe location to contact project management and emergency services.

11.1 INCIDENT REPORTING

Field personnel are responsible for immediate reporting to the SSHO of any event that may adversely impact personnel, the environment, or that may cause equipment damage, regardless of the severity. All "near misses" must also be reported. A "near miss" is an event that did not, but had the potential to, cause injury or damage.

It is the responsibility of the Field Manager and SSHO to investigate all injuries, property damage, environmental events, and near misses. The primary purpose of reporting accidents and incident investigations is to prevent recurrence of such events.

An accident report will be completed and submitted to the contract coordinator in accordance with site requirements.

11.2 POTENTIAL EMERGENCIES

Credible potential emergencies for this project include fires, minor chemical spills, and personnel injury including heat illnesses.

11.2.1 Fires

Small quantities of flammable solvents (typically less than 10 gallons gasoline) may be present on site. Additionally, vehicle/ATV engines and exhaust systems may have the potential to start brush on fire. Do not park vehicles on dry grass. In the event of a fire, Boeing Security will be notified immediately. If it is safe to do so, on-site personnel may attempt to extinguish minor, incipient fires with the available fire extinguishers and isolate any nearby flammable materials. If there is any doubt about the safety of extinguishing the fire, site personnel will evacuate the area.

The supervisor or knowledgeable employee will provide the fire department with relevant information when they arrive.

11.2.2 Spills

Potential spills include releases of fuels. Fuels will be used in small quantities (e.g., rental vehicles). In light of the small quantities of liquids, it is not likely for site operations to generate a major spill. In the event of a spill or leak, the employee making the discovery will immediately notify the SSHO or Field Manager. The SSHO or Field Manager will assess the situation and take appropriate measures as follows.

For small quantities (most likely spill scenario), the field crew will use spill cleanup materials and containerize spilled material and other material such as soil that has become contaminated. Cleanup will be performed wearing PPE deemed necessary by the SSHO or Field Manager. For larger quantity spills, the SSHO will notify Boeing Security and initiate cleanup and control, if feasible, with available equipment. Cleanup will be performed wearing appropriate protective gear. If the spill cannot be resolved without undue danger (fire or similar hazard) to personnel, the area will be evacuated and the response turned over to local emergency response personnel.

All spills will be reported to the SSFL contract coordinator, Program Manager, and the Project Environmental Compliance Officer.

11.2.3 Medical Emergencies

In the event of a medical emergency, Boeing Security will be notified immediately. At least one first aid/CPR-trained individual will be on staff at all times. Contaminated injured personnel will be decontaminated to the extent feasible. Personnel with minor (non-life threatening) injuries will follow normal decontamination procedures (e.g., removal of PPE). Personnel with serious injuries will be decontaminated, if necessary, by disrobing and wrapping in a blanket. Decontamination may be bypassed in the event of life-threatening injuries or illnesses.

11.3 EMERGENCY PHONE NUMBERS

Emergency telephone numbers are listed below. A telephone will be present on site and available for use.

Boeing Security, Fire Protection and Emergency Medical Technicians	911 or from cell phone 818-466-8911
West Hills Medical Center, West Hills, CA	818-676-4100
Boeing Health, Safety, and Rad Manager (Phil Rutherford)	818-466-8840
Boeing H&S Supervisor (Bob Mako)	818-466-8735
Site Safety and Health Officer (Randy Hansen)	314-486-6916
Program Manager (Dawn Peterson)	702-839-5602
Radiation Control Manager (Dennis Chambers)	314-770-3068
Field Radiation Protection Manager (Mark Peterson)	314-581-7367

These telephone numbers will be posted on site. A hospital map is presented in Appendix A of this SSHP. This map includes written directions of the route to the hospital. It is recommended

that personnel with injuries requiring professional medical attention be transported to the hospital by ambulance.

11.4 EVACUATION

Personnel covered under this Site SSHP will be trained in the Site emergency procedures including, but not limited to, evacuation routes and assembly areas. All employees will be familiar with evacuation routes and assembly areas as indicated in Figure 11-1.

11.5 EMERGENCY EQUIPMENT

Several items of emergency equipment will be maintained at the work site. Any incident that is not clearly controllable by personnel wearing standard site clothing plus protective gloves and using the listed equipment will require reevaluation by the SSHO or Field Manager. If the SSHO or Field Manager does not feel that on-site personnel can safely control the emergency with the available equipment, the crew will use alternate approaches such as allowing a small fire to burn out or evacuating the site. The required emergency equipment includes:

- First aid kit indoors or in weatherproof container;
- Appropriate size and type fire extinguisher(s) 8 to 23 meters (25 feet to 75 feet) from outside flammables storage (or use) area;
- Appropriate fire extinguishers in the vicinity of fossil-fuel powered equipment;
- Basic spill cleanup materials suitable to handle small spills of decontamination fluids, hydraulic fluid, or fuels (e.g., absorbent pads, tubes, and nitrile or similar gloves); and
- Telephone for contact of emergency services and, depending on site conditions, portable radios for on-site communication.

Note: Project personnel are not trained to respond to emergencies other than fighting minor fires in their incipient stages, containment and cleanup of minor spills, and evacuation to a safe location to contact project management and emergency services.

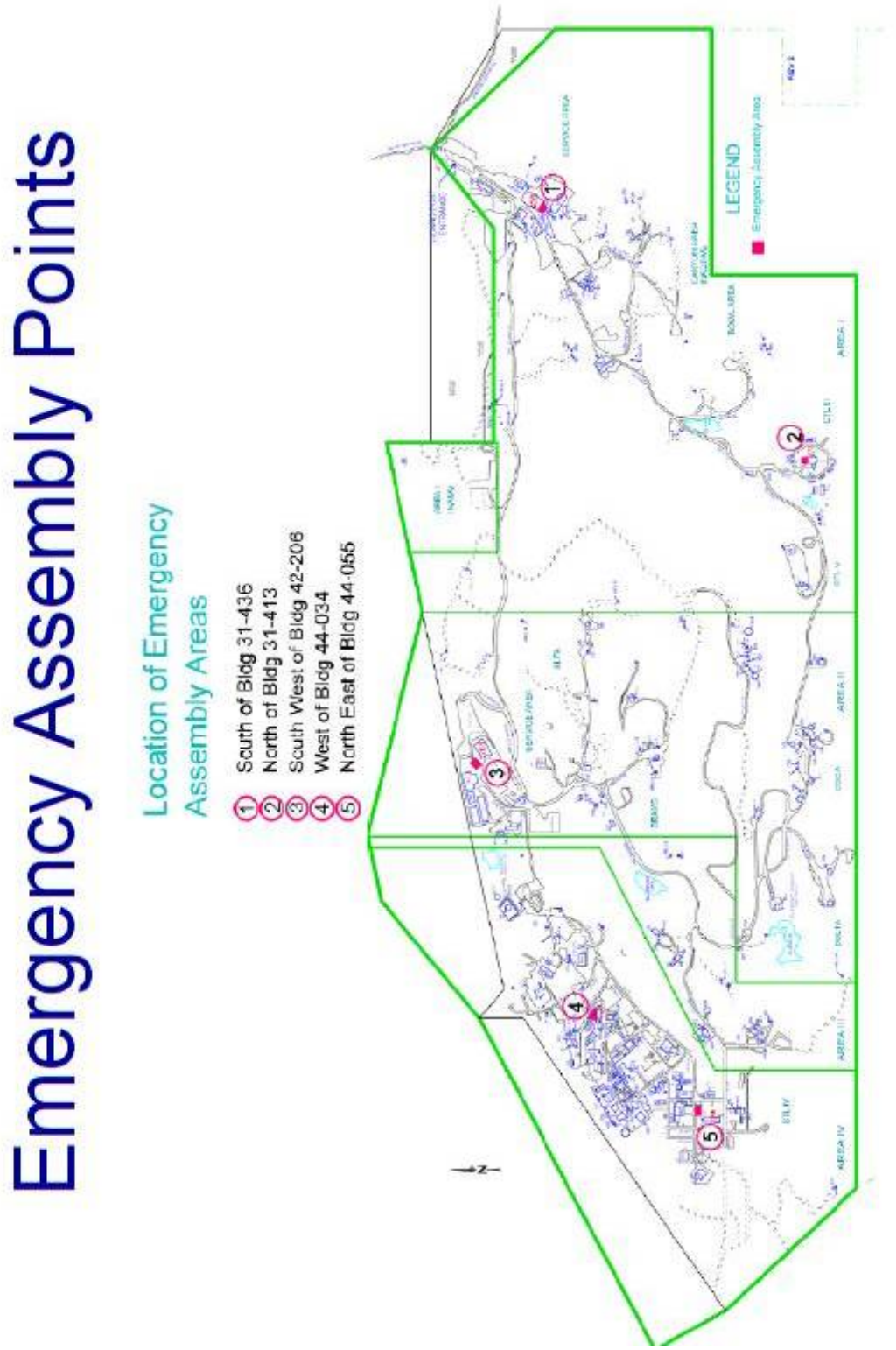

Figure 11-1. Evacuation Routes and Assembly Areas

12.0 LOGS, REPORTS, AND RECORD KEEPING

A system of reports and logs will be used to document activities related to site Health and Safety. These reports will include injuries, accidents, near accidents, interpretations of the SSHP or regulations, interactions with auditors, regulators, and any abnormal/unusual events. Some of the record keeping information, as applicable, is listed below. Electronic documentation may be kept on site in lieu of hard copies.

- Accident and injury reports for all accidents other than minor first aid cases;
- Training certificates;
- Records or logbooks detailing site training, topics covered, names and signatures of participants and trainer, general site activities, inspections, surveillances, site workers, H&S problems, and/or problem resolutions as appropriate;
- Medical clearance forms;
- Daily drilling safety inspection logs will contain the dates of inspections, identify the person doing the inspection, the examined areas/activities/equipment, any deficiencies, and any corrective actions taken (drilling safety inspection logs may be documented in a logbook);
- Related procedural forms such as personal decontamination and records of radiological surveys; and
- Records of environmental and personal exposure monitoring/sampling results will be maintained and will contain monitoring data, location and time of monitoring, types of work being done, calibration records, and the identities of personnel performing monitoring.

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13.0 REFERENCES

American Conference of Governmental Industrial Hygienists 1997, "*Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices"*.

U.S. Department of Energy, 10 CFR 835, *"Occupational Radiation Protection"*

U.S. Department of Energy, 10 CFR 851, *"Worker Safety and Health Protection Program"*

U.S. Department of Energy Order 458.1, *Radiation Protection of the Public and Environment*, 11 Feb 11.

National Institute for Occupational Safety and Health 1997, "*Pocket Guide to Chemical Hazards"*.

NIOSH/OSHA/USCG/EPA 1985. "*Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities"*, October.

OSHA 29 CFR 1910, "*Occupational Safety and Health Standards for General Industry", United States Department of Labor.*

Department of Energy, 10 CFR 835, "Occupational Radiation Protection."

National Fire Protection Association Standard – 10, *"Standard for Portable Fire Extinguishers"*.

American National Standard Institute, Z-89.1-1986, *"Protective Headwear for Industrial Workers-Requirements"*.

American National Standard Institute, Z-87.1-1989, "*Occupational and Educational Eye and Face Protection"*.

American National Standard Institute, Z-41.1-1991, *"Personnel Protection – Protective Footwear"*.

SAIC, 2007a. *SAIC St. Louis Health Physics Procedures*.

SAIC, 2007b. *St. Louis Environmental Compliance and Health and Safety (EC&HS) Procedures Manual*.

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ATTACHMENT 1

HOSPITAL LOCATION MAP

Route from SSFL to West Hills Medical Center

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Map to West Hills Hospital

7300 Medical Center Drive

West Hills, Ca. 91307

Emergency Services: (818)676-4999

- Exit Boeing SSFL onto Woolsey Canyon Road - head down the mountain.
- Turn **RIGHT** onto Valley Circle Blvd
- Turn **LEFT** onto Roscoe Blvd.
- Turn **RIGHT** onto Woodlake Ave
- Turn **LEFT** onto Medical Center Drive

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ATTACHMENT 2

SAIC ST. LOUIS HEALTH PHYSICS PROCEDURES

HP Procedures Referenced in this Document

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SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-03

REV. 1

RADIOLOGICAL LIMITS

APPROVED BY: ___ DATE: 12/11/02

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APPROVED BY:_____ DATE: 12/11/02

EC/HS Manager

APPROVED BY:_____ DATE:_____

QA/QC Officer

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1.0 Purpose

This procedure establishes the guidelines to determine site limits on surficial radiological contamination, individual dose, and the concentrations of radioactive material in air.

2.0 Scope

This procedure applies to all SAIC and subcontractor personnel at sites working under this SAIC radiation safety program.

3.0 References

3.1 10 CFR 20, "Standards for Protection Against Radiation"

3.2 ANSI 13.12 – 1999, "Surface and Volume Radioactivity Standards for Unrestricted Use"

3.3 HP-01, "Health Physics Manual"

3.4 HP-11, "Radiological Monitoring"

3.5 NRC Regulatory Guide 1.86, "Termination of Operating Licenses from Nuclear Reactors"

3.6 NUREG-1640, "Radiological Assessments for Unrestricted Release of Equipment and Materials from Nuclear Facilities" (Draft)

3.7 U.S. Army Corps of Engineers Manual No. EM 385-1-1, Section 06.E, "Ionizing Radiation"

3.8 U.S. Army Corps of Engineers Regulation No. ER 385-1-80, "Ionizing Radiation Safety"

4.0 Definitions

4.1 **Administrative Exposure Limit** – A limit established in order to stress individual responsibility for maintaining exposures as low as reasonably achievable (ALARA) and to assist in the prevention of any individual exceeding regulatory exposure limits.

4.2 **Committed Dose Equivalent (CDE)** – the dose equivalent to organs or other tissues that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

4.3 **Committed Effective Dose Equivalent (CEDE)** – the dose equivalent to the whole body that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

4.4 **Contamination** - The deposition of radioactive material on accessible surfaces of structures, objects, equipment, or personnel that exceeds site surficial release limits. Contamination may be either "fixed" (e.g., not removable by rubbing with a dry smear) or "removable". Total contamination refers to fixed plus removable contamination.

4.5 **Derived Air Concentration (DAC)** - The concentration of a given radionuclide in air which, if breathed by Reference Man for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 m^3 per hour) results in an intake of one Annual Limit on Intake (ALI).

4.6 **Declared Pregnant Woman** – a woman who has voluntarily informed the RPM, in writing, of her pregnancy and the estimated date of conception.

4.7 **Deep Dose Equivalent (DDE)** – external whole body dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

4.8 **Dose** – a generic term meaning absorbed dose, effective dose equivalent, committed effective dose equivalent (CEDE), total effective dose equivalent (TEDE), etc. as used in this procedure.

4.9 **Extremity** - Hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

4.10 **Lens (Eye) Dose Equivalent** – external exposure to the lens of the eye taken as the dose equivalent at a tissue depth of 0.3 cm (300 mg/cm^2).

4.11 **Exposure** – being exposed to ionizing radiation or to radioactive materials.

4.12 **Minimum Detectable Activity (MDA) -** The smallest amount of radioactivity that can be detected given the conditions of a specific sample.

4.13 **Shallow Dose Equivalent** – the dose equivalent at a tissue depth of .007 centimeter averaged over an area of 1 square centimeter when applied to the external exposure of the skin or an extremity.

4.14 **Total Effective Dose Equivalent (TEDE)** – the sum of the DDE and the CEDE.

4.15 **Total Organ Dose Equivalent (TODE)** – the sum of the DDE and CDE.

5.0 Responsibilities

5.1 The Radiation Protection Manager (RPM) shall:

5.1.1 Calculate or approve existing administrative and/or project limits, and document the limits on Attachment 2, or equivalent.

5.1.2 Post Attachment 2 (or equivalent) in an appropriate project work area as directed by the site RPM.

5.2 Health Physics Technicians (HPTs) shall:

5.2.1 Evaluate survey results against the project/site limits of Attachment 2, or equivalent.

6.0 Procedure

6.1 General Requirements

6.1.1 The following limits are project and site specific; administrative dose, surficial contamination, airborne DAC values, and personnel release. The RPM should use this procedure as a guideline to establish these limits.

6.1.2 Prior to the start of work, the RPM, or designee shall establish and/or calculate all applicable limits for a project or site, and document the limits on Attachment 2, "Site Limits", or equivalent. The RPM shall approve all site limits.

6.1.3 Supporting information, such as source term and calculations, shall be attached, and filed in health physics files.

6.1.4 Attachment 2 (or equivalent) shall be revised during the project when determined necessary by the RPM. A copy of the most current Attachment 2 (or equivalent) should be posted at the site in an appropriate project work area as determined by the RPM.

6.1.5 Alternatively, previously established limits may be adopted for use at client sites when; the limits are contained in an approved document, and the limits are approved by the RPM.

6.2 Dose Limits

6.2.1 Regulatory Dose Limits

6.2.1.1 Individual doses for occupational workers shall not exceed 5 rem TEDE or 50 rem TODE per calendar year, excluding medical and background radiation exposures.

6.2.1.2 Individual doses for visitors and members of the general public shall not exceed 0.1 rem TEDE per calendar year.

6.2.1.3 The total radiation dose to the unborn child of a declared pregnant female shall not exceed 0.5 rem TEDE for the duration of pregnancy.

6.2.1.4 Doses to the skin, the eye and the extremities shall not exceed 50 rem, 15 rem, and 50 rem, respectively.

6.2.2 Administrative Dose Limits

6.2.2.1 Unless otherwise documented for the site, individual doses for visitors or the general public should not exceed 0.05 rem TEDE per calendar year from site activities.

6.2.2.2 Unless otherwise documented for the site on Attachment 2 (or equivalent), the more limiting of the following administrative dose limits shall apply to individual doses for radiological workers:

6.2.2.2.1 TEDE limited to 0.5 rem/yr.

6.2.2.2.2 TODE limited to 5.0 rem/yr.

6.2.2.2.3 Eye Dose Equivalent limited to 1.5 rem/yr.

6.2.2.2.4 Shallow Dose Equivalent limited to 5 rem/yr.

6.2.2.2.5 Extremity Dose limited to 5 rem/yr.

6.2.2.2.6 Declared pregnant employees – 500 mrem for the entire gestation period. Declared pregnant females should be limited to exposure rates less than 50 mrem per month unless otherwise approved by the RPM.

6.2.2.2.7 Cumulative Lifetime Exposure Limit limited to 1 rem per year of age.

6.2.2.3 Approval by the RSO is required for any employee to exceed an administrative dose limit, and shall be documented in the employee's exposure record.

6.2.2.4 Alternate site specific administrative dose limits may be established by the RPM with written approval from the RSO, as documented on Attachment 2, or equivalent.

6.3 Surficial Contamination Limits

6.3.1 The RPM shall provide HPTs with project or site-specific surficial contamination limits on Attachment 2, or equivalent.

6.3.2 Using site characterization data, surficial contamination limits may be derived using Regulatory Guide 1.86 guidance, as presented in Attachment 1, "Regulatory Guide 1.86 Surface Contamination Limits" (or equivalent). Column 1 (Average) values should be used for total activity. Column 3 "Removable" values should be used for removable activity.

6.3.3 Surficial contamination limits may be derived by using the most conservative radionuclide present, or by weighting the radionuclides using the following equation:

$$\text{Weighted Limit (dpm/100cm}^2\text{)} = \frac{1}{F_1/\text{Limit}_1 + F_2/\text{Limit}_2 + F_3/\text{Limit}_3}$$

Where:

F = The fractional abundance of the radionuclide ($\geq$1% abundance)

Limit = The radionuclide surficial contamination limit.

6.3.4 Alternate means of deriving project or site surficial contamination limit may be established by the RPM.

6.4 Derived Air Concentration and Air Effluent Values

6.4.1 The RPM shall provide HPTs with project or site -specific DAC values on Attachment 2, or equivalent.

6.4.2 Using site characterization data, effective DAC values may be derived using the DAC values specified in 10 CFR 20 Appendix B, Table 1, Column 3.

6.4.3 Using site characterization data, effective air effluent concentration (AE) values may be derived using the AE values specified in 10 CFR 20 Appendix B, Table 2, Column 1.

6.4.4 DAC or AE values may be derived by using the most conservative radionuclide present, or by weighting the radionuclides using the following equation:

$$\text{Weighted DAC or AE } (\mu Ci/ml) = \frac{1}{F_1/DAC_1 + F_2/DAC_2 + F_3/DAC_3}$$

Where:

F = The fractional abundance of the radionuclide ($\geq$1% abundance)

DAC = The radionuclide 10 CFR 20 Appendix B DAC or AE value

6.4.5 Alternate means of deriving site DAC or AE values may be established by the RPM, as documented in the SSHP, technical work record (TWR), or equivalent document.

6.4.6 In conjunction with establishing site-specific DAC & AE values, the RPM, or designee, shall provide site-specific minimum air sample volumes on Attachment 2 that are based on the established DAC & AE values.

6.5 Personnel Release Limits

6.5.1 The RPM shall provide HPTs with site-specific total (direct frisk) personnel contamination limits on Attachment 2, or equivalent.

6.5.2 Personnel contamination release criteria should be calculated from the MDA of personnel release detection equipment, in accordance with HP-11, “Radiological Monitoring” Attachment 2 “Radiological Survey Calculation” (or equivalent).

6.5.3 Personnel contamination scanning techniques and detection equipment shall be of sufficient sensitivity to detect less than 5000 dpm/100cm^2 beta or 100 dpm/100cm^2 alpha.

6.6 Additional Guidance

6.6.1 The RPM may use the reference listed in Section 3.0 of this procedure (as appropriate) as additional guidance for determination or derivation of site radiological limits. The use or derivation of site radiological limits other than those specified in this procedure should be coordinated with the project client.

7.0 Records

All records generated as a result of this procedure shall be maintained by RPM until transmitted to the appropriate Central Records Facility.

Regulatory Guide 1.86 Surface Contamination Limits

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

[a] Where surface contamination by both alpha and beta-gamma-emitting nuclides exist, the limits established for alpha and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination of objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Site Limits

Project/Site: _____

Type	Value	Units
Occupational administrative dose		Rem TEDE
Total alpha surficial contamination		dpm/100cm^2
Total beta surficial contamination		dpm/100cm^2
Removable alpha surficial contamination		dpm/100cm^2
Removable beta surficial contamination		dpm/100cm^2
Occupational alpha DAC value		µCi/ml
Occupational beta DAC value		µCi/ml
Minimum Occupational Air Sample Volume		Liters
Non-occupational alpha AE value		µCi/ml
Non-occupational beta AE value		µCi/ml
Minimum Non-occupational Air Sample Volume		Liters
Personnel release (alpha)		cpm/probe area
Personnel release (beta)		cpm/probe area

Notes:
1) Attach supporting information, such as source term and calculations.
2) Dose limits not listed are equivalent to the dose limits contained within the procedure, unless specified.
3) If a limit does not apply to the project/site, place an "N/A" in the "Value" column.
4) Any volumetric release limits applicable to release of material/equipment at the site should be specified.

Approved By (RPM): _____ Date: _____

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SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-04

REV. 2

QUALIFICATIONS AND TRAINING

APPROVED BY:_____ DATE: _____
Radiation Safety Officer

APPROVED BY:_____ DATE: _____
EC/HS Manager

APPROVED BY:_____ DATE:_____
QA/QC Officer

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF ATTACHMENTS

1.0 Purpose

This procedure describes the qualifications and training necessary to ensure that radiological workers and the health physics staff can perform their duties in accordance with the SAIC Health Physics Program.

2.0 Scope

This procedure applies to all SAIC and subcontractor personnel working under the SAIC Health Physics Program. This procedure does not apply to respiratory protection training.

3.0 References

3.1 HP-01, "Health Physics Manual"

3.2 10 CFR 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations"

3.3 10 CFR 20, "Standards for Protection Against Radiation"

3.4 49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements", Subpart H, "Training"

3.5 U.S. Army Corps of Engineers Regulation No. ER 385-1-80, "Ionizing Radiation Safety"

3.6 U.S. Army Corps of Engineers Manual No. EM 385-1-1, Section 06.E, "Ionizing Radiation"

3.7 International Air Transport Association (IATA), "Dangerous Goods Regulations"

3.8 NUREG/CR-5569, "Health Physics Positions (HPPOS) Database"

4.0 Definitions

4.1 **Hazmat Employee** – A person employed by a hazmat employer and who in the course of employment directly affects hazardous materials transportation safety. This term includes an owner operator of a motor vehicle which transports hazardous materials in commerce. This term includes an individual, including a self employed individual, employed by a hazmat employer who, during the course of employment:

1. Loads, unloads, or handles hazardous materials;
2. Manufactures, tests, reconditions, repairs, modifies, marks, or otherwise represents containers, drums, or packaging as qualified for use in the transportation of hazardous materials;
3. Prepares hazardous materials for transportation;
4. Is responsible for safety of transporting hazardous materials; or
5. Operates a vehicle used to transport hazardous materials.

4.2 **Hazmat Employer** – A person who uses one or more of its employees in connection with: transporting hazardous materials in commerce; causing

hazardous materials to be transported or shipped in commerce; or representing, marking, certifying, selling, offering, manufacturing, reconditioning, testing, repairing, or modifying containers, drums, or packaging as qualified for use in the transportation of hazardous materials. This includes an owner-operator of a motor vehicle which transports hazardous materials in commerce.

4.3 **Health Physics Technician (HPT)** – Individual knowledgeable in the field of health physics, responsible for implementation of Health Physics Program and procedure requirements.

4.4 **Radiation Protection Manager (RPM)** – An individual who, by virtue of qualifications and experience, assumes the role and responsibilities of the RSO at a specific client site. The site RPM is delegated the authority to implement the SAIC Health Physics Program except for the responsibilities listed in Section 6.4.3 of this procedure.

4.5 **Radiation Safety Officer (RSO)** - An individual who, by virtue of qualifications and experience, has been given the authority to implement the radiation safety program. The RSO is qualified to direct the use of radioactive material in a manner that protects health and minimizes danger to life or property. The RSO is responsible for recognizing potential radiological hazards, developing a radiation safety program to protect against these hazards, training workers in safe work practices, and supervising day-to-day radiation safety operations.

4.6 **Radiation Worker** – An individual that, by virtue of his/her job assignment, is likely to receive in excess of 100 millirem per year total effective dose equivalent (TEDE). Radiation workers are required to successfully complete Radiation Worker Training (RWT) prior to unescorted access to the Restricted Area and annually, thereafter.

4.7 **Restricted Area –** A radiological area, access to which is limited, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

4.8 **Task Evaluation Standards (TES)** – HPT training standards, which describe the knowledge and requirements necessary to perform an individual health physics task. The HPT trainee is required to discuss knowledge items and perform the task according to the standard, without coaching, in order to successfully qualify on the task. Some tasks may only require discussion or simulation, based on the nature of the task.

4.9 **Transportation Representative (TR)** - An individual maintaining requisite training and qualifications in accordance with 49 CFR 172, Subpart H, and IATA, if applicable. The TR is responsible for characterization, classification (if waste), packaging, marking, labeling, and preparation of radioactive material/waste shipments in accordance with applicable regulatory requirements, including generation of required shipping papers. Additionally, the individual is responsible for the assessment of incoming radioactive material shipments and manifests to ensure compliance with regulatory requirements.

4.10 **Year** – For the purpose of determining HPT experience, a year may be defined as a period of 2000 hours obtained in no less than a 40 week period.

5.0 Responsibilities

5.1 The Radiation Safety Officer (RSO) shall:

5.1.1 Assign a project Radiation Protection Manager (RPM), as necessary, to meet project performance requirements. The RSO shall verify the candidate RPM has the requisite education, training and experience.

5.1.2 Review the past experience of prospective HPTs to ensure that HPT qualifications meet the requirements of this procedure.

5.1.3 Provide training to meet the requirements of this procedure.

5.1.4 Approve all material presented in health physics procedures, TES, and RWT.

5.1.5 Approve the qualifications of individuals that present training material.

5.2 The Transportation Representative (TR) shall:

5.2.1 Maintain shipper training and qualifications as specified in 49 CFR 172, Subpart H, and IATA, “Dangerous Goods Regulations”.

5.2.2 Maintain and implement the SAIC Transportation Security Plan required by 49 CFR 172, Subpart I and ensure applicable components of the Plan are including in the training provided to “hazmat employees”.

5.2.3 Develop, maintain and provide, as directed by the RSO, training to project employees commensurate with the requirements in 49 CFR 172, Subpart H, and IATA “Dangerous Goods Regulations”.

5.3 Health Physics Technicians (HPTs) shall:

5.3.1 Successfully qualify on the requirements of this procedure prior to performing health physics tasks.

5.4 Project/employee supervisors (radiation worker and/or hazmat employee supervisors):

5.4.1 Identify employees requiring access to a Restricted Area, ensuring Site Orientation Training (SOT) and RWT are scheduled and completed prior to unescorted Restricted Area access, and ensuring RWT is completed annually.

5.4.2 Ensuring hazmat employees receive training required by this procedure at the specified frequency.

5.4.3 Restricting employees from access to a Restricted Area or work with hazardous materials, as applicable, if an employee’s RWT or hazmat training expires.

5.5 Radiation workers (including health physics staff) shall:

5.5.1 Successfully complete SOT and RWT prior to unescorted Restricted Area access.

5.5.2 Maintain radiation worker qualifications current (complete retraining annually) for the duration of time unescorted Restricted Area access is required. Health physics staff maintain radiation worker qualifications through the maintenance of their individual training programs. Annual radiation worker retraining is not required.

5.6 Hazmat employees (including health physics personnel) shall:

5.6.1 Successfully complete training designed to address the requirements of 49 CFR 172, Subpart H, and IATA, "Dangerous Goods Regulations", if handling or preparing hazardous materials for shipment by air, within 90 days following initial employment or change in job responsibilities subject to initial training.

5.6.2 Prior to completion of initial training, perform tasks subject to the training requirements only under the direct supervision of a properly trained and knowledgeable hazmat employee.

5.6.3 Perform only those functions/tasks trained to complete.

5.6.4 Successfully complete retraining every three (3) years to meet the requirements of 49 CFR 172, Subpart H.

5.6.5 If handling or preparing hazardous materials for transport by air, successfully complete retraining every two (2) years to meet the requirements of IATA, "Dangerous Goods Regulations".

6.0 Procedure

6.1 General Requirements

6.1.1 Prior to allowing unescorted access into a Restricted Area, personnel shall successfully complete SOT and RWT.

A. Other RWT programs may be accepted in lieu of SAIC RWT if; certification of successful completion of the training is provided, and the training is determined by the RSO to be equivalent to SAIC RWT.

B. The RSO may permit access to the Restricted Area without completing SOT and RWT, provided an individual who has satisfactorily completed SOT and RWT accompanies the person at all times while in the Restricted Area. Within the Restricted Area, this access shall be limited to posted Radiation Areas or Radioactive Material (Storage) Areas.

6.2 Site Orientation Training (SOT)

6.2.1 Employees shall successfully complete SOT prior to being allowed unescorted access to Restricted Areas of the site.

6.2.2 SOT shall contain the following information at a minimum:

A. Names of site HP staff and designees;

B. Hazards and symptoms of exposure to radiation and/or radioactive materials, including the contaminants present, exposure limits, required monitoring, and pregnancy concerns;

C. Site and task PPE, including training on correct use of PPE;

D. Safe work practices to minimize risk;

E. Safe use of engineering controls and equipment;

F. Medical surveillance requirements and employee medical/ exposure records access;

G. Response to abnormal conditions, alarms and/or other forms of emergency communications;

H. Content of the site emergency response plan, including actions to be taken by employees;

I. Site control measures; and

J. Reporting requirements.

6.3 Radiation Worker Training (RWT)

6.3.1 RWT shall be completed prior to initial unescorted access to the Restricted Area and annually thereafter (every 12 months).

6.3.2 RWT shall include a written examination, in which the trainee is required to answer at least 70% of the questions correctly.

6.3.3 RWT is not required for approved RWT instructors by virtue of their knowledge of the subject matter.

6.3.4 RWT shall contain the following topics at a minimum:

A. The provisions of applicable regulations (and the SAIC St. Louis Health Physics Program and procedures) concerning occupational radiation protection, including employee rights and responsibilities, risks from occupational exposure to ionizing radiation, as well as prenatal exposure controls;

B. Radiological fundamentals;

C. Biological effects resulting from exposure to sources of ionizing radiation;

D. Exposure limits (administrative and regulatory), including employee responsibilities;

E. As Low As Reasonably Achievable (ALARA) Program;

F. Personnel monitoring;

G. Radiological access controls and postings;

H. Radioactive contamination control;

I. Radiological emergencies, including employee actions in the event of an emergency; and

J. Packaging, marking, labeling and preparation of radioactive materials or radioactive waste for shipment, commensurate with assigned duties and responsibilities. This shall include applicable regulations governing this activity (49 CFR, 10 CFR and IATA), as well as components of the Transportation Security Plan, if applicable.

6.3.5 RWT for employees at U.S. Department of Energy sites, as well as other project sites involving work in contaminated areas, potential contaminated areas, work requiring access to high and/or very high radiation areas or other areas as determined by the RSO, shall include a practical factors evaluation. This shall include demonstration of the following:

A. Ability to read, understand and comply with the requirement of a radiation work permit (RWP) or health and safety work permit (HSWP), including:

1. Identification of the unique number assigned to the RWP/HSWP, effective date and termination date;
2. Scope of work allowed by the RWP/HSWP, including radiological areas where the work will be performed;
3. Pre-job briefing requirements;
4. Engineering controls, if specified;
5. Protective clothing, other PPE and dosimetry requirements;
6. Health Physics survey requirements;
7. Radiological hazards present in the work area, including contamination levels, airborne radioactivity and radiation dose rates;
8. Radiological hold points, including identification of abnormal conditions and “back out” criteria;
9. Other ALARA requirements, including tools/work practices to minimize personnel exposure, contamination control measures, low dose waiting areas and radioactive waste minimization/ reduction; and
10. Personnel, equipment and material survey requirements.

B. Using the information presented in an RWP or HSWP, demonstrate the following:

1. Properly select, inspect and don protective clothing and other PPE, if required;
2. Complete all prerequisites necessary to access the work area, including: briefings, verifying correct dosimetry (including dose and dose rate alarm set-points, if using electronic dosimeters) and

dosimetry placement, material preparation, identification of radiological areas and low exposure waiting areas;

3. Access a simulated work area, demonstrating knowledge and understanding of radiological postings;
4. Perform a simulated task in the area, utilizing appropriate tools and work control measures specified in the RWP/HSWP;
5. Proper identification of abnormal conditions and demonstration of acceptable response actions, including response to radiological alarms;
6. Demonstrate knowledge of radiological hold points and health physics survey requirements;
7. Demonstrate knowledge of proper methods for removal of tools and equipment from radiological areas while minimizing the potential spread of contamination;
8. Properly doff protective clothing and exit the work area;
9. Properly perform required survey instrument inspections, pre-use checks and complete personnel monitoring;
10. Demonstrate the proper response to an alarm or indication of elevated radioactivity while performing a personnel survey or faulty radiation survey equipment; and
11. Demonstrate the ability to determine and record exposure.

6.4 Qualifications of the Radiation Safety Officer (RSO)

6.4.1 The RSO shall have a minimum of four (4) years of applied professional level radiation safety experience, a minimum of 1 year of supervisory experience, and a Bachelor of Science (BS) in Health Physics or other related educational field. Experience as an HPT shall not be used as credit toward the four years of professional level experience.

NOTE: Certification by the American Board of Health Physics demonstrates acceptable equivalency to the education and experience requirements for the RSO.

6.4.2 The RSO should participate in refresher training. Refresher training may consist of; attendance at seminars or training courses on radiation protection issues; self development through review of books and literature on radiation protection issues; or attendance at scientific meetings where radiation protection issues are discussed.

6.4.3 The RSO may delegate responsibilities described in health physics procedures to a Site Radiation Protection Manager (RPM), except for; establishing alternate administrative exposure limits, approval to exceed site administrative exposure limits in excess of the authorization provided in HP-01, regulatory agency notification, approval to dispose of

radioactive material or radioactive waste, safety and health plan approval, and Health Physics procedure approval.

6.5 Qualifications of the Radiation Protection Manager (RPM)

6.5.1 An individual designated as Site RPM, with RSO responsibilities delegated as allowed by this procedure, shall meet the following minimum requirements:

6.5.1.1 Certification as a registered radiation protection technologist by the National Registry of Radiation Protection Technologists (NRRPT);

6.5.1.2 A four-year degree in health physics, radiation physics, industrial safety, or related field and 1 year of experience as a senior-level health physics technician;

6.5.1.3 Qualification or previous experience as a radiological engineer or an ALARA engineer; or

6.5.1.4 Qualification or designation as a health physicist.

6.5.2 The Site RPM should participate in refresher training.

6.6 Qualifications of Transportation Representative (TR)

6.6.1 A TR shall possess a high school diploma or equivalent and three (3) years of experience in characterization of hazardous materials, classification of radioactive waste, packaging, labeling, marking, shipment and receipt of radioactive material packages.

6.6.2 A TR that directs the work of others shall also have a minimum of one (1) year supervisory experience or, for an entry level supervisory TR, demonstrated supervisory and leadership capabilities, as determined acceptable by the RSO.

6.6.3 A TR that also performs package and/or shipment or receipt radiological surveys shall also meet the qualification requirements of a senior level HPT.

6.6.4 A TR shall possess a current (within 3 years of hire or assignment date) training certificate or complete a training program, with successful completion of a written and/or oral examination, sufficient to demonstrate proficiency in executing responsibilities associated with hazardous materials transportation regulations in 49 CFR and IATA, if shipping hazardous material by air.

6.6.5 A TR shall successfully complete retraining every three (3) years to address the requirements in 49 CFR, Subpart H and, if packaging or preparing shipments by air; retraining every two (2) years to address the requirements in IATA, “Dangerous Goods Regulations”.

6.7 Qualifications of Health Physics (Technician) Supervisor (HPS)

6.7.1 A HPS shall have the same education and applicable health physics technician experience as a senior level HPT. The HPS shall have, in addition to the senior level HPT experience, at least one year of supervisory experience or, for an entry level HPS, demonstrated supervisory and leadership capabilities, as determined acceptable by the RSO.

6.7.2 A HPS also performing senior level HPT tasks shall complete all Task Evaluation Standard requirements.

6.8 Qualifications of Health Physics Technicians (HPTs)

6.8.1 The RSO, RPM or HPS (for HPTs only) shall review prospective or newly hired health physics personnel (SAIC and contractor personnel) education and work experience, including employment verification sufficient to validate the minimum experience requirement, and classify each as junior level (Jr. HPT) HPT or senior level (Sr. HPT) HPT.

A. A Sr. HPT shall possess a high school diploma or equivalent and three (3) years of applicable health physics technician experience. Knowledge of health physics fundamentals should be demonstrated and verified by the RSO. This may include verification of one of the following:

1. Completion of an Associates or Bachelors degree in health physics or nuclear engineering.
2. Completion of health physics technician training provided through an Institute for Nuclear Power Operations (INPO) accredited training program.
3. Registration by the National Registry of Radiation Protection Technologists (NRRPT).
4. Successful completion of the “Northeast Utilities Exam” or equivalent.
5. Completion of DOE radiological control technician (RCT) core training (or successful completion of a comprehensive challenge examination).
6. Successful completion of a written or oral examination administered by the RSO or individual(s) designated by the RSO.
7. Other means determined appropriate by the RSO.

NOTE: A Sr. HPT assigned to a project at a DOE site is required to complete 6.8.1.A.5 and the oral examination requirement in 6.8.1.A.6.

B. A Jr. HPT shall possess a high school diploma or equivalent.

NOTE: A Jr. HPT shall <u>not</u> perform job coverage, equipment or material release surveys, radioactive material receipt or shipping surveys, personnel decontamination or approve

RWPs/HSWPs or radioactive effluent release permits unless under the direct supervision of a fully qualified Sr. HPT, HPS, RPM or the RSO.

6.8.2 Education and/or training may be substituted for up to one (1) year of HPT experience using the following guidance:

Training/Education	Experience Allowance
Associates, Bachelors or Advanced Degree In Health Physics or Nuclear Engineering	1 Year
Navy Engineering Laboratory Technician (ELT) Training	1 Year
Commercial Nuclear Utility Sponsored HPT Training Program	Duration of training at 1:1 up to a maximum of 1 year
Health Physics Short Courses	Duration of courses at 1:1 up to a maximum of 1 year

6.8.3 Work experience credited toward the minimum requirement for an HPT will be determined using the following guidance:

Type of HPT Related Experience	Experience Allowance
Navy ELT (non-overhaul)	1:1 up to 1 year
Navy ELT (overhaul)	1:1 with no limit
Shipyard/Tender HPT	1:1 with no limit
National Laboratory HPT	1:1 with no limit
Fuel Processing/ Plutonium Production HPT	1:1 with no limit
Nuclear Power Plant Sr. or Jr. HPT (operational HPT performing job coverage)	1:1 with no limit
Dosimetry, Respiratory Protection, Count Room (radiochemistry) or Instrument Calibration Technician	1:1 up to 6 months
Control Point Monitor, Laundry Monitor or Decontamination Technician (with performance of radiological surveys)	1:1 up to 3 months
Radiological Worker Training (RWT) Instructor	1:1 up to 6 months
HPT Training Instructor	1:1 up to 1 year
Nuclear Facility Decommissioning HPT	Typically 1:1 with no limit
Miscellaneous HPT Work Experience at Other Facilities	Case-by-case, as determined by the RSO

6.9 HPT, HPS and TR Training and Qualification

6.9.1 The RSO, RPM or HPS (for HPTs only) shall initiate Attachment 1, “Health Physics Training and Qualifications”, for each newly hired HPT, HPS or TR.

6.9.2 The RSO, RPM or HPS (for HPTs only) shall determine required reading/ self study and identify each using Attachment 2, "Health Physics Required Reading".

6.9.3 The RSO, RPM or HPS (for HPTs only) shall determine TES completion requirements and identify each on Attachment 1.

NOTE: Completion of each TES may be accomplished through discussion (D), simulated performance (S) or actual performance (P), as determined by the RSO, RPM or HPS.

6.9.4 Initial training completion shall be documented on Attachment 1 or equivalent, and include:

A. Completion of Attachment 2 required reading/self study assignment, including review of HP-01, Health Physics Manual, SAIC health physics procedures, and applicable federal and state regulations.

B. Successful completion of Task Evaluation Standards. The TES requirements for each HPT shall be determined commensurate with HPT duties. These may include, but are not limited to the tasks identified on Attachment 1.

6.9.5 Following completion of all training requirements identified on Attachment 1, the employee shall sign and date Attachment 1 indicating successful completion.

6.9.6 The RSO or RPM shall verify completion of Attachment 1.

6.9.7 The RSO or RPM may promote a Jr. HPT to Sr. HPT when the Sr. HPT qualification and experience requirements are met. This action shall be documented on Attachment 1, as well as any additional training and/or qualification requirements.

6.10 Retraining

6.10.1 Permanently employed SAIC personnel and temporary personnel (SAIC and SAIC contractor personnel) assigned to a project for 6 months or longer shall participate in continuing training.

6.10.2 Continuing HPT training shall include:

A. A review of the SAIC Health Physics Manual, HP-01, and all health physics procedures every three (3) years,

B. Reviewing health physics procedure revisions, as documented on Attachment 3, "Health Physics Required Reading Log", or equivalent,

C. Annual review of applicable changes to regulations, industry events, industry events and lessons learned, deficiencies identified during the performance of periodic program reviews, and general topics, as determined by the RSO, RPM or HPS and documented on Attachment 3, or equivalent, AND

D. Formal specialized training commensurate with the duties of the HPT, HPS or TR, as required by the RSO or RPM. This specialized training

may be conducted concurrently with other re-qualification efforts, such as HAZWOPER.

6.10.3 All hazmat employees, including health physics personnel and the TR, involved in preparing hazardous material/waste for transport by any mode other than air transport shall complete retraining:

A. Every three (3) years at a minimum (49 CFR 172, Subpart H).

B. When conditions, processes or new transportation hazards are identified, or the individual's job assignment changes, necessitating training.

C. As determined necessary by the RSO or RPM.

6.10.4 All hazmat employees, including health physics personnel and the TR, involved in preparing hazardous material/waste for transport by air shall complete retraining:

A. Every two (2) years at a minimum to satisfy the requirements of IATA, Dangerous Goods Regulations.

B. When conditions, processes or new transportation hazards are identified, or the individual's job assignment changes, necessitating training.

C. As determined necessary by the RSO or RPM.

NOTE: Training specified in 6.10.3 and 6.10.4 shall be commensurate with the employee's assigned duties and responsibilities.

6.10.5 All employees required to maintain radiation worker qualifications shall complete retraining annually (no later than 12 months from the initial or last retraining date). Health Physics staff (Jr. and Sr. HPTs, HP Supervisors, RPMs, Health Physicists, and the RSO) maintain their radiation worker qualification through the maintenance of their individual training programs. Annual retraining is not required for health physics staff.

6.10.6 The RSO or RPM may allow a grace period, of 30 days, from the required HPT or radiation worker retraining completion date. However, the initial training date shall be maintained as the basis for determining training/retraining expiration.

Example: A Sr. HPT completes required training and qualifications on January 15, 2006. The Sr. HPT is then required to complete retraining no later than December 31, 2006. The RSO allows a 30 day grace period, extending the retraining requirement to January 31, 2007. Annual retraining must be completed again no later than December 31, 2007 (December is maintained as the individual's retraining expiration month). For the purpose of retraining, qualifications and expiration dates may be tracked on a monthly basis. Therefore, in this example, the Sr. HPT could complete retraining at any time prior to December 31st.

7.0 Records

7.1 All records generated as a result of this procedure shall be maintained by the RSO or RPM until transmitted to the appropriate Central Records Facility.

7.2 Employee training records shall be maintained in accordance with SAIC Human Resources personnel management policies and procedures.

Health Physics Training and Qualifications

Technician Name (Print):	**Employment Date:**
Education/work history evaluation: Jr. HPT _____ Sr. HPT _____ HPS _____ TR _____ *Attach a copy of resume, work history evaluation and supporting documents, e.g., TR training certificate, etc.*	
Fundamental knowledge of health physics documented (Sr. HPT and HPS)? Yes/ No/ NA (RSO or RPM) _____ Date: _____	
Required reading/self study complete (HP-01, HP procedures, regulations). (HPS/HPT/TR) _____ Date: _____	
Hazmat training complete (49 CFR 172, Subpart H) commensurate with duties. (RSO, RPM or HPS) _____ Date: _____	

TASK EVALUATION STANDARDS

Task Evaluation Standard Title or Category	**Method[1]**				**Completion**	**Evaluator**
	D	**S**	**P**	**NA**	**HPT Initial/Date**	**Initial/Date**
Maintain HP records and issue dosimetry.						
Control point monitoring						
Setup and operation of radiation survey instruments.						
QC checks of radiation survey instruments.						
Obtain, count, evaluate and document an air sample.						
Perform and document a radiation and contamination survey.						
Setup and post a radiation area, contamination area, radioactive material (RAM) area, airborne radioactivity area.						
Perform job coverage in a radiation area and contamination area.						
Perform job coverage in a high radiation area, airborne radioactivity area and high contamination area.						
Perform a RAM receipt survey.						
Label and control RAM.						
Perform and document a RAM/waste package survey.						
Perform and document a RAM/waste shipment survey.						
Generate, revise and terminate an RWP or HSWP.						
Source leak test, inventory & control.						
Perform and document an equipment/material release survey.						
Response to personnel contamination monitor alarm.						
Personnel and equipment decontamination.						
Response to area radiation or airborne radioactivity monitor alarms.						
Response to abnormal radiological conditions.						
Other TES – *attach separate completion records*.						

Completed: (Employee) _____ Date: _____ Verified: (RSO or RPM) _____ Date: _____

[1] D = discuss; S = Simulate; P = Perform; NA = Not Applicable (Determined by RSO, RPM or HPS). Use D or S when radiological conditions prohibit actual performance or conditions do not currently exist (event driven, such as response to alarms, etc.).

Attachment 2

Health Physics Required Reading

Entire Staff ☐ HPS ☐ TR ☐ Sr. HPT ☐ Jr. HPT ☐

Year:_____

Number	Title	Issue Date	Completion Date

Required reading should be numbered using the following format: YY-XX (YY = year, XX = sequential number)

Attachment 3

Health Physics Required Reading Log

Entire Staff ☐ HPS ☐ TR ☐ Sr. HPT ☐ Jr. HPT ☐

Title:					
Issued By:		**Issue Date:**		**RR Number:**	
Printed Name	**Signature**	**Date**	**Printed Name**	**Signature**	**Date**

Signature indicates the subject document has been read.

SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-10

REV. 1

PERSONNEL AND EQUIPMENT DECONTAMINATION

APPROVED BY:_____ DATE: 12/11/02

r

APPROVED BY:_____ DATE: 12/11/02

EC/HS Manager

APPROVED BY:_____ DATE:_____

QA/QC Officer

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1.0 Purpose

This procedure establishes guidelines for performing and documenting decontamination of personnel and equipment.

2.0 Scope

This procedure applies to decontamination at sites working under this SAIC radiation safety program.

3.0 References

3.1 10 CFR 20, “Standards for Protection Against Radiation”

3.2 HP-01, “Health Physics Manual”

3.3 HP-03, “Radiological Limits”

3.4 HP-11, “Radiological Monitoring”

3.5 HP-22, “Radiological Reporting”

3.6 U.S. Army Corps of Engineers Manual No. EM 385-1-1, Section 06.E, “Ionizing Radiation”

3.7 U.S. Army Corps of Engineers Regulation No. ER 385-1-80, “Ionizing Radiation Safety”

4.0 Definitions

4.1 **Contamination** - The deposition of radioactive material on accessible surfaces of structures, objects, equipment, or personnel that exceeds site surficial release limits pursuant to HP-03, “Radiological Limits”. Contamination may be either "fixed" (e.g., not removable by rubbing with a dry smear) or "removable". Total Contamination refers to fixed plus removable contamination.

4.2 **Decontamination –** The removal of radioactive contamination from surfaces, people or equipment.

4.3 **Restricted Area –** A radiological area, access to which is limited, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

5.0 Responsibilities

5.1 The Radiation Protection Manager (RPM) shall:

5.1.1 Verify compliance with this procedure during planned and periodic audits of the radiation safety program.

5.1.2 Review incidents involving contamination pursuant to HP-22, “Radiological Reporting”.

5.2 Health Physics Technicians (HPTs) shall:

5.2.1 Perform personnel decontamination in accordance with the requirements of this procedure.

5.2.2 Direct equipment decontamination in accordance with the requirements of this procedure.

6.0 Procedure

6.1 General Decontamination

6.1.1 Personnel or equipment shall be considered to be contaminated if any surface exceeds the contamination limits specified in HP-03, "Radiological Limits".

6.1.2 Surveys shall be performed and documented pursuant to HP-11, "Radiological Monitoring".

6.1.3 Following decontamination, surfaces shall be resurveyed to determine if the surface meets release criteria.

6.1.4 Personnel performing decontamination shall wear protective clothing appropriate for the levels of contamination encountered.

6.1.5 Decontamination shall be performed starting at areas of low contamination levels and moving to higher levels of contamination.

6.1.6 The RPM shall be notified of all personnel contamination incidents.

6.2 Personnel Decontamination

6.2.1 Decontamination shall be performed with the least possible insult to the individual. If skin irritation occurs, decontamination efforts shall be discontinued and the RPM shall be immediately notified.

6.2.2 If extraordinary means (in excess of this procedure) are required to decontaminate an individual, or when decontaminating a wound, medical personnel shall direct the decontamination.

6.2.3 The temperature of personnel decontamination water should be lukewarm.

6.2.4 Decontaminate skin in the following manner:

6.2.4.1 Survey the affected area to determine the magnitude and extent of the contamination. Document initial survey results on Attachment 1, "PCR", Attachment 1 from HP-11, "Radiological Monitoring and/or equivalent forms.

6.2.4.2 Wash the affected area thoroughly using soap and water (or, if water is not available, wipe the area with pre-moistened towelettes).

6.2.4.3 If multiple washings are not effective, consider wrapping the affected area in plastic to induce sweating.

6.2.4.4 Continue the decontamination effort until the contamination has been removed. If the contamination cannot be removed, contact the RPM.

6.2.5 During the decontamination process, care should be taken to avoid cross contamination of the hair, mouth, eye, or nose.

NOTE:

Lifesaving measures and medical attention to seriously injured personnel shall take precedence over personnel decontamination procedures.

6.2.6 To decontaminate nasal passages, have the individual use moderate nose blowing to remove the contamination. Nasal passages may be surveyed using cotton swabs. The RPM shall determine if a bioassay sample is required.

6.2.7 All contamination incidents shall be documented on Attachment 1, "Personnel Contamination Report" (PCR) and/or Attachment 1 from HP-11, "Radiological Monitoring" All contamination incidents shall be tracked on Attachment 2, "Personnel Contamination Log" and reported in accordance with the requirements in HP-22, "Radiological Reporting". Equivalent forms may be used at the discretion of the RPM.

6.2.8 If radon is suspected as the cause of the contamination incident, attempt to verify by determining the half-life of the contaminant (i.e. on the decontamination materials), or performing an immediate lab analysis. Note the investigation results on the PCR.

6.2.9 If personnel contamination activity in excess of 15,000 dpm/100cm^2 is encountered, save the decontamination materials for lab analysis in order to support a skin dose evaluation, at the direction of the RPM.

6.3 Personal Clothing Decontamination

6.3.1 Personal clothing may be decontaminated by the following methods:

6.3.1.1 Attempt to remove the contamination by tape press.

6.3.1.2 Send the contaminated item to a licensed laundering vendor.

6.3.1.3 With the owner's permission, cut out the contaminated areas of the clothing or shoes and dispose of as radwaste.

6.3.1.4 Other appropriate methods as determined by the RPM.

6.4 Equipment Decontamination

6.4.1 Equipment shall be decontaminated in a Restricted Area.

6.4.2 Loose contamination may be removed from equipment surfaces by one of the following methods:

6.4.2.1 Wiping the surface with a moist rag.

6.4.2.2 Vacuuming the surface with a high efficiency particulate (HEPA) filter equipped vacuum.

6.4.2.3 Spraying the equipment with pressurized hot water/steam.

6.4.3 Liquid waste generated during decontamination shall be collected so that the liquids may be contained, unless waived by the RPM.

6.4.4 Fixed contamination may be removed by removing the top surface layer using abrasive means (i.e. angel grinder, disc sander, sand blaster, etc.).

7.0 Records

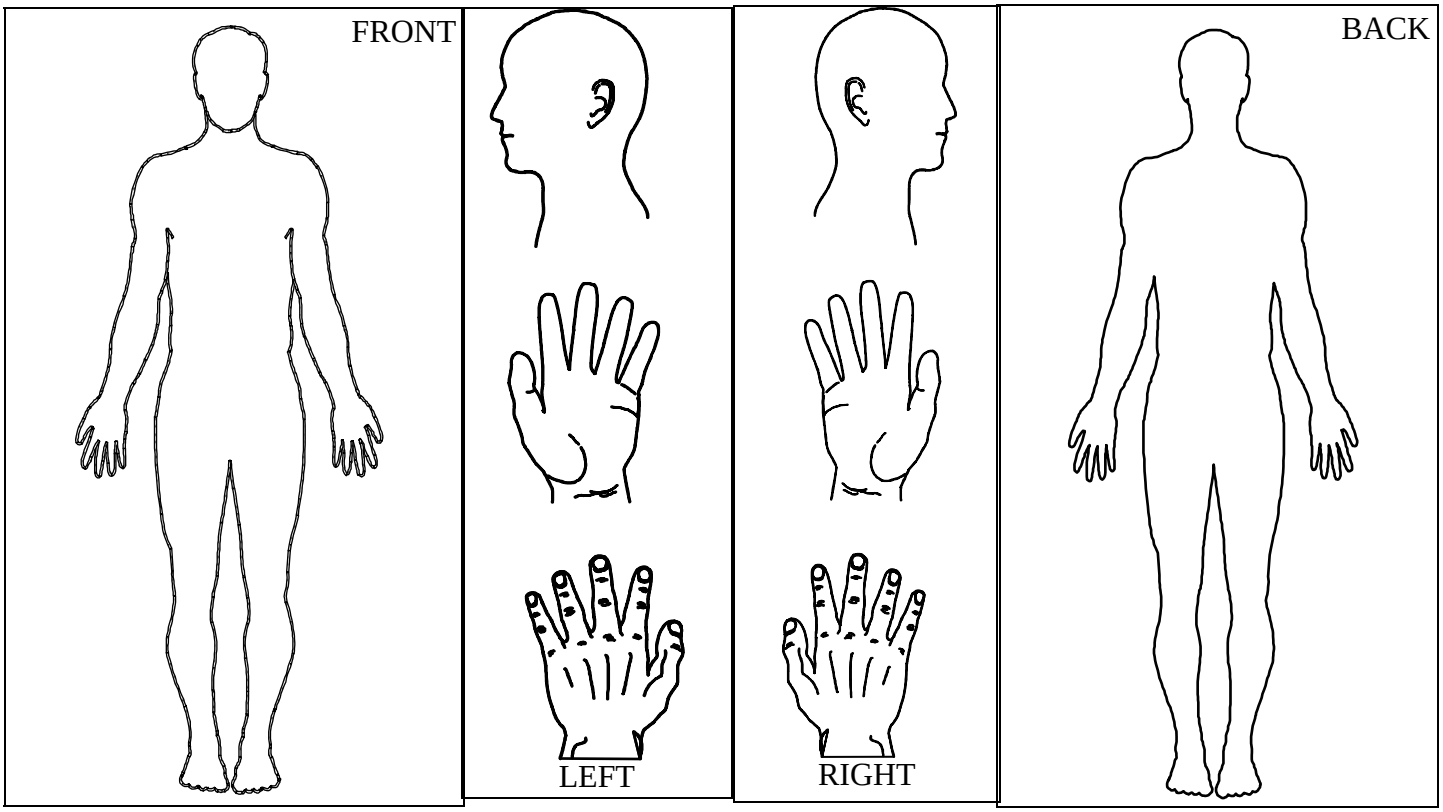
All records generated as a result of this procedure shall be maintained by RPM until transmitted to the appropriate Central Records Facility.

PERSONNEL CONTAMINATION REPORT

Site:_____

Employee Name	SSN	Company	Date/Time of Occurrence

HSWP NO.	Inst. Type: _____ Serial Number: _____ Calibration Due Date: _____ Inst. Type: _____ Serial Number: _____ Calibration Due Date: _____



INDICATE THE CONTAMINATED AREAS IN THE DIAGRAM ABOVE

SPECIFY CALCULATED ACTIVITY IN UNITS OF DPM/100cm^2

DESCRIBE THE CONTAMINATION INCIDENT, THE SITE LOCATION WHERE THE INDIVIDUAL BECAME CONTAMINATED, THE DECONTAMINATION METHODS USED, AND THE POST-DECONTAMINATION SURVEY RESULTS:

PERSONNEL MONITORING INCIDENT REPORT INITIATED IN ACCORDANCE WITH HP-22? □ YES □ NO

Initiated By:_____ Date:_____

Contaminated Individual: _____ Date:_____

Reviewed By:_____ Date:_____

PERSONNEL CONTAMINATION REPORT LOG

Site: _____ Year: _____

Date	Individuals Name	HPID #	Entered By	Remarks

REVIEWED BY_____DATE_____

SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-11

REV. 1

RADIOLOGICAL MONITORING

APPROVED BY: ___ DATE: 12/11/02

r

APPROVED BY:_____ DATE: 12/11/02

EC/HS Manager

APPROVED BY:_____ DATE:_____

QA/QC Officer

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SECTION **PAGE**

LIST OF ATTACHMENTS

1.0 Purpose

The purpose of this procedure is to provide guidelines for performance and documentation of radiological surveys and sampling.

2.0 Scope

This procedure applies to all areas of a site working under this SAIC radiation safety program, including those areas where radioactive materials are not normally stored or handled.

3.0 References

3.1 10 CFR 20, “Standards for Protection Against Radiation”

3.2 HP-01, “Health Physics Manual”

3.3 HP-03, “Radiological Limits”

3.4 HP-10, “Personnel and Equipment Decontamination”

3.5 HP-20, “Radiological Posting and Labeling”

3.6 HP-30, “Radiological Instrumentation”

3.7 HP-40, “Personnel Radiation Exposure Monitoring”

3.8 NUREG-1507, “Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions”

3.9 NRC Regulatory Guide 8.21, "Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants," 1979

3.10 NRC Regulatory Guide 8.23, “Radiation Safety Surveys at Medical Institutions,” January 1981

3.11 NRC Regulatory Guide 8.25, “Air Sampling in the Workplace,” 1992

3.12 NRC Regulatory Guide 8.30, “Health Physics Surveys in Uranium Mills,” June 1983

4.0 Definitions

4.1 **Annual Limit on Intake (ALI) -** The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by Reference Man that would result in a committed effective dose equivalent of 5 rem or a committed dose equivalent of 50 rem to any individual organ or tissue. ALI values are given in Table 1, Columns 1 and 2 of Appendix B, 10 CFR 20.1001-2401.

4.2 **Airborne Radioactivity Area** – a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

4.2.1 In excess of the derived air concentrations (DACs) specified in Appendiix B, to 10 CFR 20, or

4.2.2 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 one week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

4.3 **Breathing Zone** - That region in the vicinity of a worker's mouth and nostrils from which air is drawn into the lungs while performing his/her assigned work. Air sampled from this region represents the air the worker breathes while at work, whether standing, sitting, or moving.

4.4 **Chain of Custody** – An unbroken trail of accountability that ensures the physical security of radioactive materials.

4.5 **Contact Exposure Rate** - The exposure rate from a surface or piece of equipment measured with the radiation detector housing positioned a distance of no greater than 0.5 cm (1/4 inch) from the surface or equipment.

4.6 **Contamination Area –** Any area with total and/or smearable (removable) contamination levels greater than site specific contamination limits as documented on Attachment 2 of HP-03, "Radiological Limits" or other site specific documentation (i.e., Site Safety and Health Plan (SSHP), Radiation Protection Plan (RPP), etc.).

4.7 **Contamination** - The deposition of radioactive material on accessible surfaces of structures, objects, equipment, or personnel that exceeds the site-specific surficial release limits pursuant to HP-03, "Radiological Limits". Contamination may be either "fixed" (e.g., not removable by rubbing with a dry smear) or "removable". Total contamination refers to fixed plus removable contamination.

4.8 **Controlled Area** – An area, outside of a restricted area but inside the site boundary, access to which can be limited for any reason..

4.9 **Derived Air Concentration (DAC)** - The concentration of a given radionuclide in air which, if breathed by Reference Man for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 m^3 per hour) results in an intake of one Annual Limit on Intake (ALI). DAC values are given in Table 1, Column 3 of Appendix B of 10 CFR 20.

4.10 **General Area Exposure Rate** - An indication of the potential for a human to incur a radiation dose. Ambient (i.e., general area) exposure rates are measured in units of *millirem per hour* or *microroentgen per hour*.

4.11 **Geometry** - The size and type of container used to hold a sample during counting.

4.12 **Intake** - Amount of radioactive material entering the body through the nose, mouth, or skin.

4.13 **Loose surface contamination (Removable)** - Radioactive contamination easily transferred by normal handling and contact.

4.14 **Minimum Detectable Activity (MDA)** - The smallest amount of radioactivity that can be detected given the conditions of a specific sample.

4.15 **Monitoring** - The measurement of radioactivity in the whole body, in a region of the body, in material eliminated from the body or in the air for purposes of estimating the intake of radioactive material. The term monitoring also includes interpretation of the measurements.

4.16 **Radiation Detection Instrument** - A device, consisting of a detector and a ratemeter, which detects ionizing radiation.

4.17 **Radiation Survey Instrument** - A hand-held radiation survey instrument capable of detecting ionizing radiation.

4.18 **Radioactive Material Storage Area (RMSA) –** An administratively designated area where radioactive material is stored and controlled.

4.19 **Representative** - Faithfully showing the quality and characteristics of the area from which a sample is drawn or a measurement is made.

4.20 **Restricted Area –** A radiological area, access to which is limited, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

4.21 **Sample** – a representative portion of a medium (i.e., air, water, soil, etc.) of interest, or one or more separated constituents from a representative portion of the medium.

4.22 **Scan** – An evaluation technique performed by moving a survey instrument over a surface of an object at a specified speed and distance above the surface of the object to detect radiation.

4.23 **Stop Work Authority** – The authority residing in all management and radiological workers for immediately stopping work for the following reasons:

4.23.1 If conditions develop that were not anticipated which would result in a significant increase in radiological or industrial safety hazards.

4.23.2 The conditions on the job have degraded to the point that the work is not being performed consistent with the ALARA concept.

4.23.3 The potential for deterioration of occupational safety exists if the job is continued.

4.23.4 The work practices may result in violation of regulatory or NRC license requirements or radiation safety procedures.

4.24 **Unrestricted Area** - Any area to which access is neither limited nor controlled.

4.25 **Unrestricted Release** - Equipment, components, materials, land areas (property), and other items that may be used, transferred, sold, or disposed of without regard for their radiological constituents.

5.0 Responsibilities

5.1 The Radiation Protection Manager (RPM) shall:

5.1.1 Assure that all radiological monitoring surveys (i.e., contamination, radiation, airborne concentration, etc.) are performed pursuant to this procedure.

5.1.2 Verify compliance with this procedure during planned and periodic surveillances of the radiation protection program.

5.1.3 Specify the types and frequency of air sample collection.

5.1.4 Ensure individual DAC-hour dose records are maintained, if internal monitoring is required pursuant to HP-40, “Personnel Radiation Exposure Monitoring”, in accordance with the requirements of this procedure.

5.1.5 Ensure that radiological monitoring survey documentation is reviewed in accordance with the requirements of this procedure.

5.2 HPTs shall:

5.2.1 Perform all radiological monitoring surveys (i.e., contamination, radiation, airborne concentration, etc.) in accordance with the provisions of this procedure.

5.2.2 Perform air sampling as required by this procedure.

5.2.3 Perform air sample evaluation as required by this procedure.

5.2.4 Conduct routine surveillance surveys in accordance with the provisions of HP-12, “Health Physics Oversight”.

6.0 Procedure

6.1 General Requirements

6.1.1 Maintain exposures ALARA when conducting radiological monitoring surveys.

6.1.2 Instrumentation referenced in this procedure is to be prepared for use, and used, in accordance with HP-30, “Radiological Instrumentation”.

6.1.3 Performance requirements for coverage, release, and routine surveillance surveys are defined in HP-12, “Health Physics Oversight”.

6.1.4 Radiological monitoring surveys shall be performed, as appropriate, to:

6.1.4.1 Establish and maintain HSWPs.

6.1.4.2 Determine whether the confinement or radioactive materials is effective.

6.1.4.3 Measure airborne radioactivity concentrations, radioactive contamination and radiation levels in the workplace.

6.1.4.4 Estimate worker intakes and/or exposures to radiation.

6.1.4.5 Determine posting requirements.

6.1.4.6 Determine appropriate protective equipment and measures.

6.1.4.7 Warn of elevated radiation, contamination, and/or airborne radioactivity levels.

6.1.4.8 Investigate emergency situations.

6.1.4.9 Investigate abnormal conditions.

6.1.4.10 Release material or equipment for unrestricted use or disposal.

6.1.4.11 Investigate anticipated or changing radiological conditions.

6.1.4.12 Comply with other radiation safety procedures.

6.1.4.13 Comply with regulations or NRC license requirements.

6.1.4.14 Investigate radiological conditions in accordance with HP-12, "Health Physics Oversight" Attachment 5, "Routine Surveillance Frequency".

6.1.5 In addition to surveys required by Section 6.1.3, the following air sample surveys shall be required:

6.1.5.1 To monitor airborne concentrations of radioactive material to uncontrolled areas (for non-occupational exposure to members of the public), as directed by the RPM.

6.1.5.2 To monitor airborne concentrations of radioactive material in work areas where personnel exposure is likely to exceed 500 mrem/yr CEDE, as determined by the RPM.

6.1.5.3 To monitor airborne concentrations of radioactive material in work areas where personnel exposure is <u>not likely</u> to exceed 500 mrem/yr CEDE, as determined by the RPM, for the purpose of routine surveillance in accordance with Section 6.13 of this procedure.

6.1.5.4 During entries into "Airborne Radioactivity Areas".

6.1.5.5 Whenever respirators are worn for the purpose of protecting individuals from airborne radioactive material exposure.

6.1.5.6 As determined by the RPM.

6.1.6 Each survey shall be planned in regard to:

6.1.6.1 Specific radiation types.

6.1.6.2 Predetermined radiation levels, contamination levels, or airborne concentrations.

6.1.6.3 Locations where the radiation, contamination and/or airborne radioactive material is expected.

6.1.6.4 The minimum detection sensitivity for each survey (i.e., survey instrument MDA or MDC based on survey parameters such as instrument background, scan speed, count time, etc.).

6.1.7 Radiation and contamination surveys shall be documented on Attachment 1, or equivalent.

6.1.8 The RPM, or designee should establish, and make available, minimum air sample volumes and count times for occupational and non-occupational samples based on site specific data, as applicable and available. Minimum site specific air sample volumes shall be documented on HP-03, "Site Limits", Attachment 2.

6.1.9 Air sample volumes and count times should be of sufficient volume and duration to detect a minimum detectable concentration of 10% of the DAC or 100% of the Air Effluent Concentration (AE), if practical.

6.1.10 Airborne radioactive material surveys shall be documented on Attachment 4, or equivalent.

6.1.11 The RPM shall evaluate the need for personnel radiation exposure monitoring in accordance with HP-40, "Personnel Radiation Exposure Monitoring".

6.1.12 Surveys shall be signed by the individual(s) that performed the survey, and reviewed by the RPM, or designee.

6.2 General Area Radiation Surveys

6.2.1 General area surveys shall be performed with a portable radiation survey instrument that is sensitive to gamma, beta, and/or neutron radiations (i.e., microR meter, microrem meter, ionization chamber, remball, etc.), as appropriate.

6.2.2 Hold the instrument detector at waist level, slowly walking over the area of interest. General area surveys are conducted to ascertain the general area dose rate in accessible areas where personnel may be working or standing near surfaces that contribute to whole body exposure.

6.2.3 An increase in the instrument response or in the needle/indicator movement may indicate the presence of radioactivity in excess of background. The instrument shall be held stationary in the locations where the increased response is noted in order to confirm the response.

6.2.4 General area surveys should include normally accessible areas.

6.2.5 Obtain a representative number of general area radiation readings at knee level when the source of radiation is below waist level (i.e., radioactive material storage areas (RMSA)). Note the position of the reading on the radiation survey form (i.e. knee level).

6.2.6 Document radiation levels on Attachment 1. Any comments and notations that may be necessary for interpretation of results should be recorded on the survey form.

6.3 Contact Radiation Surveys

6.3.1 Surveys shall be performed with a portable radiation survey instrument that is sensitive to gamma, beta, and/or neutron radiations (e.g., microrem meter, microR meter, ionization chamber, remball, etc.), as appropriate.

6.3.2 Contact surveys should be taken so the detector housing is within ¼ inch of the item being evaluated. The detector housing should be positioned so that the active area of the detector is as close to the radiation source as practical.

6.3.3 A general area survey should be performed each time contact dose rates are measured, as appropriate.

6.3.4 Dose rate contributors shall be clearly identified on the survey form (i.e., bags, drums, piping, equipment, etc.).

6.4 Beta Radiation Surveys

6.4.1 Beta dose rate contribution is determined by calculating the open window reading and closed window reading difference, multiplied by the appropriate beta correction factor.

6.4.2 Beta radiation surveys shall be conducted where bulk beta-emitting radioactive materials are being used, handled, or stored as determined necessary by the RPM.

6.4.3 Beta radiation surveys may not be necessary when beta-emitting radioactive materials are present in the matrix of soil contamination, at the discretion of the RPM.

6.5 Removable Contamination (Smear) Surveys

6.5.1 Smear surveys shall be performed to assess removable contamination on vehicles, equipment, structures, bench tops, fume hoods, and other items.

6.5.2 Using moderate pressure, wipe the smear over an area of 100 cm^2. A 100 cm^2 area is approximated by a four-inch square or an eighteen-inch "S" shaped wipe.

6.5.3 Ensure sufficient quantities of smears are taken to adequately assess the magnitude and extent of contamination.

6.5.4 The smear should be placed in a sample holder (e.g., smear booklet or glassine envelope) such that individual smears are separated from each other to prevent cross contamination.

6.5.5 Smears shall be evaluated with a radiation detection instrument (i.e., bench scaler, gas flow proportional counter, liquid scintillation counter, etc.) that is sensitive to the type of radiation expected to be encountered.

6.5.6 Smear results (i.e., gross cpm) shall be converted to dpm/100 cm^2 , as applicable, in accordance with the Attachment 3, equations 1 and 2. Items with total surface area < 100 cm^2 shall be smeared over the entire surface and documented as dpm/item. Smear results shall be recorded on Attachment 1, or equivalent.

6.5.7 Smear results shall be compared with applicable site removable contamination criteria pursuant to HP-03, "Radiological Limits". The RPM shall be notified when unexpected removable contamination is encountered.

6.5.8 The RPM shall review survey data and implement appropriate controls (i.e., respiratory protection, protective clothing, area entry restrictions, etc.) as necessary.

6.6 Total Contamination (Direct Frisk) Surveys

6.6.1 Direct frisk surveys shall be performed to measure total (fixed plus removable) surficial contamination on personnel, vehicles, equipment, structures, and other items.

6.6.2 Direct frisk surveys shall be performed with a portable survey instrument (e.g., GM detector, dual-phosphor scintillation detector, gas flow proportional detector, etc) that is sensitive the type of radiation expected to be encountered.

6.6.3 Direct frisk scan surveys shall be conducted by moving the detector at 1-2 inches/second and with the active area of the detector at ¼ inch (alpha) and ½ inch (beta) from the surface of interest, as applicable.

6.6.4 When an increased instrument count rate is detected, the surveyor shall pause to allow the instrument response to stabilize.

6.6.5 Direct frisk activity (dpm/100cm^2) shall be calculated in accordance with Attachment 3, equations 1, 2, and 3.

6.6.6 Alternate scan speed and/or distance may be implemented at the discretion of the RPM.

6.6.7 Scan area coverage for release surveys of equipment and materials shall be 100% of accessible areas unless otherwise specified by the RPM.

6.6.8 A fixed-point (stationary) measurement should be performed where elevated activity was noted (and confirmed) during a scan survey.

6.6.9 Survey results shall be recorded on Attachment 1, or equivalent.

6.6.10 The surveyor shall compare survey results with applicable site specific total contamination criteria in accordance with HP-03, "Radiological Limits", and notify the RPM when unexpected surficial contamination is encountered.

6.7 Personnel Release Surveys

6.7.1 A radiological survey is required upon exit from any potentially contaminated area as determined by the RPM, or designee.

6.7.2 When scan area coverage (i.e., whole body, hand and foot, etc.) is not specified on a guiding document (SSHP, HSWP, etc.), the RPM, or designee should determine scan area coverage by evaluating the level of removable contamination in the work area, and the likelihood of contact with the contamination.

6.7.3 If the survey indicates contamination above background, the initial survey, personnel decontamination, and re-survey shall be performed and documented in accordance with HP-10, "Personnel and Equipment Decontamination". Surveys that do not indicate personnel contamination are not required to be documented.

6.8 Release surveys of equipment/materials for unrestricted use

6.8.1 Equipment and materials being surveyed for unrestricted release shall be surveyed in accordance with Sections 6.5 and 6.6 of this procedure (total and removable contamination surveys).

6.8.2 Equipment/material release surveys shall be documented on Attachment 1, or equivalent.

6.8.3 Release surveys shall be conducted by a Senior HPT or under the direction of a Senior HPT.

6.9 Airborne Particulate Sampling

6.9.1 Airborne particulate radioactivity shall be determined using an air pump connected to a filter cartridge.

6.9.2 In order to meet MDA requirements, verify the required minimum air sample volume from Attachment 2 of HP-03, "Site Limits" prior to collecting an air sample and document the minimum air sample volume on Attachment 4 of this procedure.

6.9.3 The flow rate to be used for calculations should be the average of the pre- and post-sampling flow rates.

6.9.4 The filter cartridge should contain a membrane filter, rather than a glass fiber filter, unless specified by the RPM.

6.9.5 Air shall be drawn through the filter for the duration of monitoring, or until visible dust loading or decreased flow is noted.

6.9.6 The following information should be recorded on Attachment 4 (or equivalent); the sample location, sample ID number, sampler ID, sampler calibration due date, sample date, the time at start/stop, the flow rate at start/stop, minimum air sample volume, HSWP number (as applicable), monitored workers and whether the sample is occupational/non-occupational.

6.9.7 The filter shall be removed from the cartridge and placed in a sample envelope such that individual filters are separated from each other to prevent cross contamination.

6.10 Air Sample Types

6.10.1 When occupational air sampling is required in the workplace, the RPM shall specify the type of occupational air sample that is required, including:

6.10.1.1 A breathing zone (BZ) sample is obtained within the *breathing zone* of the worker, i.e., in the vicinity of the nose and mouth. Sampling shall be performed at low flow rates with the intent of collecting a sample representative of what an individual worker is breathing.

6.10.1.2 A general area (GA) sample (or continuous air monitor sample) is collected in a fixed position without regard to the specific work evolution that represents the environment in the room.

6.10.1.3 A work area (WA) sample, which is temporary in nature, and obtained when a sample would be (conservatively) representative of a work crew. The sample should be obtained between the source of airborne exposure and the breathing zone of the individual with the highest likelihood for exposure. For example, an air sample placed near a drilling mast (or in the breathing zone of the individual handling the augers) would provide a conservative estimate of exposure for the entire drilling crew.

6.10.1.4 In situations in which there is a potential for accidents to cause intakes exceeding 40 DAC-hours in one day continuous air monitoring should be conducted. Monitoring may be through the use of BZ, GA, or WA samples, as determined appropriate by the RPM.

6.10.2 Perimeter (non-occupational) air samples shall be used to monitor non-occupational exposure, as required by the RPM. Perimeter air samples shall be placed at the boundary of the unrestricted area at sufficient locations to determine potential exposure to receptors.

6.11 Air Sample Evaluation

6.11.1 Air sample data shall be documented on Attachment 4, "Air Sample Report", or equivalent. As an alternative, air sample information may be entered into an air sample database, as directed by the RPM.

6.11.2 When the need for gross alpha/beta analysis is not immediate (i.e., internal monitoring is not required pursuant to HP-40, "Personnel Radiation Exposure Monitoring"), air sample counting and evaluation may be delayed to reduce the interference of radon and thoron components. Air samples should be counted 10-14 days after collection for accurate indication of actual air concentrations without radon and/or thoron interference.

6.11.3 In situations in which there is a potential for intakes to exceed 40 DAC-hours in one week, air samples should be screened on a daily basis (credit may be taken for respiratory protection factors if respirator protection is worn).

6.11.4 Screening air sample results > 1.0 DAC or 1.0 AE requires immediate notification of the RPM. In addition, Attachment 4 shall be reviewed by the RPM, or designee within 24 hours of counting the elevated screening sample.

6.11.5 Formal air sample results (i.e., reported from the laboratory or final count results) shall be reviewed by the RPM or designee within 7 days of receipt of the results.

6.11.6 Air samples may be screened (counted) for gross alpha and/or beta with a bench counter (e.g. dual phosphor scintillator, gas flow proportional counter) using the following method, as appropriate:

6.11.6.1 Place the air sample filter on the count tray, taking care not to disturb the active surface of the filter.

6.11.6.2 Close and lock the count tray,

6.11.6.3 Ensure the sample count time is set correctly to satisfy MDA requirements.

6.11.6.4 Count the sample.

6.11.6.5 Record the results of the count on Attachment 4.

6.11.6.6 Calculate the air sample activity and DAC-hrs in accordance with Attachment 3, Equations 10 and 12, respectively.

6.11.6.7 Document air sample activity and DAC-hours on Attachments 4 and 5, respectively. Equivalent forms may be used at the discretion of the RPM.

6.11.7 Air samples may also be evaluated (counted) by other methods or sent to a qualified vendor as determined appropriate by the RPM.

6.12 DAC-Hour Tracking

6.12.1 The HPTs shall complete Attachment 5, “DAC-hour Tracking” when:

6.12.1.1 Air monitoring (i.e., required internal monitoring) is conducted.

6.12.1.2 DAC-hour tracking is not required for air sampling conducted solely for routine surveillance purposes.

6.12.2 DAC-hours should be calculated using formal air sample results.

6.12.3 All individuals that were in the sampled area during the time frame of the air sample shall be entered on Attachment 5.

6.12.4 If internal monitoring is required, copies of Attachment 5 shall be forwarded to individual dose files when calculated individual DAC-hrs are equal to, or greater than, 0.4 DAC-hrs (1 mrem). As an alternate method, DAC-hr tracking results may be maintained by transferring dose information to an electronic dose-tracking database, as determined by the RPM.

6.13 Routine Surveillance Surveys

6.13.1 Routine surveillance surveys shall be conducted to verify that the radiological controls implemented by this radiation safety program are sufficient to prevent the spread of contamination, generation of airborne radioactivity, or radiation levels >2 mrem/hr outside Controlled Areas.

6.13.2 Routine surveillance surveys shall be conducted by HPTs in accordance with the requirements set forth in HP-12, “Health Physics Oversight”.

6.14 Walkover Surveys

6.14.1 Walkover surveys shall be performed with a portable survey instrument that is sensitive to gamma radiation (i.e., scintillation detector) in order to find contamination in soil or other media.

6.14.2 Walkover surveys should be conducted by moving the detector at a rate that does not exceed 1.5 feet/second (0.5 meter per second) at 4” (10 cm) from the surface.

6.14.3 An increase in the instrument response or in the needle/indicator movement may indicate the presence of radioactivity above background. The instrument should be held stationary for a time period determined appropriate by the RPM, or designee at locations where the increased response is noted in order to determine if the response is above or below the site investigation level.

6.14.4 Alternate scanning speed, scanning distance, or modes of transport (e.g., ATV) may be implemented, as long as survey data quality objectives are met, at the discretion of the RPM.

6.14.5 Instrument count-rate and other notations that may be necessary for interpretation of results shall be documented on Attachment 1, unless otherwise recorded electronically.

6.15 Radiological Sampling

6.15.1 Samples (i.e., water, soil, etc.) shall be collected in accordance with the provisions of a site-specific sampling plan, or equivalent document.

6.15.2 A chain-of-custody record shall be initiated by the individual collecting or overseeing the collection of samples.

6.15.3 A copy of the chain-of-custody form shall accompany the samples throughout transportation and analyses.

6.15.4 Any break in custody or evidence of tampering shall be documented and may comprise the validity of the sample results.

6.15.5 Sample custody shall be assigned to one individual at a time in order to prevent confusion of responsibility.

6.15.6 Custody is maintained when:

6.15.6.1 The sample is under direct surveillance by the assigned individual.

6.15.6.2 The sample is maintained in a tamper-free or tamper-evident container.

6.15.6.3 The sample is within a controlled-access facility.

6.15.7 Samples that are submitted to a radioanalytical laboratory should be accompanied by a "Request for Analysis" form used by the laboratory, if required.

6.15.8 The radioanalytical laboratory shall have written procedures that document the laboratory's analytical capabilities for the request analysis and a QA/QC program which assures the validity of the analytical results.

6.16 Additional Guidance

6.16.1 The RPM may use the references contained in Section 3.0 of this procedure as additional guidance to determine appropriate elements of the radiological monitoring program for specific client facilities or sites.

7.0 Records

7.1 The RPM shall maintain records of surveys and calibrations required by this procedure, for thee (3) years after the record is made.

7.2 Records of the results of surveys, measurements, and calculations shall be maintained until the NRC terminates the license (if applicable) requiring the record if used to determine:

7.2.1 External dose (i.e., DDE, shallow dose equivalent, lens (eye) dose equivalent, dose to extremities, etc.) from radiation sources external to the body;

7.2.2 Internal dose (i.e., CEDE, CDE) from the intake of radioactive materials;

7.2.3 The release of radioactive effluents to the environment;

7.2.4 Compliance with the dose limit for members of the public.

7.3 All records generated as a result of this procedure shall be maintained by the RPM until transmitted to the appropriate Central Records Facility.

SAIC RADIOLOGICAL SURVEY REPORT

SURVEY LOCATION:	HSWP:	Page of
PURPOSE OF SURVEY:	DATE:	TIME:

Instrument Type(s): (√ if used)	Detector Area (cm^2)	Serial Number:		Cal. Due Date:		Background: (CPM)		Efficiency (%)	
		meter	detector	meter	detector	Alpha (α)	Beta (βγ)	Alpha (α)	Beta (βγ)
☐ Ludlum 2221/43-10 ___	N/A								
☐ Ludlum 2360/43-89 ___	125								
☐ Ludlum 2221/44-9 ___	15.5								
☐ Micro-R ___	N/A								

Contamination Limits: ($dpm/100cm^2$) Removable α _____ Removable βγ _____ Total α _____ Total βγ _____

Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	$dpm/100cm^2$ α Removable	Gross CPM βγ Removable	Net CPM βγ Removable	$dpm/100cm^2$ βγ Removable	Gross CPM α Total	Net CPM α Total	$dpm/100cm^2$ α Total	Gross CPM βγ Total	Net CPM βγ Total	$dpm/100cm^2$ βγ Total	mR/hr or μR/hr

REMARKS:

TECHNICIAN(S) SIGNATURE/DATE: _____/_____ _____/_____

REVIEWER SIGNATURE/DATE: _____/_____

SAIC RADIOLOGICAL SURVEY REPORT (Supplement)

SURVEY LOCATION:													Page of
Contamination Limits: (dpm/100cm²)		Removable α _____			Removable βγ _____			Total α _____			Total βγ _____		
Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	dpm/100cm² α Removable	Gross CPM βγ Removable	Net CPM βγ Removable	dpm/100cm² βγ Removable	Gross CPM α Total	Net CPM α Total	dpm/100cm² α Total	Gross CPM βγ Total	Net CPM βγ Total	dpm/100cm² βγ Total	mR/hr or µR/hr

REMARKS:

TECHNICIAN(S) SIGNATURE/DATE: _____/_____ _____/_____

REVIEWER SIGNATURE/DATE: _____/_____

SAIC RADIOLOGICAL SURVEY REPORT (Map)

SURVEY LOCATION:	HSWP:	Page of
LEGEND: (Fill in blank) _____= Smear Location _____= G/A Dose Rate □ mR/hr □ µR/hr	DATE:	TIME:
REMARKS:		
TECHNICIAN(S) SIGNATURE/DATE: _____/_____ _____/_____		
REVIEWER SIGNATURE/DATE: _____/_____		

SAIC RADIOLOGICAL SURVEY REPORT WALKOVER SURVEYS

SURVEY LOCATION:				
DATE:	TIME:	HSWP:		
PURPOSE OF SURVEY:				
Instrument Type(s): (√ if used)	**Serial Number: (meter/detector)**	**Cal Due Date: (meter-detector)**	**Background: (CPM α/βγ)**	**Efficiency (%) (α/βγ)**
____Ludlum 2221/44-10				N/A

REMARKS:

TECHNICIAN(S) SIGNATURE/DATE: _____/_____ _____/_____

REVIEWER SIGNATURE/DATE: _____/_____

RADIOLOGICAL SURVEY CALCULATIONS

Count-rate
(Equation 1)

$$\text{Net Counts Per Minute (NCPM)} = \text{GCPM} - \text{BCPM}$$

GCPM = gross counts per minute
BCPM = background counts per minute

Activity
(Equation 2)

$$\text{DPM} = \frac{\text{NCPM}}{\varepsilon_i}$$

NCPM = net counts per minute
ε_i = instrument efficiency (cd^{-1})

Activity - Direct Frisk
(Equation 3)

$$\text{dpm}/100\ \text{cm}^2 = \frac{\text{NCPM}}{\varepsilon_i \times \text{DA}} \times \frac{100\ \text{cm}^2}{100\ \text{cm}^2}$$

where: Ludlum 43-93 probe area = 126 cm^2
Ludlum 44-9 probe area = 15.5 cm^2
Ludlum 43-89 probe area = 125 cm^2
Ludlum 43-5 probe area = 76 cm^2

dpm = disintegrations per minute
ε_i = instrument efficiency (cd^{-1})
DA = detector area (cm^2)
NCPM = net counts per minute

Counter Detection Limit (L_D) – 95% confidence level, **differing** count/background count times
(Equation 4)

$$L_D = 3 + 3.29\sqrt{(R_B)(T_S)(1+\frac{T_S}{T_B})}$$

L_D = *a priori* detection limit [minimum significant activity level]
R_B = background count rate (cpm)
T_B = background count time (minutes)
T_S = sample count time (minutes)

The detection limit, L_D, is the *a priori* (before the fact) activity level that an instrument can be expected to detect 95% of the time. It is the smallest amount of activity that can be detected at a 95% confidence level. It should be used to calculate the minimum detection capability of an instrument.

Counter Detection Limit (L_D) – 95% confidence level, **same** count/background count times
(Equation 5)

$$L_D = 3 + 4.65\sqrt{R_B}$$

L_D = *a priori* detection limit [minimum significant activity level]
R_B = background counts

The detection limit, L_D, is the *a priori* (before the fact) activity level that an instrument can be expected to detect 95% of the time. It is the smallest amount of activity that can be detected at a 95% confidence level. It should be used to calculate the minimum detection capability of an instrument.

Portable Counter (time count) Minimum Detectable Activity (MDA)
(Equation 6)

$$\text{MDA (dpm/100 cm}^2) = \frac{L_D}{[DA][\varepsilon_i][\varepsilon_s][T]} x \frac{100 cm^2}{100 cm^2}$$

L_D = *a priori* detection limit [minimum significant activity level]
DA = detector area (cm^2)
ε_i = instrument efficiency (cd^{-1})
ε_s = surface efficiency (unitless)
T = count time (minutes)

Notes: Surface efficiency is normally only used during a final status survey and is otherwise set to one (1).

Bench Counter Smear Minimum Detectable Activity (MDA)
(Equation 7)

$$\text{Smear MDA (dpm/100 cm}^2) = \frac{L_D}{(T)(\varepsilon_i)}$$

L_D = *a priori* detection limit [minimum significant activity level]
T = smear count time (minutes)
ε_i = instrument efficiency (cd^{-1})

Notes: Smear is assumed to have been wiped over a 100 cm^2 area on the item surveyed.

Frisker Scan Minimum Detectable Activity (MDA)
(Equation 8)

The observable background counts (*b*) is defined as the number of background counts observed within the observation interval (*i*). The equation used for calculating *b'* is as follows:

$$b = (\text{BCPM}) \times (i) \times (1 \text{ min}/60 \text{ sec}) = \text{counts/interval}$$

BCPM = instrument background (or reference area background count rate for final status surveys)
i = observation interval (seconds)

The minimum detectable number of net source counts in the interval is given by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (*d*) as shown below:

$$s_i = d\sqrt{b} \quad \text{(counts per observation interval)}$$

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d*, is defined as the index of sensitivity and is dependent on the selected decision errors for Type I (alpha) and Type II (beta) errors. A true positive error (1-β) of 95% and a false positive error (alpha) of 60% may be selected to be consistent with NUREG 1507. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

$$\text{MDCR (cpm)} = s_i \times (60/i)$$

Finally, the scan MDAs for surfaces may be calculated:

$$\text{Scan MDA} = \frac{\text{MDCR}}{\sqrt{p}\ \varepsilon_i\ \varepsilon_s\ DA} \times \frac{100 \text{ cm}^2}{100 \text{ cm}^2}$$

where:

MCDR = minimum detectable count rate (cpm)

ε_i = instrument efficiency (cd^{-1})

ε_s = surface efficiency (unitless - normally only used for final status surveys)

p = surveyor efficiency (unitless - normally assumed to be 50% (0.50))

DA = detector area (cm^2)

Air Sample Minimum Detectable Concentration (MDC)
(Equation 9)

$$\text{Air Sample MDC } (\mu\text{Ci/ml}) = \frac{L_D}{(T)\,(\varepsilon_i)\,(\varepsilon_c)\,(V)\,(2.22\ E^9)}$$

where:
L_D = *a priori* detection limit [minimum significant activity level]
T = air sample count time (minutes)
ε_i = instrument efficiency (cd^{-1})
ε_c = collection efficiency (default to 0.99
V = sample volume (ml)
2.22E9 = conversion from dpm to µCi and L to ml.

Air Sample Activity
(Equation 10)

$$\text{Air Sample Activity } (\mu\text{Ci/ml}) = \frac{(\text{NCPM})}{(\varepsilon_i)\,(\varepsilon_c)\,(V)\,(2.22\ E^9)}$$

where:
NCPM = Net counts per minute = Gross counts per minute – background counts per minute
ε_i = Instrument efficiency (cd^{-1})
ε_c = Collection efficiency (default value is 0.99)
V = Sample volume (liters) [if converting from ft^3, multiply ft^3 by 28.3 to calculate liters]
2.22E9 = conversion from dpm to µCi and L to ml.

DAC Fraction
(Equation 11)

$$\text{DAC Faction} = \frac{\text{Air Sample Activity } (\mu\text{/mL})}{\text{Site (alpha or beta) DAC Value } (\mu\text{Ci/mL})}$$

DAC = derived air concentration

DAC-hrs
(Equation 12)

$$\text{DAC-hrs} = (\text{DAC Fraction}) * (\#\text{ hrs in monitored work area})$$

Dose Equivalent
(Equation 13)

$$CEDE = DAC - hrs \times 2.5 \frac{mrem}{DAC - hr}$$

CEDE = committed effective dose equivalent (mrem)
DAC-hrs = derived air concentration hours

AIR SAMPLE REPORT

Section I

Date: _____ Sample ID: _____ HSWP#: _____

Occupational: ☐ DAC value: _____ µCi/ml (**H**) Breathing Zone: ☐ General Area: ☐ Work Area: ☐

Non-Occupational: ☐ AE value: _____ µCi/ml (**H**) Radionuclides: _____

Site: _____ Location: _____ Sampled By: _____

Wearer (if applicable): _____ Activity Performed: _____

Monitored Workers: _____

Pump Model: _____ Serial Number: _____ Calibration Due Date: _____

Flow Meter: _____ Serial Number: _____ Calibration Due Date: _____

Sample Information	Time			Flow Rate (lpm)	
Date	Start	Stop	Total (minutes)	Start	Stop
	Total Time:			Average Flow Rate: _____ (lpm)	

Minimum Occupational Air Sample Volume: _____ Liters Minimum Non-Occupational Air Sample Volume: _____ Liters

Sample Volume = _____ (lpm) x _____ (minutes) = _____ Liters (**A**)

Remarks: _____

Sent to lab **after** a screen for final count ☐ (Section II required) Sent to lab **without** a screen for final count ☐ (Section II NOT required)

Section II

Instrument Information	Serial Number:		Cal. Due Date:				
Instrument Type	meter	detector	meter	detector	1st Count	2nd Count	3rd Count
					☐	☐	☐
					☐	☐	☐
					☐	☐	☐

Count Information		**ALPHA**			**BETA**		
Variables	**Units**	**1st Count**	**2nd Count**	**3rd Count**	**1st Count**	**2nd Count**	**3rd Count**
Count Date							
Count Time (e.g., noon, 1300, etc.)							
Sample Count Time	Minutes						
Total Counts	Counts						
Sample Count Rate	CPM						
Background Count Rate	CPM						
Volume of Air (Liters) (**A**)	Liters						
Net Count Rate (CPM) (**B**)	CPM						
Counter Efficiency (**C**)							
Collection Efficiency (**D**)	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Efficiency = (**C**) x (**D**) (**E**)							
Activity (DPM) = (**B**) / (**E**) (**F**)	DPM						
Conc. = (**F**) / (2.22E9 x (**A**)) (**G**)	µCi/ml						
DAC/AE Fraction = (**G**) / (**H**)							
Final Count?	Yes / No						

Note: DAC/AE fractions > 1.0 requires immediate RPM notification. **RPM Notified** ☐

Calculated By: _____ Date: _____

Reviewed By: _____ Date: _____

DAC-HR TRACKING

Site: _____ Air Sample Date/Time: _____ HSWP: _____ Sample ID: _____

NAME	HPID#	WORK AREA	TIME IN	TIME OUT	TOTAL TIME (HR)[1]	Sample Results (μCi/mL)	Sample DAC (μCi/mL)	Corrected DAC Fraction[2]	DAC-hrs[3]	CEDE[4] (mrem)	CALCULATED BY (INITIALS)

[1] Total time is to be recorded in hours and fractions of hours (e.g. 1.5).

[2] PF = 1 for no respirator; PF = 50 for Full Face Negative Pressure; PF = 2000 for a Supplied Air; PF = 10,000 for SCBA (see 10 CFR 20, Appendix A)
Corrected DAC-Fraction = Sample Results/Sample DAC/PF

[3] Calculate DAC-Hrs by multiplying the total time by the Corrected DAC Fraction.

[4] Calculate CEDE by multiplying DAC-hrs by (2.5 mrem per DAC-hr).

Reviewed by RPM: _____ DATE: _____

If monitoring is required and ≥ 0.4 DAC-hrs calculated (i.e., 1 mrem), dose records updated by: _____ Date: _____

SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-12

REV. 1

HEALTH PHYSICS OVERSIGHT

APPROVED BY: ___ DATE: 12/11/02

r

APPROVED BY:_____ DATE: 12/11/02

EC/HS Manager

APPROVED BY:_____ DATE:_____

QA/QC Officer

TABLE OF CONTENTS

SECTION **PAGE**

LIST OF ATTACHMENTS

1.0 Purpose

This procedure establishes guidelines and requirements for health physics (HP) oversight, including; restricted area requirements, job coverage, stop-work, release surveys, and routine surveillance.

2.0 Scope

This procedure applies to HP oversight at sites working under this radiation safety program. At sites controlled by others, the provisions of their HP program may apply.

3.0 References

3.1 10 CFR 20, “Standards for Protection Against Radiation”

3.2 HP-01, “Health Physics Manual”

3.3 HP-03, “Radiological Limits”

3.4 HP-05, “Personal Protective Equipment”

3.5 HP-06, “Radiological Respiratory Protection”

3.6 HP-10, “Personnel and Equipment Decontamination”

3.7 HP-11, “Radiological Monitoring”

3.8 HP-20, “Radiological Posting and Labeling”

3.9 HP-22, “Radiological Reporting”

4.0 Definitions

4.1 **Airborne Radioactivity Area** – a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

4.1.1 In excess of the derived air concentrations (DACs) specified in Appendiix B, to 10 CFR 20, or

4.1.2 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 one week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

4.2 **Contamination** - The deposition of radioactive material on accessible surfaces of structures, objects, equipment, or personnel that exceeds site surficial release limits. Contamination may be either "fixed" (e.g., not removable by rubbing with a dry smear) or "removable". Total Contamination refers to fixed plus removable contamination.

4.3 **Contamination Area –** Any area with total and/or smearable (removable) contamination levels greater than site specific contamination limits as documented on Attachment 2 of HP-03, “Radiological Limits” or other site specific documentation (i.e., Site Safety and Health Plan (SSHP), Radiation Protection Plan (RPP), etc.).

4.4 **Controlled Area** – An area, outside of a restricted area but inside the site boundary, access to which can be limited for any reason.

4.5 **High Radiation Area –** Any area accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 100 mrem in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates.

4.6 **Hot Spot** – A source of radiation emanating from equipment or components that is greater than 50 mrem/hr on contact and of a significantly higher (factor of three) radiation level than the surrounding general area, where it is likely personnel could receive exposure higher than expected while in the area. Post as a "HOT SPOT" with additional information concerning the area and applicable dose rates.

4.7 **HPT Coverage** – The assistance provided by HPTs for the purpose of keeping radiation exposure ALARA, preventing the spread of contamination and airborne radioactive material hazards, and monitoring the general work area.

4.7.1 Continuous Coverage - HPTs providing continuous coverage are in the area to monitor radiological conditions during performance of the task and are available to direct or stop work activities as conditions warrant. Line-of-sight coverage is not required (e.g., HPTs may leave the immediate work area to count smears or air samples).

4.7.2 Intermittent Coverage - The assignment of an HPT to one or more jobs, such that HP coverage is periodic. HPTs providing intermittent coverage are aware of the worker's presence in the work area, but radiological conditions do not require continuous communication with the workers.

4.8 **Loose surface contamination (Removable)** - Radioactive material easily transferred by normal handling and contact.

4.9 **Radiation Area –** Any area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 5 mrem in 1 hour at 30 cm from the radiation source or any surface that the radiation penetrates.

4.10 **Radioactive Material Area (RMA) –** an area or room in which there is used or stored an amount of radioactive material exceeding 10 times the quantity of such material specified in Appendix C to 10 CFR 20.

Note: If a combination of materials is present (i.e., a combination of uranium and ^{60}Co), the following relationship must be used to determine if the area must be posted as an RMA:

$$\frac{\mu Ci_{Co}}{10Q_{Co}} + \frac{\mu Ci_{U}}{10Q_{U}} \leq 10$$

where Q = the quantity shown in Appendix C of 10 CFR 20.

4.11 **Radioactive Material Storage Area (RMSA) –** An administratively designated area where radioactive material is stored and controlled.

4.12 **Restricted Area –** A radiological area, access to which is limited, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.,

4.13 **Stop Work Authority** – The authority provided to HPTs and radiological workers to immediately stop work for the following reasons:

4.13.1 If conditions develop that were not anticipated which would result in a significant increase in radiological or industrial safety hazards.

4.13.2 The conditions on the job have degraded to the point that the work is not being performed consistent with the ALARA concept.

4.13.3 The potential for deterioration of occupational safety exists if the job is continued.

4.13.4 The work practices may result in violation of regulatory requirements or HP procedures.

4.14 **Unrestricted Area** - Any area to which access is neither limited nor controlled.

4.15 **Unconditional (Unrestricted) Release** - Equipment, components, materials, land areas (property), and other items that may be used, transferred, sold, or disposed of without regard for their radiological constituents.

4.16 **Very High Radiation Area –** Area accessible to individuals in which the radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads in 1 hour at 1 meter (m) from the source or any surface that the radiation penetrates.

4.17 **Volumetric material** – Material that takes the shape of its container, such as; water, sand, or soil.

5.0 Responsibilities

5.1 The Radiation Protection Manager (RPM) shall:

5.1.1 Verify compliance with this procedure during planned and periodic audits of the radiation safety program.

5.1.2 Shut-down or prevent a task or project from starting if the task/project may violate requirements for radiological protection, and specify the actions that are necessary to continue work and lift the stop-work order.

5.1.3 Specify job coverage requirements on a Site Safety and Health Plan, Work Plan, HSWP, or equivalent.

5.1.4 Ensure that radiological workers are trained on restricted area requirements.

5.2 Health Physics Technicians (HPTs) shall:

5.2.1 Shut-down or prevent a task from starting if the task may violate regulatory requirements for radiological protection.

5.2.2 Perform job coverage, release surveys, and routine surveillance in accordance with the requirements of this procedure.

5.2.3 Initiate stop-work orders in accordance with the provisions of this procedure.

5.3 Radiological workers shall:

5.3.1 Comply with the requirements in Attachment 1, "Radworker Restricted Area Requirements".

5.3.2 Shut-down or prevent a task from starting if the task may violate regulatory requirements for radiological protection.

6.0 Procedure

6.1 General Requirements

6.1.1 Radiation and contamination surveys shall be performed in accordance with HP-11, "Radiological Monitoring".

6.1.2 Airborne radioactivity surveys shall be performed in accordance with HP-11, "Radiological Monitoring".

6.1.3 Survey results shall be compared against the criteria specified in HP-03, "Radiological Limits".

6.1.4 Respiratory protection shall be considered and used in accordance with the provisions of HP-06, "Radiological Respiratory Protection".

6.2 Restricted Area Requirements

6.2.1 Prior to allowing unescorted access into the Restricted Area, personnel are required to successfully complete Site Orientation Training and Radiation Worker Training (RWT) in accordance with HP-04, "Qualifications and Training". The RPM may permit an individual access to the RESTRICTED AREA without this training, provided the individual is accompanied by a qualified escort and a waiver form has been completed and signed by the RPM, or designee.

6.2.2 No entry is permitted into the Restricted Area without sufficient cause for the entry (i.e., no "sightseeing" in contamination, airborne radioactivity, radiation or high radiation areas).

6.2.3 Individuals with accumulated exposure > 70% of allowable administrative exposure limits will be restricted from entry into High Radiation Areas.

6.2.4 Approval by the RSO and/or an extension of the administrative dose limit is required for individuals with accumulated exposure > 70% of allowable administrative exposure limits.

6.2.5 Individuals shall follow Restricted Area requirements in accordance with Attachment 1, while working in Restricted Areas.

6.3 Job Coverage

6.3.1 Job specific surveys shall be performed as frequently as necessary to document the level of radiological hazards in the work area.

6.3.2 Continous coverage shall be provided for all entries into High Radiation Areas or Airborne Radioactivity Areas, and for work that may cause a significant change to radiological conditions.

6.3.3 Intermittent coverage shall be provided for entries into Restricted Areas with little, or no potential to change radiological conditions.

6.4 High Radiation Areas (HRA) and Very High Radiation Areas (VHRA)

6.4.1 HRAs and VHRAs shall be conspicuously posted and barricaded in accordance with 10 CFR 20.

6.4.2 Entryways to HRAs and VHRAs should be locked, except during periods when access to the areas is required. Positive controls shall be maintained during each entry into a HRA.

6.4.3 When conditions are impractical for barricading or locking, such as limited evolution jobs or temporary storage, flashing lights (normally red) are utilized with the HRA and VHRA postings to alert the individual to potential entry into a HRA or VHRA.

6.4.4 Direct surveillance, to prevent unauthorized entry, may be substituted for locked areas or flashing lights for temporary HRAs or VHRAs.

6.4.5 Personnel entering a HRA or VHRA shall have one or more of the following:

6.4.5.1 A radiation monitoring device which continuously indicates the radiation exposure rate in the area.

6.4.5.2 A radiation monitoring device which continuously integrates the radiation exposure rate in the area and alarms when a preset integrated dose is received. Entry into such areas with this monitoring device may be made after the exposure rate level in the area has been established and personnel have been made knowledgeable of them.

6.4.5.3 A HPT with a radiation exposure rate monitoring device, and who is responsible for providing positive control over the activities within the area.

6.4.6 In addition to the requirements for entry into HRAs, the following requirements shall apply for entry into VHRA:

6.4.6.1 Areas are posted as Very High Radiation Areas if dose rates could exceed 500 rads in 1 hour at 1 meter from any source.

6.4.6.2 The RPM shall institute the controls necessary (in addition to the controls above) to ensure that an individual is not able to gain unauthorized access to VHRAs in which radiation levels could be encountered at 500 rads or more in one hour at 1 meter from a radiation source or any surface through which the radiation penetrates.

6.5 Stop Work

6.5.1 All HPTs and other radiological workers shall have the responsibility and authority to initiate a stop-work order.

6.5.2 If radiological conditions exceed expected levels to an extent where additional protection measures may be required, HPTs shall initiate a stop-work order and notify the RPM.

6.5.3 Once aware of known or suspected unsafe work conditions, the individual shall assess the situation and, as necessary, issue a stop-work order. The RPM shall be notified immediately.

6.5.4 Specific work activities shall be permitted to proceed to a safe condition after issuance of the stop-work order. The RPM, or designee should supervise specific work activities as they proceed to a safe shut down.

6.5.5 Stop Work orders shall be documented in accordance with HP-22, "Radiological Reporting".

6.6 Personnel Release Surveys

6.6.1 A personnel release survey (frisk with a handheld radiological survey instrument) is required upon exit from any potentially contaminated area as determined by the RPM, or designee.

6.6.2 Radiological workers may perform personnel frisks unless otherwise specified on the task specific HSWP.

6.6.3 A whole-body frisk should take approximately 2 - 3 minutes, and include the: head, neck, chest, abdomen, shoulders, arms, back, hips, seat of pants, legs, shoe tops, shoe bottoms, personnel dosimetry, and hard-hat, as applicable.

6.6.4 When an increased instrument count rate is detected above the background count rate, the surveyor shall pause over the suspect area for a time sufficient to allow the instrument response to stabilize.

6.6.5 If personnel skin or clothing contamination above background is confirmed, personnel decontamination shall be performed and documented in accordance with HP-10, "Personnel and Equipment Decontamination".

6.7 Surficial Material and Equipment Release Surveys

6.7.1 Material and equipment that may be unconditionally released include; sampling equipment, PPE, monitoring equipment, or any other solid item.

6.7.2 When surveying materials, consideration must be made for the chemical hazards associated with the material. If the material is radiologically clean but has a chemical hazard, the site Project Manager must be contacted for correct disposition of the material.

6.7.3 Clients may restrict the release of selected materials, such as PPE. Verify release restrictions in site work plans or safety and health plans prior to releasing an item for unrestricted use.

6.7.4 A surficial total and removable contamination survey must be performed prior to unconditional release.

6.7.5 Only Health Physics personnel may perform material or equipment release surveys.

6.7.6 Surveys should be concentrated on locations most likely to be contaminated. However, the entire item shall be surveyed for total contamination by direct frisk of accessible surfaces, unless documented otherwise by the RPM.

6.7.7 Materials with inaccessible surfaces should be evaluated for release on a case-by-case basis. Factors to be considered are; the removable contamination activity of the work area, the likelihood of internal contamination based on the function of the item, or whether disassembly of the item is practical.

6.7.8 Release survey results shall be compared to the surficial contamination limits provided by the RPM on Attachment 2 of HP-03, "Radiological Limits".

6.8 Material Conditional Release Surveys

6.8.1 At no time shall materials/items conditionally released from the Restricted Area be removed from the site without approval of the RPM.

6.8.2 Radioactive materials (i.e., calibration sources, samples, etc.) that do not meet the requirements for unrestricted release may need to be removed from the Restricted Area for use in instrument performance tests, sample analysis, or other program needs. These items may be removed from the Restricted Area in accordance with the following requirements:

6.8.2.1 Radioactive source standards must be under continuous control of HPTs.

6.8.2.2 Radioactive material, other than source standards, shall be placed in closed containers with the exterior of the container meeting the unconditional release limits for removable contamination. The container will also have the appropriate labels or stickers in accordance with 10 CFR 20.

6.8.2.3 Packages of radioactive material offered for transport in accordance with 49 CFR shall meet the removable contamination limits.

6.9 Vehicle Release Surveys

6.9.1 Vehicles shall be surveyed for removable and total contamination prior to release from the RESTRICTED AREA.

6.9.2 Only Health Physics personnel may perform vehicle release surveys.

6.9.3 During the release survey, consideration should be given for surfaces most likely to be contaminated, such as the; wheels/tires, floorboard, steering wheel, or areas where radioactive material may have been transported.

6.9.4 Surfaces shall be reasonably free of material that will prohibit the detection of radioactivity, such as mud.

6.9.5 Vehicle identifying information, such as license plate number, rental agency, or company name, should be noted on the survey form.

6.10 Volumetric Material Release Surveys

6.10.1 A surficial survey may not be representative of volumetric material radioactivity; HPTs shall contact the RPM for release requirements. At no time shall volumetric material (or an item known or suspected to be volumetrically contaminated) be released from the site without approval of the RPM.

6.10.2 Sampling shall be performed to determine volumetric material activity, as directed by the RPM, or designee. The RPM, or designee shall compare the concentration of radionuclides in the material with appropriate volumetric release limits with concurrence of the project client.

6.10.3 An unopened container of volumetric material, such as a bag of sand, may be released using standard survey techniques.

6.10.4 Materials and equipment requiring volumetric release surveys may also require surficial release surveys, as determined by the RPM, or designee.

6.11 Routine Surveillance

6.11.1 At projects/sites controlled by this radiation safety program with an expected duration longer than three months, the RPM shall specify the frequency of routine surveys by completion of Attachment 2, “Routine Surveillance Frequency”.

6.11.2 Routinely accessed Restricted Areas shall be routinely surveyed at the frequencies specified by the RPM. Survey frequencies should be based on the likelihood of changing radiological conditions. Types of routine surveys may include; removable contamination surveys, total contamination surveys, radiation surveys, and/or airborne radioactive material surveys.

6.11.3 HRAs and VHRAs do not require routine surveillance. Surveys in posted HRAs and VHRAs should be conducted as appropriate when access is required into the area to verify the magnitude and extent of potential radiological hazards in the area. Pre-entry surveys should cover areas that are planned to be accessed by personnel, at a minimum.

6.11.4 When performing a routine surveillance survey, the area and type of work in the area should be considered, specifically:

6.11.4.1 Office areas should routinely have desktops and door handles smeared because those and similar areas are the most likely areas where contamination would be spread.

6.11.4.2 Work areas should routinely have hand tools, control panels or other items frequently handled smeared because these areas are most likely to become contaminated.

6.11.4.3 Consideration should be given to all likely areas where contamination may have been spread not just those areas where personnel walk.

7.0 Records

All records generated as a result of this procedure shall be maintained by the RPM until transmitted to the appropriate Central Records Facility.

Radworker Restricted Area Requirements

Prior to entry into a Restricted Area:

1. Pick up your TLD and SRD (if required) from the issue point.

2. Log in, if required by the HSWP, by filling out the sign-in sheet and proceed to the Restricted Area. If respiratory protection is required, use the code at the bottom of the sheet to indicate the type of respirator you are using. Accurately account for time and radiation exposure in the Restricted Area.

3. Properly don PPE in accordance with HP-05, "Personnel Protective Equipment", HPT instructions, or posted instructions, as applicable.

4. Remove all external packaging if bringing materials and equipment into the Restricted Area to minimize generation of radioactive waste.

5. Take only the tools and materials actually needed for the work; limit the amount of materials in the area.

6. Report the presence of treated or open wounds to the HPT covering the activity.

While in the Restricted Area:

7. Utilize the appropriate container for all potentially non-radioactive trash generated outside of a Contaminated Area. Ensure protective clothing, respirators and radwaste are placed in the proper containers.

8. While working in Contamination Areas keep your hands away from your face and use caution not to splash or cause a spill while handling liquids.

9. Do not sweep with standard brooms in a Restricted Area. Masslinn mops are the only approved "sweeping" means. All vacuum cleaners used in the Restricted Area should be HEPA filtered vacuums.

10. Ensure that the HPT covering the activity is contacted before entry is made to any normally inaccessible area.

11. Notify the HPT covering the activity prior to entry into any Airborne Radioactivity Area or HRA.

12. Notify the HPT covering the activity for any changes to the job scope, prior to air tool usage in Contamination Areas and any radiological deficiency (e.g., postings missing or defaced, barriers down or damaged).

13. DO NOT move or remove postings, barriers, shielding or equipment unless directed to do so by a Senior HPT, Health Physicist, or the RPM.

14. Follow all HPT instructions and HP procedures. Promptly obey "stop work" and "evacuate" instructions issued by the HPT covering the activity.

15. DO NOT smoke, chew, eat, or drink or bring smoking, eating, chewing, or drinking materials into the Restricted Area.

16. Properly doff PPE, and perform an appropriate body frisk (as required by the HSWP or HPT instruction) when leaving a Contamination Area.

17. Minimize the spread of a known or a potential radioactivity spill, and notify the HPT covering the activity.

18. Avoid unnecessary contact with contaminated surfaces, including your clothing (if contaminated), tools and other equipment.

19. Keep your radiation and hazardous material exposure ALARA, including leaving Radiation Areas or Airborne Radioactivity Areas when not working.

20. Exit the area promptly if a wound occurs, or any injury is received, and notify the HPT covering the activity.

21. Maintain good housekeeping practices to minimize the spread of contamination.

22. If utilizing a self reading dosimeter:

    - And the dosimeter reads greater than 1/2 full scale, have a HPT re-zero the dosimeter prior to entering the Restricted Area.
    - If a dosimeter reads 3/4 full scale or greater while working in the Restricted Area, exit the area and have an HPT document exposure and re-zero the dosimeter.
    - Notify the HPT covering the activity immediately anytime a self-reading dosimeter reads off-scale, is dropped, or is lost.
    - Keep track of your own radiation dose.
    - Notify the HPT covering the activity of any unexpected exposures received (e.g., receiving high exposures in low exposure areas).
    - Do not exceed your remaining allowable exposure.

<u>Upon Exit from the Restricted Area:</u>

23. Perform an appropriate body frisk as required by the HSWP, posted instructions, or HPT instructions.

24. Sign out of the HSWP (as required), and return your dosimetry to the issue point.

ROUTINE SURVEILLANCE FREQUENCY

Site:_____ Date: _____ Signature (RPM):_____

Frequency	Location/Description	Radiation Survey[1]	Contamination Survey[2]	Air Sample[3]

[1] List the requirement such as general area and/or on-contact radiation survey.
[2] List the requirement such as total and/or removable contamination survey.
[3] List the requirement such as breathing zone (occupational), work area (occupational), general area (occupational), and/or perimeter (non-occupational) air samples.

SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-20

REV. 1

RADIOLOGICAL POSTING AND LABELING

APPROVED BY:_____ DATE: 12/11/02
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APPROVED BY:_____ DATE: 12/11/02
EC/HS Manager

APPROVED BY:_____ DATE:_____
QA/QC Officer

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SECTION **PAGE**

1.0 Purpose

This procedure establishes guidelines and requirements for radiological postings and labels.

2.0 Scope

This procedure applies to all radiological areas at sites working under this SAIC radiation safety program.

This procedure is based primarily upon the requirements set forth in 10 CFR 20. Sites other than those regulated by the Nuclear Regulatory Commission (NRC) may require establishment of guidelines and requirements for radiological postings differing from those set forth in this procedure (i.e., 10 CFR 835). SAIC will document these differences and establish guidelines and requirements for radiological postings in the Site Safety and Health Plan (SSHP) or other appropriate document for that site, as applicable.

3.0 References

3.1 10 CFR 19, "Notices, Instructions and Reports for Workers; Inspection and Investigations"

3.2 10 CFR 20, "Standards for Protection Against Radiation"

3.3 DOE-STD-1098-99, "Radiological Control Standard"

3.4 HP-01, "Health Physics Manual"

3.5 HP-03, "Radiological Limits"

4.0 Definitions

4.1 **Airborne Radioactivity Area** – a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

4.1.1 In excess of the derived air concentrations (DACs) specified in Appendix B, to 10 CFR 20, or

4.1.2 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 one week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

Posting requirement: "CAUTION - AIRBORNE RADIOACTIVITY AREA" or "DANGER – AIRBORNE RADIOACTIVITY AREA".

4.2 **Contamination Area –** Any area with total and/or smearable (removable) contamination levels greater than site specific contamination limits as documented on Attachment 2 of HP-03, "Radiological Limits" or other site specific documentation (i.e., Site Safety and Health Plan (SSHP), Radiation Protection Plan (RPP), etc.). Post as: "CONTAMINATION AREA".

4.3 **Controlled Area** – An area, outside of a restricted area but inside the site boundary, access to which can be limited for any reason.

4.4 **High Radiation Area –** Any area accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 100 mrem in 1 hour at 30 cm from the radiation source or from any surface that the radiation penetrates. Posting requirement: "CAUTION – HIGH RADIATION AREA" or "DANGER – HIGH RADIATION AREA".

4.5 **Hot Spot** – A source of radiation emanating from equipment or components that is greater than 50 mrem/hr on contact and of a significantly higher (factor of three) radiation level than the surrounding general area, where it is likely personnel could receive exposure higher than expected while in the area. Post as a "HOT SPOT" with additional information concerning the area and applicable dose rates.

4.6 **Radiation Area –** Any area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 5 mrem in 1 hour at 30 cm from the radiation source or any surface that the radiation penetrates. Posting requirement: "CAUTION – RADIATION AREA".

4.7 **Radioactive Material Area** – Any area, room or enclosure within a Restricted Area where radioactive material is present, handled or stored in quantities exceeding 10 times the quantity in appendix C of 10 CFR 20. Posting requirement: "CAUTION – RADIOACTIVE MATERIAL(S)" or "DANGER – RADIOACTIVE MATERIAL(S)".

Note: If a combination of materials is present (i.e., a combination of uranium and ^{60}Co), the following relationship must be used to determine if the area must be posted as an RMA:

$$\frac{\mu Ci_{Co}}{10Q_{Co}} + \frac{\mu Ci_{U}}{10Q_{U}} \leq 10$$

where Q = the quantity shown in Appendix C of 10 CFR 20.

4.8 **Radioactive Material Storage Area (RMSA) –** An administratively designated area where radioactive material is stored and controlled. Post as "RADIOACTIVE MATERIAL STORAGE AREA".

4.9 **Restricted Area –** A radiological area, access to which is limited, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Post as: "RESTRICTED AREA".

4.10 **Very High Radiation Area –** Area accessible to individuals in which the radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads in 1 hour at 1 meter (m) from the source or any surface that the radiation penetrates. Posting requirement: "GRAVE DANGER - VERY HIGH RADIATION AREA".

5.0 Responsibilities

5.1 The Radiation Protection Manager (RPM) shall:

5.1.1 Ensure radiological areas are established based upon current radiological conditions.

5.1.2 Ensure posting requirements are met prior to approval of all Health and Safety Work Permits.

5.1.3 Remove postings and labels used to identify radiation hazards when the conditions that required their use no longer exist.

5.2 Health Physics Technicians (HPTs) shall:

5.2.1 Post areas in accordance with the requirements of this procedure.

6.0 Procedure

6.1 Posting and Labeling Requirements

6.1.1 Radiological area posting/labeling requirements shall be as described in 10 CFR 20, Subpart J.

6.1.2 Any area, room, or enclosure under this programs control that meets the definitions described in Section 4.0 shall be posted as described in the definition.

6.1.3 Areas or containers meeting the exceptions of 10 CFR 20.1903 or 20.1905 are not required to be posted/labeled but may be as an added measure of information and safety.

6.1.4 Each posted area shall be defined and clearly marked with appropriate signs and may include a portion or all of a room, building, area, or vehicle. Areas without clearly defined existing boundaries (e.g., walls, doors or fences) may be defined by the use of magenta/yellow tape, ribbon, or rope.

6.1.5 Any container of radioactive material shall be labeled as “CAUTION – RADIOACTIVE MATERIAL” unless specifically exempted from labeling pursuant to 10 CFR 20.1905. The label shall provide sufficient information to avoid exposure; such as the date, dose rate, and container activity information.

6.1.6 Warning signs, tags, labels, notices and other radiation hazard identification markings shall be removed only by authorization of the RPM, or designee when conditions requiring their use no longer exist.

6.1.7 Form USNRC-3, "Notice to Employees", or equivalent, should be posted in prominent locations within the area if the work being performed is under the jurisdiction of the USNRC.

6.2 Exceptions to Posting Requirements

6.2.1 Areas or rooms containing radioactive materials for periods less than 8 hours are not required to be posted if:

6.2.1.1 The materials are constantly attended and controlled by an individual who takes necessary precautions to prevent exposures in excess of the limits stated in HP-03, “Radiological Limits”.

6.2.1.2 The area or room is subject to HP staff control.

6.2.2 A room or area is not required to be posted with a caution sign due to the presence of a stated source unless the source creates a "Radiation Area" due to its presence in the area.

6.3 Exemptions to Labeling Requirements

6.3.1 The following are not required to be labeled:

6.3.1.1 Containers holding radioactive materials in concentrations less than the quantities listed in Appendix C to 10 CFR 20.

6.3.1.2 Containers holding radioactive materials in concentrations less than those specified in table 3 of Appendix B to 10 CFR 20.

6.3.1.3 Containers attended by an individual who takes precautions necessary to prevent exposure to individuals in excess of the limits established in HP-03, "Radiological Limits."

6.3.1.4 Containers when they are in transport and labeled in accordance with DOT regulations.

6.3.1.5 Containers that are accessible only to individuals authorized to handle or use them.

6.3.1.6 Installed manufacturing or process equipment such as piping and tanks.

6.4 Caution or Danger Signs

6.4.1 Each Caution (or Danger) posting shall depict a magenta (or black) trefoil symbol on a yellow background, as described in 10 CFR 20.1901. Each area, building, or room shall be posted at each entrance point.

6.4.2 Each sign, tag, or label shall be displayed prominently and shall be recognizable from a safe distance, and kept current, reflecting any changes in radiological conditions.

6.4.3 Supplementary notices specifying the requirements for entry to and exit from areas and other special precautions that are to be exercised should be posted in conjunction with radiation warning signs and tags to provide personnel with any required additional instructions or information not given by the signs and tags.

6.4.4 Caution signs may not be necessary in areas/rooms containing radioactive materials for a period of less than eight (8) hours, provided that the materials are attended throughout the temporary storage period by an individual who has been trained in the precautions for radiation exposure of personnel.

7.0 Records

There are no records generated by this procedure.

SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-21

REV. 1

HEALTH AND SAFETY WORK PERMITS

APPROVED BY: ___ DATE: 12/11/02

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APPROVED BY:_____ DATE: 12/11/02

EC/HS Manager

APPROVED BY:_____ DATE:_____

QA/QC Officer

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LIST OF ATTACHMENTS

1.0 Purpose

The purpose of this procedure is to provide the guidelines and requirements for the generation, implementation, revision, and termination of Health and Safety Work Permits (HSWP) at sites were SAIC is responsible for maintaining radiological safety.

2.0 Scope

This procedure applies to all personnel requiring access to a location covered by an HSWP under this SAIC radiation safety program.

3.0 References

3.1 HP-01, "Health Physics Manual"

3.2 HP-02, "ALARA Program"

3.3 10 CFR 20, "Standards for Protection Against Radiation"

4.0 Definitions

4.1 **Health and Safety Work Permit (HSWP)** – A document used for control of specific work that provides the minimum protective requirements for the performance of that work.

4.2 **HSWP Package** – A compilation of documentation providing the complete record of an HSWP from its generation to its closure. The completed HSWP Package should contain:

4.2.1 The Pre-Job ALARA review, as applicable;

4.2.2 Pre-Job briefing forms;

4.2.3 HSWP and revisions;

4.2.4 Post-Job ALARA review, as applicable; and

4.2.5 Other documentation as determined by the Radiation Protection Manager (RPM).

4.3 **Radiological or Industrial Safety Hold** - A planned point when work stops due to the potential health and safety consequences of performing the next step.

4.4 **Restricted Area –** A radiological area, access to which is limited, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

5.0 Responsibilities

5.1 The RPM shall:

5.1.1 Ensure that HSWPs are initiated as required by this procedure.

5.1.2 Determine if a Pre-Job ALARA Review is required and ensure reviews are completed prior to approval of the HSWP.

5.1.3 Review and approve all HSWPs prior to job commencement.

5.1.4 Conduct a quarterly assessement of active HSWPs to confirm that the exposure conditions and training/use requirements reflected on the HSWP are current and appropriate.

5.1.5 Maintain copies of terminated HSWP's as part of the radiation protection records.

5.1.6 Maintain a log of HSWPs that have been established and their status.

5.2 All personnel performing work under an HSWP shall:

5.2.1 Read the current version of the HSWP and clearly understand the work to be performed;

5.2.2 Comply with the requirements of the HSWP;

5.2.3 Complete the HSWP Entry Control Log prior to entering and upon exiting the work area, if required by the HSWP;

5.2.4 Notify the HPT covering the activity of any unexpected change in conditions in the work area;

5.2.5 Make every effort to minimize the spread of contamination and ensure proper disposition of materials;

5.2.6 Notify the HPT covering the activity when a hold, as specified in the work procedure, work instructions, or on the HSWP is encountered, and

5.2.7 Attend a pre-job briefing on the current revision of the HSWP.

5.3 Health Physics Technicians (HPTs) shall:

5.3.1 Perform required surveys and monitoring for HSWPs;

5.3.2 Perform pre-job briefings for HSWPs;

5.3.3 Provide coverage for the job, as applicable;

5.3.4 Periodically review HSWP Entry Control Logs at their work area for accuracy and completeness;

5.3.5 Notify the RPM if an HSWP revision becomes necessary.

6.0 Procedure

6.1 General

6.1.1 An HSWP shall be initiated for any of the following conditions:

6.1.1.1 Work in or entry into a Contamination Area, Radiation Area, High Radiation Area, Very High Radiation Area, or Airborne Radioactivity Area.

6.1.1.2 Transfer of or work with radioactive material as determined by the RPM,

6.1.1.3 Any work as determined by the site RPM.

6.1.2 The RPM shall review scheduled work and assign a Senior HPT to perform the HSWP assessment if warranted by the hazard. Otherwise the RPM shall perform the assessment.

6.1.3 The RPM, or designee shall issue the HSWP number. This number shall be entered on Attachment 1 or equivalent. The HSWP number uses the following format: the year, next sequential number and the revision (e.g., 01-04.02).

6.1.4 The RPM, or designee and work supervisor shall document the Pre-job ALARA Review, if required, in accordance with HP-02, "ALARA Program".

6.1.5 Using HSWP assessment data and the Pre-job ALARA Review, if completed, the RPM, or designee will complete Attachment 2, "Health and Safety Work Permit".

6.1.6 Prior to issue of the HSWP:

6.1.6.1 The HSWP shall be reviewed by the RPM, or designee and Local EC & HS Official and approved by the RPM.

6.1.6.2 The RPM or HPT covering the activity shall conduct a pre-job briefing for all HSWPs. The pre-job briefing shall:

6.1.6.2.1 Include a discussion of the completed Pre-job ALARA Review, as applicable;

6.1.6.2.2 Consist of a step-by-step overview of the job, as applicable;

6.1.6.2.3 Consist of a review of the requirements of the HSWP; and

6.1.6.2.4 Be documented on Attachment 3 or equivalent form.

6.1.7 After an HSWP number is issued, the RPM, or designee shall establish and maintain an HSWP Package, which includes; the HSWP, pre-job ALARA review (as applicable), HSWP Assessment (as applicable), and pre-job briefing forms.

6.1.8 Only personnel who have attended a pre-job briefing and signed the briefing form shall be authorized to perform work under that HSWP. Personnel preparing, reviewing or approving HSWPs or giving pre-job briefings are considered authorized on the briefing form by merit of their familiarity with the requirements of the HSWP.

6.1.9 All personnel shall complete the Entry Control Log for the HSWP under which they are performing work, if required by the HSWP.

6.1.10 Dose in, Dose out, and Total Dose sections of the HSWP Entry Control Log shall be completed if a direct reading dosimeter is required by the HSWP.

6.1.11 Prior to end of shift, the HPT covering the activity should ensure all personnel have logged out of the HSWP Entry Control Logs and all log entries are complete.

6.1.12 The RPM or designee shall ensure that supporting documentation outlined in Section 4.2 are placed in the HSWP Package.

6.1.13 HSWPs shall remain active for the duration of the work, up to a maximum of one year.

6.1.14 The RPM or HPTs shall perform quarterly assessments of all HSWPs to verify the HSWP requirements are appropriate for the work being performed (i.e. conditions or work to be performed have not changed significantly).

6.1.14.1 The quarterly assessments shall be performed and documented.

6.1.14.2 Verification of the quarterly assessment shall be made by signing and dating the appropriate space on Attachment 2 (or equivalent) and indicating whether a revision is necessary.

6.1.14.3 If necessary, revisions to HSWPs shall be made according to this procedure.

6.1.15 Site-specific work plans, radiation protection plans, or health and safety plans may be used in lieu of HSWPs to control on-site SAIC activities if approved by the RSO.

6.2 Radiological Holds

6.2.1 Radiological holds shall be identified in the additional requirements section of the HSWP or in the appropriate procedure/instruction for work covered by the HSWP.

6.2.2 Work shall be stopped and the HPT covering the activity shall be notified when a radiological hold is encountered.

6.2.3 Work shall not resume until the RPM, or designee has evaluated conditions and authorization is given.

6.3 HSWP Revision

6.3.1 An HSWP shall be revised if any of the following conditions apply:

6.3.1.1 Changes in conditions sufficient to warrant a change in personnel protection or monitoring requirements, (e.g., a change in protective clothing, respiratory protection equipment, or dosimetry).

6.3.1.2 A significant change in the scope of the job as it is described on the HSWP.

6.3.1.3 The RPM, or designee determines a revision is necessary.

6.3.2 When an HSWP is determined to need revision, the RPM, or designee shall employ a complete revision or a pen and ink change, as necessary. Complete revisions shall be performed as follows:

6.3.2.1 During transition from one revision to another, all work under the HSWP shall stop to ensure all personnel actively working on the HSWP are notified of the revision and are briefed on the changes and requirements for performing work on the revised HSWP. Complete Attachment 3 or equivalent form.

6.3.2.2 Work under the revised HSWP may begin after personnel are briefed and appropriate documentation is complete.

6.3.2.3 Remove all copies of the terminated HSWP and HSWP Entry Control Logs.

6.3.2.4 Sign and date the "Terminated by" blank on the original HSWP and provide the reason for the termination.

6.3.2.5 Prepare and issue the revised HSWP according to the requirements of this procedure.

NOTE:

All personnel shall be briefed on the changes made under the revised HSWP before being authorized to enter the work area governed by that HSWP.

6.3.2.6 The revised HSWP shall retain the same number as the original HSWP except the "Rev" designator, which will be .00 for initial HSWPs, shall be changed to .01 for the first revision and .02 for the second, etc.

6.3.3 Pen and ink changes shall be authorized by the RPM, or designee, for minor changes to personal protection or monitoring requirements. Pen and ink changes shall be made as follows:

6.3.3.1 Pen and ink changes shall be made on the original and all copies of the latest revision to the HSWP.

6.3.3.2 Deletions to requirements shall be made using a single line strikeover then initialing and dating the revision.

6.3.3.3 Additions to requirements shall be initialed and dated after the addition.

6.3.3.4 The "Additional Requirements" section of the HSWP shall be used to clarify any pen and ink changes, if necessary.

6.3.3.5 If numerous pen and ink changes have made the HSWP illegible, a complete revision shall be performed. Personnel performing work covered by the revised HSWP shall be briefed on the revision and shall document the briefing by resigning the pre-job briefing form (Attachment 3 or equivalent) prior to working under the revised HSWP.

6.3.3.6 The RPM, or designee shall ensure that all personnel that were briefed on the previous version of the HSWP are contacted and informed of the revision to the HSWP, as applicable.

6.4 HSWP Termination

6.4.1 HSWPs shall be terminated for any of the following reasons:

6.4.1.1 Any condition requiring a complete revision to the HSWP.

6.4.1.2 Completion of the job.

6.4.1.3 If the time limits are reached.

6.4.2 The RPM or designee shall complete the “Terminated by”, “Reason for Termination”, and revision or HSWP termination blanks on the original maintained in the HSWP Package.

6.4.3 After HSWP termination, the RPM, or designee shall perform the Post-Job ALARA Review, if required, in accordance with HP-02, “ALARA Program”.

7.0 Records

All records generated as a result of this procedure shall be maintained by the RPM until transmitted to the appropriate Central Records Facility.

HSWP LOG

PERMIT NUMBER	JOB DESCRIPTION	DATE AUTHORIZED	DATE TERMINATED

HEALTH AND SAFETY WORK PERMIT

HSWP No: ___ ___-___ ___ . ___ ___ Date Issued: _____ Expiration Date: _____

Client: _____ Location: _____ Site: _____

Job Description: _____

_____

H/S COVERAGE

- ☐ Continuous
- ☐ Intermittent
- ☐ Buddy System
- ☐ Confined Space Entry Permit.
- ☐ Notify H/S upon entry to area.
- ☐ HSWP Entry / Exit Log Required
- ☐ HPT perform all personnel frisk surveys
- ☐ Radiological Workers may perform personnel frisk surveys

DRESS REQUIREMENTS

- ☐ Cotton Coverall
- ☐ Canvas Hood
- ☐ Paper Coveralls
- ☐ Plastic Coveralls
- ☐ Tyvek Coveralls
- ☐ Skull Cap
- ☐ Cloth Gloves
- ☐ Rubber Gloves
- ☐ Plastic Booties
- ☐ Lab Coat
- ☐ Surgeon's gloves
- ☐ Rubber Apron
- ☐ Rubber Shoe covers
- ☐ No personal outer-clothing.
- ☐ Tape gloves and booties to PCs
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____
- ☐ Other_____

DOSIMETRY REQUIREMENTS

- ☐ Self Reading Dosimeter
- ☐ Whole Body TLD
- ☐ Ring TLD
- ☐ Electronic Dosimeter
- ☐ Multi-Badging

RESPIRATORY PROTECTION

- ☐ Air Purifying Respirator
- ☐ Powered Air Purifying Respirator
- ☐ Air Line Respirator
- ☐ SCBA
- ☐ Other_____
- ☐ Other_____

SAFETY EQUIPMENT

- ☐ Safety Glasses
- ☐ Steel-toed Shoes
- ☐ Goggles
- ☐ Hard Hat
- ☐ Face-Shield
- ☐ Leather Apparel
- ☐ Hearing Protection
- ☐ Welding Shield w/ _____ number lens
- ☐ Other _____
- ☐ Other _____
- ☐ Other _____
- ☐ Other _____

ADDITIONAL REQUIREMENTS (ALARA considerations, Pen and Ink changes, safety, job specific):

_____

_____

_____

_____

_____

_____

A PRE-JOB BRIEFING IS REQUIRED PRIOR TO ENTRY ON THE HSWP

Reviewed By:_____ Date:_____
Local EC&HS Representative

Approved By:_____ Date:_____
Radiation Protection Manager

Collective dose goal:_____Approved by:_____ Date:_____

Terminated by: _____ Date: _____

Revision termination____ HSWP termination:_____ (check one)

Reason for termination: _____

HSWP CONTINUATION SHEET

Page 2 of 2

QUARTERLY ASSESSMENT VERIFICATION HSWP Number_____			
Date (month/day/year)	**Signature of RPM/HPT**	**Revision Required Yes***	**No**

*****If "Yes", state the reason a revision is required and whether a pen and ink change or complete revision is necessary:

Revision approved: _____ Date: _____
RPM

PRE-JOB BRIEFING

HSWP No. ___ ___-___ ___ . ___ ___ **Date**: _____

PRE-JOB BRIEFING CHECKLIST	**INITIALS**
• Discuss Pre-job ALARA review, if applicable	
• Review requirements of HSWP	
• Review the step-by-step aspects of the job, ensuring all personnel are aware of their required actions	

Job Description: _____

PERSONNEL ATTENDING PRE-JOB BRIEFING

Printed Name	Signature*	HPID No.

*** By signature, personnel certify they have read, understand, and will comply with the requirements of the HSWP.**

Signature _____ _____
RPM Date

HSWP ENTRY CONTROL LOG

HSWP No. ___ ___-___ ___. ___ ___ CLIENT: _____ LOCATION: _____

AREA _____ DATE _____

A PRE-JOB BRIEFING IS REQUIRED PRIOR TO ENTRY ON THIS HSWP

HPID #	PRINTED NAME	TIME IN	DOSE IN	RESP TYPE	TIME OUT	DOSE OUT	TIME IN	DOSE IN	RESP TYPE	TIME OUT	DOSE OUT	TOTAL DOSE

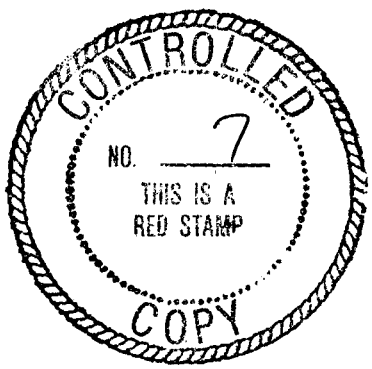
RESP. TYPE: FF = FULL FACE; SCBA = SELF CONTAINED BREATHING APPARATUS; AL = AIRLINE

Reviewed by: _____ Date: _____

SAIC ST. LOUIS

HEALTH PHYSICS PROCEDURE

HP-30
REV 3



RADIOLOGICAL INSTRUMENTATION

APPROVED BY: _____ DATE: 7/15/03
Radiation Safety Officer

APPROVED BY: _____ DATE: 7/15/03
EC/HS Manager

APPROVED BY: _____ DATE: 7/15/2003
QA/QC Officer

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1.0 Purpose

This procedure establishes the guidelines and requirements for the calibration, setup, operation, and quality control of radiological survey instruments.

2.0 Scope

This procedure applies to all radiation survey instruments utilized at locations where this SAIC radiation safety program is implemented.

3.0 References

3.1 10 CFR 20, “Standards for Protection Against Radiation”

3.2 ANSI N323A-1997, “American National Standards Radiation Protection Instrumentation Test and Calibration”

3.3 ANSI N42.17A - 1997, "American National Standard Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions"

3.4 HP-01, “Health Physics Manual”

3.5 HP-03, “Radiological Limits”

3.6 NRC Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment”

3.7 NRC NUREG-1507, “Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions”

4.0 Definitions

4.1 **Background Test** – Daily verification of satisfactory count rate instrument operation by measuring background counts at fixed location.

4.2 **Bench Counter** – alpha and/or beta scintillation (non-portable) counting system.

4.3 **Calibration** – Adjustment of instrumentation so the accuracy and performance meet requirements specified by procedures.

4.4 **Calibration Equipment** – Equipment that is certified as calibrated to standards which are traceable to the National Institute of Standards and Technology (NIST) and that is used to perform calibration tests on radiation survey instruments.

4.5 **Due Date** – The next date an instrument is due to be calibrated.

4.6 **Frisker** – Geiger-Mueller (GM), alpha and/or beta scintillation, or other appropriate portable contamination survey instruments.

4.7 **Minimum Detectable Concentration (MDC)** - The *a priori* activity level that a specific instrument and technique can be expected to detect 95% of the time.

4.8 **Out-of-Calibration (OOC)** – Instrument removed from service due to a lapsed calibration due date.

4.9 **Out of Service (OOS)** – Status of any instrument not available for issue and use due to damage, equipment failure, or removed from service for long-term storage.

4.10 **Out-of-Specification Condition** – Status of instrument that does not meet calibration criteria or QC checks.

4.11 **Portable Scaler** – Frisker instrument with a timed integrated count function.

4.12 **Pre-operational Checks (POCs)** – Checks performed on any portable instrument daily or prior to use.

4.13 **QC Checks** – Daily response checks on radiation survey instrumentation to verify acceptable instrument performance.

4.14 **Radiation Survey Instruments** – Instrumentation used to measure radiation or sample mediums where radioactive material may be present.

4.15 **Source Test** – Verification of satisfactory instrument operation using a radioactive source.

5.0 Responsibilities

5.1 The Radiation Protection Manager (RPM) shall:

5.1.1 Approve of instrument calibration laboratories, after verifying that they meet the requirements of this procedure.

5.1.2 Review and approve instrument background acceptance criteria, source test acceptance criteria, instrument efficiency, and MDCs.

5.2 Radiological Workers and Health Physics Technicians (HPTs) shall:

5.2.1 Perform pre-operational and QC checks on radiation survey instruments in accordance with this procedure.

5.2.2 Maintain instrument accountability in accordance with this procedure.

5.2.3 Operate radiation survey instruments in accordance with this procedure or Technical Manual guidance.

6.0 Procedure

6.1 Instrument Calibration

6.1.1 Radiation survey instruments shall be calibrated under any of the following conditions:

6.1.1.1 Prior to calibration due date,

6.1.1.2 After maintenance and repair that may affect calibration,

6.1.1.3 If a pre-op check, background test, or source test out-of-specification condition cannot be corrected by minor repair, such as battery change, cord replacement, or detector window replacement.

6.1.2 Instrumentation shall be calibrated at the frequencies specified in Attachment 5. More frequent calibrations may be necessary due to instrument repair or performance concerns, as determined by the RPM.

6.1.3 Instruments shall be calibrated in accordance with the guidance of ANSI N323A-1997.

6.1.4 Upon completion of calibration, each instrument shall labeled with the following information:

6.1.4.1 Instrument serial number

6.1.4.2 Initials or other specific identifying mark of the calibrator, and

6.1.4.3 Calibration due date.

6.1.5 Radiation survey instruments shall be uniquely identified on the instrument housing.

6.2 Source Decay Corrections

6.2.1 Radioactive source decay corrections shall be performed at a frequency to ensure the reported source activity used to determine instrument response does not exceed ± 5% of the actual source activity. Source decay corrections should be calculated by the formula provided in Attachment 4, Equation 3.

6.3 Determination of Acceptance Criteria

6.3.1 Instrument Setup General Requirements

6.3.1.1 Following on-site instrument calibration, or upon receipt from a calibration facility, survey instrument background acceptance criteria, source acceptance criteria, and instrument efficiency (for alpha and/or beta) shall be established and documented on Attachments 1, 2 or 11, or equivalent forms.

NOTE: It may be necessary to establish site specific background acceptance criteria, source acceptance criteria and instrument efficiency when using instruments at different sites having significantly different background count rates, as determined by the RPM.

6.3.1.2 QC parameters may be updated due to change in instrument location, area background, or other parameters that affect instrument response.

6.3.1.3 Source tests shall be performed in a consistent and reproducible manner.

6.3.2 Bench Counter Setup

6.3.2.1 Bench counter background, source, and efficiency data shall be recorded on Attachment 2, or equivalent.

6.3.2.2 Count times for bench counters shall be established in order to meet MDC requirements, as practical. Count times may be initially set as:

6.3.2.2.1 Air sample (occupational) – 10 minutes

6.3.2.2.2 Air sample (non occupational) – 60 minutes

6.3.2.2.3 Smear – 1 minute

6.3.2.3 In order to establish bench counter background acceptance criteria:

6.3.2.3.1 Obtain 10 background counts.

6.3.2.3.2 Determine the standard deviation of the 10 background counts.

6.3.2.3.3 Determine the mean of the background counts.

6.3.2.3.4 Establish background acceptance criteria as ± 3 standard deviations of the mean background.

6.3.2.4 In order to establish bench counter source test acceptance criteria:

6.3.2.4.1 Obtain 10 source counts.

NOTE: NIST traceable sources are recommended, but not required.

6.3.2.4.2 Determine the mean source counts.

6.3.2.4.3 Establish source acceptance criteria as ± 20% of the mean source counts.

6.3.2.5 In order to establish bench counter instrument efficiency:

6.3.2.5.1 Determine the net count-rate by subtracting the mean background count-rate from the mean source count-rate.

6.3.2.5.2 Determine the instrument efficiency by dividing the net count-rate by the source activity. Source activity should be calculated as shown on Attachment 4 Equation 6, or by other methods as determined appropriate by the RPM.

6.3.2.6 Calculate the MDC for counting smears in accordance with Attachment 4, equation 2. Compare the smear MDC with the contamination release limit pursuant to HP-03, “Radiological Limits”. If the smear MDC is greater than the release limit, increase the count time until the analysis of the smear with the bench counter can detect less than the release limit.

6.3.2.7 Calculate MDC for counting air samples, given a minimum air sample volume, in accordance with Attachment 4, equation 5. Compare the air sample MDC with 0.10 DAC. If necessary, increase the minimum sample volume and/or count time to achieve an MDC less than 0.10 DAC, as practical.

6.3.2.8 Bench counter MDC data shall be recorded on Attachment 3, “Bench Counter MDC Record”, or equivalent.

6.3.3 Portable Scaler Setup

6.3.3.1 Portable scaler setup data shall be recorded on Attachment 2, or equivalent.

6.3.3.2 Portable scaler background acceptance criteria, source test acceptance criteria, and efficiency should be setup in the same manner as a bench counter, except:

6.3.3.2.1 When the detector surface area is at least 3 times larger than the source active surface area; obtain 3 source counts at the top of the active area of the detector, 4 source counts at the center of the active area of the detector, and 3 source counts at the bottom of the active area of the detector (total of 10 source counts altogether).

6.3.3.2.2 Establish background acceptance criteria as ±20% of the mean background count for NaI gamma walkover survey instruments.

6.3.4 Frisker Setup

6.3.4.1 Friskers with a timed scaler function shall be setup as a portable scaler.

6.3.4.2 Friskers without a timed scaler function should be setup in accordance with the following guidance.

6.3.4.2.1 Frisker setup data shall be recorded on Attachment 11, or equivalent.

6.3.4.2.2 Observe background and source count rates.

6.3.4.2.3 Frisker source acceptance criteria shall be determined on one scale as ± 20% of ratemeter source response.

6.3.4.2.4 Frisker background shall be determined as ± 20% of ratemeter local background response.

6.3.4.2.5 In order to establish frisker instrument efficiency, divide the net count-rate by the source activity.

6.3.5 Exposure Rate Meter Setup

6.3.5.1 Exposure rate meter setup data shall be recorded on Attachment 1, or equivalent.

6.3.5.2 Observe ratemeter source response on the most appropriate scale (i.e., the scale where the response is nearest the mid-scale reading).

6.3.5.3 Exposure rate meter source acceptance criteria shall be determined as ± 20% of ratemeter source response using an appropriate gamma emitting check source.

6.4 Pre-Operational Checks

6.4.1 Pre-operational checks shall be performed prior to instrument use. The following pre-operational checks shall be satisfactorily completed:

6.4.1.1 Verify instrument calibration is current.

6.4.1.2 Check the instrument for physical damage that may affect correct operation.

6.4.1.3 Battery check the instrument.

6.4.1.4 Verify all external cable connections are hand tight, as applicable.

6.4.1.5 Check zero adjustment of instrument, as applicable.

6.4.1.6 Ensure source and background tests have been completed for the current day by checking the Instrument QC Check Log (Attachment 8, or equivalent form) or the instrument's daily source check sticker, if applicable.

6.4.2 If any pre-operational check fails to meet requirements, make an immediate repair (e.g. replace batteries), or tag the instrument as Out of Service in accordance with Section 6.7.1 of this procedure.

6.5 Quality Control (QC) Checks

6.5.1 General Requirements

6.5.1.1 QC checks shall be performed daily, prior to initial use, for in use radiation survey instruments. QC checks consist of the following:

6.5.1.1.1 Pre-operational checks identified in Section 6.4 of this procedure, as appropriate;

6.5.1.1.2 Background Test (except exposure rate meters);

6.5.1.1.3 Source Test.

6.5.1.2 Upon completion of a satisfactory daily QC check, document that the QC check has been completed on Attachment 8, "Instrument QC Check Log", or equivalent form.

6.5.1.3 Instruments failing a QC check shall be tagged OOS, and an investigation performed, as required by Section 6.8 of this procedure.

6.5.1.4 Relocation of a bench counter instrument may require re-verification of acceptable QC checks.

6.5.2 Background Test

6.5.2.1 Background test shall be performed in a consistent manner and location.

6.5.2.2 The instrument background shall be verified to respond within background acceptance criteria.

6.5.2.3 Background tests are not required for exposure rate instruments.

6.5.3 Source Test

6.5.3.1 Source tests shall be performed in a consistent and reproducible manner.

6.5.3.2 The following source tests are required:

6.5.3.2.1 For exposure rate and count rate instruments, one point shall be verified to respond within source acceptance criteria.

6.6 Instrument Operation

6.6.1 Refer to Attachment 10 for (commonly used) instrument operation instructions. If instrument instructions are not provided, operate the instrument in accordance with the instrument Technical Manual.

6.7 Instrument Operational Status

6.7.1 Attachment 6, "Out of Service" tag, or equivalent, shall be attached to an instrument if any of the following occur:

6.7.1.1 The calibration interval has expired.

6.7.1.2 Maintenance or major repair is required.

6.7.1.3 The instrument has failed a QC check or pre-operational check, as determined by the RPM, or HPT.

6.7.2 The OOS tag shall remain attached to the instrument and the instrument shall not be released for use until appropriate action and documentation are complete.

NOTE: OOS tags are not required for instruments located in the calibration laboratory, provided that the instruments are stored in a location that clearly indicates their status.

6.7.3 Personnel using radiation survey instruments shall perform QC Checks anytime instrument response is questionable. Any instrument that provides "As Found" data within acceptance criteria will be considered as having provided satisfactory survey results and will not require an instrument investigation.

6.7.4 Equipment considered to be out-of-specification shall be tagged OOS until proper disposition is determined by the RPM or Senior HPT. Disposition may include any of the following:

6.7.4.1 Recalibration,

6.7.4.2 Repair,

6.7.4.3 Replacement of the equipment, or

6.7.4.4 Re-evaluation or revision of the acceptance criteria for the equipment as determined by the RPM.

6.8 Instrument Investigations

6.8.1 Only those out-of-specification conditions that affect proper instrument performance need to be considered for investigative purposes. The following conditions do not require investigation:

6.8.1.1 Loose cable connectors,

6.8.1.2 Meter light not operational, or

6.8.1.3 Plastic or rubber covers not pertaining to radiation detector, torn or missing.

6.8.1.4 The instrument was damaged while in use and was removed from service as soon as damage was suspected (e.g. hole in mylar window of scintillator causing upscale readings).

6.8.1.5 Other conditions, as determined by the RPM.

6.8.2 Investigations shall determine if the instrument was used for any of the following:

6.8.2.1 Assigning permanent record exposure.

6.8.2.2 Unconditional releases of equipment, material or personnel.

6.8.2.3 Determining radioactive effluent concentrations.

6.8.2.4 Shipping, receiving or labeling radioactive material.

6.8.3 If any condition of Section 6.8.2 is applicable, Attachment 7, “Defective Instrument Report” form (or equivalent) shall be completed and the need for a Radiological Incident Report (HP-22) shall be evaluated by the RPM.

6.8.4 For instruments that fail a quality control check, the investigation need only trace the instrument use back to the time of the last satisfactory quality control check.

6.9 Instrument Accountability

6.9.1 Instrument accountability should be maintained by documenting instrument sign-out and return on Attachment 9 (Instrument Sign-Out Log or equivalent form).

6.9.2 The RPM may waive the use of Attachment 9, as appropriate.

7.0 Records

All records generated as a result of this procedure shall be maintained by the RPM until transmitted to the appropriate Central Records Facility.

Exposure Ratemeter Setup Record

Date:_____ **Location:**_____

Instrument Type:_____ **Instrument Serial Number:** _____

Instrument Range	Source	Source Position	Observed Exposure Rate[1] mR/hr µR/hr	Acceptance Criteria[1,2] mR/hr µR/hr

[1] Circle correct units.
[2] ± 20% of observed exposure rate

Comments/Restrictions: _____

Calculated By: Date

Approved: RPM/Designee Date

Initial Instrument Check In (EXAMPLE)

Meter Number:	164328	Detector Number:	168667
Meter Model:	2360	Detector Model:	43-89 "A"
Cal. Due:	02/12/2002	Cal. Due:	02/12/2002

ALPHA	Source Type:	Th-230	Threshold:	120 mV		
ALPHA	Source #:	SAIC-0001				
ALPHA	Source DPM:	21300	High Voltage:	775 V		
ALPHA	Source count time:	1 minute	Bkg. count time:	10 minutes		
ALPHA						
ALPHA	Source GCPM	BKG CPM	Average Bkg. (CPM):	0.3		
ALPHA	3664	0	Average Source (GCPM):	3662		
ALPHA	3798	0.6				
ALPHA	3601	0.1	Source Range (GCPM):	2929	to	4394
ALPHA	3677	0.4	Background Range (CPM):	0	to	0.8
ALPHA	3566	0.4	Determined Efficiency:	17.2%		
ALPHA	3669	0.4				
ALPHA	3651	0.1				
ALPHA	3684	0.3	20% of Bkg.	NA		
ALPHA	3610	0.2	3 Standard Deviations of Bkg.	0.54		
ALPHA	3698	0.3				

Beta/Gamma (Circle One)

BETA	Source Type:	SrY-90	Threshold:	3.5 mV		
BETA	Source #:	SAIC-0003				
BETA	Source activity:	11774	High Voltage:	775 V		
BETA	Source count time:	1 minute	Bkg. count time:	1 minute		
BETA						
BETA	Source GCPM	BKG CPM	Average Bkg. (CPM):	132		
BETA	2979	141	Average Source (GCPM):	2970		
BETA	3015	120				
BETA	2910	130	Source Range (GCPM):	2379	to	3564
BETA	3031	139	Background Range (CPM):	92	to	171
BETA	2958	126	Determined Efficiency:	24.1%		
BETA	2949	115				
BETA	2948	118				
BETA	2973	148	20% of Bkg.	NA		
BETA	2992	125	3 Standard Deviations of Bkg.	39.83		
BETA	2948	154				

Calculated By: _____ Date: _____

Approved: _____ Date: _____
RPM/Designee

Bench Counter MDC Record

Date:_____ Location:_____

Instrument Type:_____ Instrument Serial Numbers:_____

ALPHA			**BETA**		
Smear MDC			**Smear MDC**		
Background count time (T_b)		min	Background count time (T_b)		min
Background count rate (R_b)		counts	Background count rate (R_b)		counts
Smear count time (T_g)		min	Sample count time (T_g)		min
Instrument efficiency (ε_t)		cpm/dpm	Instrument efficiency (ε_t)		cpm/dpm
Smear MDC[a]		dpm/100cm^2	Smear MDC[a]		dpm/100cm^2
Release limit		dpm/100cm^2	Release limit		dpm/100cm^2
Fraction of release limit			Fraction of release limit		
Occupational Air Sample MDC			**Occupational Air Sample MDC**		
Background count time (T_b)		min	Background count time (T_b)		min
Background count rate (R_b)		counts	Background count rate (R_b)		counts
Air sample count time (T_g)		min	Air sample count time (T_g)		min
Instrument efficiency (ε_i)		cpm/dpm	Instrument efficiency (ε_i)		cpm/dpm
Collection Efficiency (ε_c)		fraction (.99)	Collection Efficiency (ε_c)		fraction (.99)
Minimum sample volume		liters	Minimum sample volume		liters
Air Sample MDC		µCi/ml	Air Sample MDC		µCi/ml
Air sample DAC		µCi/ml	Air sample DAC		µCi/ml
DAC fraction MDC			DAC fraction MDC		

[a] This calculation assumes the smear was taken over a 100 cm^2 area. Smears taken over different sized areas should be normalized to 100 cm^2 to compare to the release limit.

Calculated By:_____ Date:_____

Approved:_____ Date:_____
RPM/Designee

Bench Counter MDC Record

Date:_____ Location:_____

Instrument Type:_____ Instrument Serial Numbers:_____

ALPHA			**BETA**		
Non-Occupational Air Sample MDC			**Non-Occupational Air Sample MDC**		
Background count time (T_b)		min	Background count time (T_b)		min
Background count rate (R_b)		counts	Background count rate (R_b)		counts
Air sample count time (T_g)		min	Air sample count time (T_g)		min
Instrument efficiency (ε_i)		cpm/dpm	Instrument efficiency (ε_i)		cpm/dpm
Collection Efficiency (ε_c)		fraction (.99)	Collection Efficiency (ε_c)		fraction (.99)
Minimum sample volume		liters	Minimum sample volume		liters
Air Sample MDC		µCi/ml	Air Sample MDC		µCi/ml
Air sample AE		µCi/ml	Air sample AE		µCi/ml
AE fraction MDC			AE fraction MDC		

Calculated By:_____ Date:_____

Approved:_____ Date:_____
RPM/Designee

Instrument Setup Calculations

Portable Counter (timed count) Minimum Detectable Concentration (MDC)
(Equation 1)

$$\text{MDC (dpm/100cm}^2) = \frac{3 + 3.29\sqrt{(R_b)(T_g)(1+\frac{T_g}{T_b})}}{\frac{[DA]}{100}[\varepsilon_i .][\varepsilon_s][T_g]}$$

DA = detector area (cm^2)
ε_i = instrument efficiency (cpm/dpm)
ε_s = surface efficiency (unitless)
R_b = background count rate (cpm)
T_b = background count time (minutes)
T_g = gross count time (minutes)

Notes: Surface efficiency is typically only used for final status surveys and is otherwise set to 1.0

Bench Counter Smear Minimum Detectable Concentration (MDC)
(Equation 2)

$$\text{Smear MDC (dpm/100cm}^2) = \frac{3 + 3.29\sqrt{(R_b)(T_g)(1+\frac{T_g}{T_b})}}{(T_g)(\varepsilon_i)}$$

ε_i = instrument efficiency (cd^{-1})
R_b = background count rate (cpm)
T_b = background count time (minutes)
T_g = smear count time (minutes)

NOTE: This calculation assumes the smear was taken over a 100 cm^2 area. Smears taken over different sized areas should be normalized to 100 cm^2 to compare to the release limit.

Instrument Setup Calculations

Radioactive Source Decay
(Equation 3)

$$A(t) = A_0 e^{-0.693t/T}$$

A_0 = original source activity
A(t) = source activity at time t
t = difference between t_0 and time t (same units as T)
T= radionuclide half life (same units as t)

Instrument Setup Calculations

Frisker/Floor Monitor Scan Minimum Detectable Concentration (MDC) –
(Equation 4)

The observable background counts (*b'*) is defined as the number of background counts observed within the observation interval (*i*). The equation used for calculating *b'* is as follows:

$$b' = (\text{BCPM}) * (i) * (1 \text{ min}/60 \text{ sec}) = \text{counts/interval}$$

BCPM = instrument or reference area background count rate (cpm)
i = observation interval (seconds)

The minimum detectable number of net source counts in the interval is given by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (d') as shown below:

$$s_i = d\sqrt{b'}$$

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d*, is defined as the index of sensitivity and is dependent on the selected decision errors for Type I (alpha) and Type II (beta) errors. A true positive error (1–β) of 95% and a false positive error (alpha) of 60% may be selected to be consistent with NUREG 1507. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

$$\text{MDCR (cpm)} = s_i \times (60/i)$$

Finally, the scan MDCs for surfaces may be calculated:

$$\text{Scan MDC} = \frac{MDCR}{\sqrt{p}\,\varepsilon_i\,\varepsilon_s\,\frac{DA}{100\ cm^2}}$$

where
MCDR = minimum detectable count rate (cpm)
ε_I = instrument efficiency (cpm/dpm)
ε_s = surface efficiency (unitless – typically only used for final status surveys, otherwise set to 1.0)
p = surveyor efficiency (unitless – typically assumed to be 0.5)
DA = detector area

Instrument Setup Calculations

Air Sample Minimum Detectable Concentration (MDC) (Equation 5)

$$\text{Air Sample MDC } (\mu\text{Ci/mL}) = \frac{3 + 3.29\sqrt{(R_b)(T_g)(1+\frac{T_g}{T_b})}}{(T_g)(\varepsilon_i)(\varepsilon_c)(V)(2.22E^9)}$$

R_b = background count rate (cpm)
T_b = background count time (minutes)
T_g = air sample count time (minutes)
ε_i = Instrument efficiency, to be expressed as counts per disintegration (e.g. 0.12)
ε_c = Collection efficiency, default with 0.99
V = Sample volume (liters) [if converting from ft^3, multiply ft^3 by 28.3 to calculate liters]
2.22E9 = conversion factor from dpm to µCi and L to ml.

Note:
When setting up a bench counter, it is necessary to make assumptions about sample volume. In the absence of work specific information, the minimum occupational sample run time may be set as 4 hours. (i.e. 4 hours x 60 minutes x 3 LPM = 720 Liters) Adjust the minimum run time as necessary to achieve 0.10 DAC, as practical.

Radioactive Sealed Source Activity Determination (Equation 6)

Sr/Y-90 Beta Sources (Other beta sources can be done the same way but may not need correction for daughter product in-growth)

1. If source activity is given on the source calibration certificate as Sr-90 activity, the activity should be doubled and then decay corrected using Equation 5. Note that backscatter corrections are not made.
2. If source activity is not given on the source calibration certificate, then the surface beta emission rate will be given. In this case the surface beta emission rate typically includes contributions from Sr-90 activity, Y-90 activity, and backscatter. The backscatter factor may or may not be given. If the backscatter factor is given then use it, if not then assume the value of 0.43 (NUREG-1507). The source activity is calculated as:

$$\text{Activity (dpm)} = (R / (1 + B)) * 2$$

R = Source surface emission rate (dpm) – This includes the 2π activity plus backscatter.
B = Backscatter factor (unitless) – This corrects R to the source Sr/Y-90 2π activity.
Note: Instrument efficiencies determined from these calculations will be high because of the actual backscatter from the source (unless you are surveying a material made of the same material as the source holder). Efficiency corrections for the material to be surveyed can be made using the methodology outlined in NCRP-112.

Alpha Sources

Backscatter is negligible for alpha sources, therefore if source activity is given on the source calibration certificate then you are done (That is the 4π activity as long as there is no concern for daughter product in-growth). If surface alpha emission rate is given then you have to double it to calculate the source 4π activity.

RADIATION SURVEY INSTRUMENT CALIBRATION FREQUENCY

Instrument Type	Application	Calibration Frequency
Count rate meters (alpha, beta, or both)	Personnel monitoring and surface contamination measurement	Annually
Exposure or dose equivalent rate meters	Determining exposure or dose equivalent rates	Annually
Alpha/beta scaler	Quantify radioactive material on smears and air sample media	Annually
Air samplers	Collect airborne radioactive material samples	Annually
Liquid Scintillation Counter	Quantify radioactive material on smears, air sample media, and liquid sample media.	Annually

Instrument Out of Service Tag (Example)

INSTRUMENT OUT OF SERVICE

Instrument ID:_____

Date:_____

Technician:_____

Defect Description:

_____
_____
_____
_____
_____

Defective Instrument Report

Model:_____ Serial Number:_____ Date:_____

Problem with Instrument:_____

_____

_____

_____

_____

Date Found Out-of-Spec: _____ By: _____/_____
(Print) Signature

Last Calibration Date: _____

Last Pre-Op Test:_____

Last QC Check:_____

Was this instrument used for any of the following surveys since the last satisfactory QC check?:

No	Yes		
☐	☐	A.	Assign permanent record exposure.
☐	☐	B.	Unconditional release of equipment, material or personnel.
☐	☐	C.	Determine radioactive effluent quantities.
☐	☐	D.	Ship, receive or label radioactive waste.

If any of the above questions are marked "Yes" a Radiological Incident Report shall be considered by the RPM.

Corrective actions taken:_____

_____

_____

_____

Evaluation Performed By: _____/_____/_____
(Print) (Signature) Date

Reviewed By: _____/_____
RPM/Designee (Date)

INSTRUMENTATION QC CHECK LOG **METER:** _____ **DATE (MO/YR):** _____

Meter		Acceptance Criteria				Alpha			
Number	Cal. Due	Bkgrd. QC (cpm) range		Source QC (ncpm) range		Source Type	Source Number	Inst. Efficiency	Inst. Avg. Bkgrd.
		Alpha	Beta	Alpha	Beta				
Detector		to	to	to	to	Beta			
Number	Cal. Due					Source Type	Source Number	Inst. Efficiency	Inst. Avg. Bkgrd.

Date	Time	Bkgrd. QC (cpm)		Source QC (ncpm)		Bat. Check Sat/Unsat	QC [1] Sat/Unsat	HPT Initial	Comment
		Alpha	Beta	Alpha	Beta				

1 An unsatisfactory QC check requires recording the result in the comment column and repeating the evaluation. Tag the instrument out of service and notify the HP Supervisor upon failing the QC check two times in succession.

Reviewed By:_____ (RPM/Designee) Date: _____

INSTRUMENTATION QC CHECK LOG **METER:** _____ **DATE (MO/YR):** _____

Source		**Acceptance Criteria**					**Model**	**Number**	**Cal. Due**
Type		**Bkgrd. QC (cpm) range**		**Source QC (cpm) range**		**Meter**			
Number		to		to		**Detector**			
Date	Time	Pre-use Bkg cpm	Post Bkg cpm[1]	Pre-use Source cpm	Post Source cpm[1]	Bat Check	HV Check	Pre-use HPT Initials	Post HPT Initials[1]

[1] Gamma scan instruments used for confirmation or verification surveys require a post check-in.

Reviewed By:_____ (RPM/Designee) Date: _____

DAILY CHECK-IN OF DOSE RATE INSTRUMENTS (IN USE INSTRUMENTS)

Source		Acceptance Criteria					Model	Number	Cal. Due
Type		Source QC	Units: _____		Scale	Meter			
Number		to				Detector			

Date	Time	Reading	Pre-op Check	Bat Check	Initial	Comments

Reviewed By: _____ Date: _____
RPM/Designee

Instrument Sign-Out Log

Location:_____ Month/Year:_____

LAST NAME (PRINT)	DETECTOR/INSTRUMENT TYPE/SERIAL#	JOB LOCATION	DATE/TIME OUT	DATE/TIME IN	RETURNED BY

Ludlum Model 3 with 43-5 probe - Operating Instructions

Instrument Operation:

1) Turn the selector knob to the “ON” position.
2) Adjust meter dial to appropriate scale.
3) When scanning, adjust response to “FAST”.
4) Plug in headset, if used.

Instrument Control Features:

AUDIO: Built in speaker with volume control
AUDIO JACK: For optional headset
METER DIAL: 0 – 5K cpm
MULTIPLIERS: X0.1, X1, X10, X100
DIGITAL RATEMETER: Provides a digital display of count rate when selector switch is in Dig. Rate position. (added option only)
RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading
RESET: Push-button to zero meter
POWER: 2 each "D" cell batteries (*housed in sealed compartment that is externally accessible*)
BATTERY LIFE: Typically 2000 hours with alkaline batteries (*battery condition can be checked on digital display*)
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)

Ludlum Model 18 with 44-9 probe - Operating Instructions

Instrument Operation:

1) Turn the selector knob to the “ON” position.
2) Adjust meter dial to appropriate scale.
3) When scanning, adjust response to “FAST”.
4) Plug in headset, if used.

Instrument Control Features:

AUDIO: Built in unimorph speaker with volume control
METER DIAL: 0 - 500 cpm, 0 – 2.5 kV, BAT OK
MULTIPLIERS: X1, X10, X100, X1000
SCALER: LCD display, and colons to indicate when a count is in process. (option ony)
COUNT: Push-button to initiate scaler count
HIGH VOLTAGE ADJUST: Accessible from front of instrument (*protective cover provided*)
RESPONSE: Will vary according to number of counts present. Typically 2 - 11 seconds from 10% to 90% of final reading
POWER: 2 each "D" cell batteries (*housed in sealed compartment that is externally accessible*)
BATTERY LIFE: Greater than 350 hours with alkaline batteries (*battery condition can be checked on meter*)
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)

Ludlum 2360 Alpha/Beta Datalogger with 43-93 probe - Operating Instructions

Instrument Operation:

1) Turn the selector knob to the “ON” position.
2) Select alpha only, beta only, or both to display.
3) Use switch to select count time, as desired.
4) To obtain a fixed-point count, depress button in handle to activate scaler.
5) Adjust meter dial to appropriate scale.

Instrument Control Features:

INDICATED USE: Alpha, beta discrimination, and data logging
DATA LOGGER: Capable of logging up to 550 individual data points with the following identifiers for each point (*All data is stored allowing batteries to be removed without loss of data*)
LOGGING PUSHBUTTON: Located in the handle; used to activate scaler and/or log a count
LOGGING FUNCTION CONTROL: Internal selection that enables the pushbutton to log the ratemeter reading, initiate a scaler count, and log the resulting reading, log both the scaler and ratemeter reading, or disables the logging function.
LOCATION CODE: A 10 character alphanumeric identifier. (*by bar code reader or PC*)
CALIBRATION DUE DATE: An internal date that disables the instrument if the required calibration interval has been missed
HEADER INFORMATION: Six lines of user defined memory at the beginning of the stack for storing user name, survey name, serial numbers, etc. (*Information is dumped with logged data*)
RS-232 PORT: Allows the instrument to be connected to a PC for data dump, and setup parameters.
AUDIO: Built in unimorph speaker with volume control
AUDIO DIVIDE: Selectable dual or individual click-per-event for alpha and beta counts and divisions of 1, 10, 100, or 1000 events-per-click(*beta channel only*)
METER DIAL: 0 - 500 cpm, 0 - 2 kV, BAT OK, OL(overload)
MULTIPLIERS: X1, X10, X100, X1000
SCALER: 6 digit LCD, overflow arrow, and colons to indicate when a count is in process
COUNT TIME: Switch selectable times of 0.1, 0.5, 1, 2, 5, 10, and 60 minutes, or PC to allow for a specific count time to be set from a PC.
SELECTOR SWITCH: Toggle switch to select alpha+beta, alpha only, or beta only
RESET/READ HV: A two position momentary action switch to allow for the meter to be reset or a reading of the HV setting.
OVERLOAD: Senses detector saturation. Indicated by red lamp on meter and meter deflecting to full scale (*Adjustable depending on detector selected*)
RESPONSE: Will vary according to the number of counts present. Typically 2 - 11 seconds from 10% - 90% of final reading
POWER: 2 each "D" cell batteries (*housed in compartment that in front of instrument*)
BATTERY LIFE: Greater than 150 hours (*battery condition can be checked on meter*)
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)

Ludlum 2929 with 43-10-1 Probe - Alpha/Beta Bench Counter Operating Instructions

Instrument Operation:

1) Turn the selector knob to the “ON” position.
2) Instrument simultaneously displays alpha and beta. .
3) Use numeral thumbwheel and multiplier to select count time.
4) Disengage sample tray locking device, and slide tray out.
5) Place smear or air sample in sample tray.
6) Slide in sample tray, and engage locking device.
7) Press “COUNT”.

Instrument Control Features:

INDICATED USE: Alpha beta sample counting with ZnS(Ag) adhered to plastic scintillation material
SAMPLE HOLDER: Anodized aluminum tray with 1" diameter sample ring to allow for 1" or 2" diameter samples
SAMPLE SIZE (maximum):2"(5.1cm) diameter X 0.4"(0.9cm) thick
AUDIO: Built in unimorph type speakers with volume controls to provide a dual tone (*1 per channel*) click-per-event audio
SCALERS: 2 ea. 6 digit LED displays providing a range of 0 - 999999 counts (*controlled by COUNT and HOLD buttons*)
TIMER: Thumbwheel adjustment from 0 - 99 minutes with selectable divisions of X0.1, X1, X10, or EXT for manual timing
METER DIAL: 0 - 2.5 kV; BAT TEST
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)

Bicron Model RSO – 50E MicroR Meter - Operating Instructions

Instrument Operation:

1) Turn the selector knob to the appropriate range.

Instrument Control Features:

INDICATED USE: Measurements of superficial or deep doses.
METER DIAL:0 - 5 microR/hr, 0 - 50 microR/hr
RANGE SELECTIONS: 12 KeV – 7MeV
LIGHT: Push-button to activate
RESET: Adjustable potenitiometer knob to zero
POWER: Two 9 volt cell batteries (*housed in sealed compartment that is externally accessible*)
BATTERY LIFE: Typically 250 hours with alkaline batteries (*battery condition can be checked on meter*)
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)

Frisker Setup Record

Meter Number: _____
Meter Model: _____
Cal Due: _____
Source Type: _____
Source Number: _____
Source DPM: _____

Detector Number: _____
Detector Model: _____
Cal Due: _____
Threshold: _____
High Voltage: _____

Instrument Range	Observed Count Rate (cpm)	Acceptance Criteria[1] (cpm)
Background Response (A)		
		to
Source Response (B)		
		to
Efficiency[2]: (%)		

[1] ± 20% of observed background or source count rate.
[2] Efficiency = Net count rate (B-A) / Source DPM

Comments/Restrictions: _____

_____ _____
Performed By Date

_____ _____
(RPM/Designee) Date

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ATTACHMENT 3

ACTIVITY HAZARD ANALYSIS

Concrete and Asphalt Coring Activity Hazard Analysis; Hand Decontamination of Equipment Activity Hazard Analysis; and Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis

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Concrete and Asphalt Coring Activity Hazard Analysis

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Travel to/at Project Site	Operation of motor vehicles and trucks	All site personnel operating motor vehicles shall comply with all federal, state, and local traffic regulations. Personnel shall only use vehicles that are in good condition and are safe to operate. Personnel shall routinely inspect vehicles and document as outlined in the SSHP. Always drive defensively: **Observe High in Steering -** Pick a safe location not necessarily the closest **Understand the Big Picture -** look for any potential dangers **Eyes are Always Moving while Driving -**scan don't stare **Make Sure to Have a Way Out -** leave sufficient space around you **Make Sure You are Seen -**make eye contact or use warning devices Personnel must follow EC&HS 110. This includes: only hands-free cell phone use, no riding in the bed of pickup trucks, always wear seatbelts, secure all equipment for transport. All personnel will wear seatbelts while vehicles are in motion, and comply with all speed limits (including site specific). Backing of vehicles shall be avoided when possible. Extra care shall be taken to back vehicles when unavoidable (e.g., use a spotter). Do not park vehicles on dry grass.
Unloading/Loading Equipment	Heavy lifting, strains, sprains.	Personnel must also follow EC&HS 150. No individual employee is permitted to lift any object that weighs over 50 lbs. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50 lb. limit.

Concrete and Asphalt Coring Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Coring into Asphalt or Concrete	Use of mechanical (coring) equipment	Only qualified personnel shall be permitted to operate equipment. Forklifts and mechanical equipment shall be inspected daily. Forklift inspections shall be documented on SAIC Procedure 26 "Powered Industrial trucks" Exhibit 26-1. Deficiencies in equipment shall be noted on the inspection form. Equipment found to be unsafe shall not be used. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts and hearing protection, as necessary. Ground personnel shall not position themselves between equipment and stationary objects and shall only approach the equipment after the bucket/fork/load (if applicable) is on the ground and after receiving a signal from the operator. Personnel shall maintain eye contact with the operator when approaching equipment. Equipment load capacities shall not be exceeded. Personnel shall never stand under suspended loads No person is to operate a powered industrial truck (e.g., a forklift) until the training requirements of SAIC EC&HS Procedure 26 "Powered Industrial Trucks" Section 26.7 "Operators Training" and 29 CFR 1910.178 are satisfied. Personnel shall ensure all mechanical guards are in place and functioning properly. All equipment shall be shut down with energies dissipated prior to performing maintenance activities. Lockout/tagout procedures may apply. Only qualified mechanics shall work on or repair mechanical equipment.
	Local Vehicle/Pedestrian Traffic	Follow Traffic Control plan for lane blockage, rerouting traffic, flagmen, etc. Follow all Federal, state, and local permits.

Concrete and Asphalt Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Coring into Asphalt or Concrete (Continued)	Slips, trips, and falls	Personnel must follow EC&HS 170. Keep work areas clear and maintain proper housekeeping - mark, barricade, or eliminate trip/fall hazards. Personnel shall not jump from equipment or elevated surfaces. Unloaded equipment and materials shall be stored appropriately.
	Hand injuries	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.
	Fire	Engines shall be shut off before refueling. A fire extinguisher shall be available at refueling areas. Smoking shall not be permitted near fueling areas. Fuel will be stored in safety cans with flash arrestors. A 20 lb ABC fire extinguisher shall be available at refueling areas.
	Electrocution	Only qualified electricians shall make electrical connections. All electrical work shall comply with National Electric Code standards. All circuit breakers shall be labeled. There shall be no work on energized electrical lines or equipment. Lockout tagout procedures (EC&HS 11) will apply during service or repair of machines or equipment in which the unexpected energization, startup, or release of stored energy could cause injury to employees. GFCIs shall be used on all power tools and extension cords. Extension cords, power tools, and lighting equipment shall be inspected before each use, protected from damage, and kept out of wet areas.

Concrete and Asphalt Coring Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Coring into Asphalt or Concrete (Continued)	Excavation hazards (contact with underground utilities)	Personnel must follow EC&HS 130 & 160. Underground utilities shall be located and marked prior to commencing excavation activities. Excluding personnel from trenches deeper than 4 feet will control cave-in hazards. Personnel will be kept at least 3 feet away from trenches deeper than 4 feet. Visual examination of excavation will be done from the trench ends, rather than the sides. If it becomes necessary for personnel to enter trenches deeper than 4 feet, the requirements of 29 *CFR* 1926.651 will be applied. This will include daily inspections of the excavation, shoring, benching or sloping of the trench sides.
	Noise	Noise surveys shall be performed to determine the extent and limits of hazardous noise areas. Engineering controls shall be implemented where feasible. Areas with noise that cannot be controlled shall be posted as such and personnel shall wear hearing protection to reduce exposures below the OSHA limits. Hearing protection is required for SAIC activities where noise levels exceed 85 dBA in an 8-hr TWA. Personnel shall wear Modified Level D (D+) PPE as required by the SSHP and specified in the HSWP.

Concrete and Asphalt Coring Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Coring into Asphalt or Concrete (Continued)	Radiological/chemical contamination (when working in radiologically and/or chemically contaminated areas).	Personnel shall wear Modified Level D (D+) PPE as required by the SSHP and outlined in the HSWP. Medical clearance in accordance with 29 CFR 1910.120 and EC&HS 12. Personal air monitoring shall be instituted (1 in 4 workers). The personal (BZ) air monitor shall be placed on the worker most likely to be exposed. TLDs shall be worn by personnel working in radiological areas or determined by the RPM and SAIC Procedure HP-40. Entry, routine, special, and exit bioassay samples shall be submitted to HP if working in radiological areas or determined by the RPM and SAIC Procedure HP-40. All employees and equipment shall be monitored for contamination prior to exit from radiological areas. The extent of personnel surveys (whole body, hand & foot, etc.) shall performed as listed on the HSWP. Minimize contact with radiological materials, survey and wash hands & face prior to taking anything by mouth (eating, drinking, smoking, chewing, etc.) No eating, drinking, smoking, chewing, etc. permitted in any radiological area. All incoming heavy equipment shall be surveyed for contamination prior to being allowed into radiological areas.

Concrete and Asphalt Coring Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Coring into Asphalt or Concrete (Continued)	Chemical hazards	Monitoring for chemicals is not anticipated to be necessary but shall be performed, if applicable. Copies of MSDSs for all hazardous chemicals on site will be maintained in the work area. MSDSs will be available to all employees for review. PPE requirements for work with or around hazardous chemicals (i.e., sample preservation or in the laboratory) shall be commensurate with hazards, chemical use and MSDS recommendations. No eating, drinking, smoking, chewing, etc. permitted in any chemical use area. Emergency eye wash (ANSI Z 358.1) will be available in the vicinity of chemical use area. Medical clearance in accordance with 29 CFR 1910.120 and EC&HS 12. Prevent contact with chemical, wash hands & face prior to taking anything by mouth (eating, drinking, smoking, chewing, etc.)
	Illumination	Site fieldwork will be conducted during daylight hours (no earlier than 15 minutes after sunrise and no later than 15 minutes before sunset) and natural illumination will be used. Work conducted in buildings will be illuminated to meet the minimums stated in 29 *CFR* 1910.120(m).
	Heat Stress	General controls will consist of making fluids readily available, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary.

Concrete and Asphalt Coring Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Coring into Asphalt or Concrete (Continued)	Cold Stress	General controls consist of adequate clothing, staying dry, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary. Move individuals who become wet to a sheltered, warm area.
	Biological hazards (bees, wasps, ticks, poison plants (poison ivy/oak/sumac))	Tape interfaces of clothing, use insect repellant, and perform self inspection for ticks as necessary. Personnel should inform supervisors of allergies to biological hazards. Wash hands and face when leaving areas where poison plants are present.
	Hazardous Material Transport	Personnel must follow EC&HS 28.
	Inclement Weather (lightning, thunderstorms, tornadoes, etc.)	Personnel will be trained during Site Orientation Training (SOT) to follow SAIC Site Safety and Health Plan for St. Louis – FUSRAP activities concerning site requirements regarding inclement weather.
Equipment To Be Used	**Inspection Requirements**	**Training Requirements**
Hilti Coring rig Support vehicles Monitoring instruments Sampling instruments Manual and electric hand tools GFCI and heavy duty extension cord	Inspect coring equipment daily prior to starting work. Inspect hand tools and extension cords each day of use. Monitoring instrumentation shall be checked daily for proper response and that the instrument has been calibrated.	Site Orientation Radiological Worker (if work is in radiological area) 40 Hr HAZWOPER & current refresher (if work is in chemically/radiologically contaminated area) Hazard Communication (if hazardous chemicals are used) Hearing Conservation (if noise exposures are > 85 dBA in 8 hr TWA)

Hand Decontamination of Equipment Activity Hazard Analysis

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Travel to/at Project Site	Operation of motor vehicles and trucks	All site personnel operating motor vehicles shall comply with all federal, state, and local traffic regulations. Personnel shall only use vehicles that are in good condition and are safe to operate. Personnel shall routinely inspect vehicles and document as outlined in the SSHP. Always drive defensively: **Observe High in Steering -** Pick a safe location not necessarily the closest **Understand the Big Picture -** look for any potential dangers **Eyes are Always Moving while Driving -**scan don't stare **Make Sure to Have a Way Out -** leave sufficient space around you **Make Sure You are Seen -**make eye contact or use warning devices Personnel must follow EC&HS 110. This includes: only hands-free cell phone use, no riding in the bed of pickup trucks, always wear seatbelts, secure all equipment for transport. All personnel will wear seatbelts while vehicles are in motion, and comply with all speed limits (including site specific). Backing of vehicles shall be avoided when possible. Extra care shall be taken to back vehicles when unavoidable (e.g., use a spotter). Do not park vehicles on dry grass.

Hand Decontamination of Equipment Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Unloading Equipment	Heavy lifting, strains, sprains.	Personnel must also follow EC&HS 150. No individual employee is permitted to lift any object that weighs over 50 lbs. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50 lb. limit.
Hand Decontamination of Equipment	Local Vehicle/Pedestrian Traffic	Follow Traffic Control plan for lane blockage, rerouting traffic, flagmen, etc. Follow all Federal, state, and local permits.
	Slips, trips, and falls	Personnel must follow EC&HS 170. Keep work areas clear and maintain proper housekeeping - mark, barricade, or eliminate trip/fall hazards. Personnel shall not jump from equipment or elevated surfaces. Unloaded equipment and materials shall be stored appropriately. Personnel trained in fall protection equipment use and inspection. Competent Person must inspect all fall protection systems and equipment. Provide and use fall protection at working heights > 6 ft. Install and use fall restraints or other appropriate controls when working on roof areas. Appropriate fall protection equipment shall be used while working in man-lifts. Only Type I ladders are permitted. Ladders shall be inspected before each use, be in good condition, and only used as intended by their design. Ladders shall be erected on level surfaces and tied off while being used. When tying off is impractical, then other personnel shall to used to steady the ladder. Personnel shall not overextend their reach while working on ladders.
	Hand injuries	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.

Hand Decontamination of Equipment Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Hand Decontamination of Equipment (Continued)	Fire	Engines shall be shut off before refueling. A fire extinguisher shall be available at refueling areas. Smoking shall not be permitted near fueling areas. Fuel will be stored in safety cans with flash arrestors.
	Hazardous energy (mechanical, potential, electrical, or otherwise)	Lockout tagout procedures will apply during service or repair of machines or equipment in which the unexpected energization, start-up, or release of stored energy could cause injury to employees.
	Electrocution	Only qualified electricians shall make electrical connections. All electrical work shall comply with National Electric Code standards. All circuit breakers shall be labeled. There shall be no work on energized electrical lines or equipment. Lockout tagout procedures (EC&HS 11) will apply during service or repair of machines or equipment in which the unexpected energization, startup, or release of stored energy could cause injury to employees. GFCIs shall be used on all power tools and extension cords. Extension cords, power tools, and lighting equipment shall be inspected before each use, protected from damage, and kept out of wet areas.
	Noise	Noise surveys shall be performed to determine the extent and limits of hazardous noise areas. Engineering controls shall be implemented where feasible. Areas with noise that cannot be controlled shall be posted as such and personnel shall wear hearing protection to reduce exposures below the OSHA limits. Hearing protection is required for SAIC activities where noise levels exceed 85 dBA in an 8-hr TWA.

Hand Decontamination of Equipment Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Hand Decontamination of Equipment (Continued)	Radiological/chemical contamination	Personnel shall wear Modified Level D (D+) PPE as required by the SSHP and outlined in the HSWP. Medical clearance in accordance with 29 CFR 1910.120 and EC&HS 12. TLDs shall be worn by personnel working in radiological areas or determined by the RPM and SAIC Procedure HP-40. Entry, routine, special, and exit bioassay samples shall be submitted to HP if working in radiological areas or determined by the RPM and SAIC Procedure HP-40. All employees and equipment shall be monitored for contamination prior to exit from radiological areas. The extent of personnel surveys (whole body, hand & foot, etc.) shall performed as listed on the HSWP. Minimize contact with radiological materials, survey and wash hands & face prior to taking anything by mouth (eating, drinking, smoking, chewing, etc.) No eating, drinking, smoking, chewing, etc. permitted in any radiological area. All incoming heavy equipment shall be surveyed for contamination prior to being allowed into radiological areas. Monitoring for chemicals is not anticipated to be necessary but shall be performed, if applicable.

Hand Decontamination of Equipment Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Hand Decontamination of Equipment (Continued)	Chemical hazards (chemical decon)	Copies of MSDSs for all hazardous chemicals on site will be maintained in the work area. MSDSs will be available to all employees for review. PPE requirements for work with or around hazardous chemicals (i.e., sample preservation or in the laboratory) shall be commensurate with hazards, chemical use and MSDS recommendations. No eating, drinking, smoking, chewing, etc. permitted in any chemical use area. Emergency eye wash (ANSI Z 358.1) will be available in the vicinity of chemical use area. Medical clearance in accordance with 29 CFR 1910.120 and EC&HS 12. Prevent contact with chemical, wash hands & face prior to taking anything by mouth (eating, drinking, smoking, chewing, etc.)
	Illumination	Site fieldwork will be conducted during daylight hours (no earlier than 15 minutes after sunrise and no later than 15 minutes before sunset) and natural illumination will be used. Work conducted in buildings will be illuminated to meet the minimums stated in 29 *CFR* 1910.120(m).
	Heat Stress	General controls will consist of making fluids readily available, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary.

Hand Decontamination of Equipment Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Hand Decontamination of Equipment (Continued)	Cold Stress	General controls consist of adequate clothing, staying dry, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary. Move individuals who become wet to a sheltered, warm area.
	Biological hazards (bees, wasps, ticks, poison plants (poison ivy/oak/sumac))	Tape interfaces of clothing, use insect repellant, and perform self inspection for ticks as necessary. Personnel should inform supervisors of allergies to biological hazards. Wash hands and face when leaving areas where poison plants are present.
	Hazardous Material Transport	Personnel must follow EC&HS 28.
	Inclement Weather (lightning, thunderstorms, tornadoes, etc.)	Personnel will be trained during Site Orientation Training (SOT) to follow SAIC Site Safety and Health Plan for St. Louis – FUSRAP activities concerning site requirements regarding inclement weather.
Equipment To Be Used	**Inspection Requirements**	**Training Requirements**
Support vehicles Brushes, soap, water, solvent rinse Cleaning cloth Manual and electric hand tools Heavy duty extension cord and GFCI Monitoring instruments	Inspect hand tools and extension cords each day of use. Inspect monitoring instruments for calibration each day of use.	Site Orientation Radiological Worker (if work is in radiological area) 40 Hr HAZWOPER & current refresher (if work is in chemically/radiologically contaminated area) Hazard Communication (if hazardous chemicals are used) Hearing Conservation (if noise exposures are > 85 dBA in 8 hr TWA)

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Travel to/at project site	Operation of motor vehicles and trucks	All site personnel operating motor vehicles shall comply with all federal, state, and local traffic regulations. Personnel shall only use vehicles that are in good condition and are safe to operate. Personnel shall routinely inspect vehicles and document as outlined in the SSHP. Always drive defensively: **Observe High in Steering -** Pick a safe location not necessarily the closest **Understand the Big Picture -** look for any potential dangers **Eyes are Always Moving while Driving -**scan don't stare **Make Sure to Have a Way Out -** leave sufficient space around you **Make Sure You are Seen -**make eye contact or use warning devices Personnel must follow EC&HS 110. This includes: only hands-free cell phone use, no riding in the bed of pickup trucks, always wear seatbelts, secure all equipment for transport. All personnel will wear seatbelts while vehicles are in motion, and comply with all speed limits (including site specific). Backing of vehicles shall be avoided when possible. Extra care shall be taken to back vehicles when unavoidable (e.g., use a spotter). Do not park vehicles on dry grass.
Unloading Equipment	Heavy lifting, strains, sprains	Personnel must also follow EC&HS 150. No individual employee is permitted to lift any object that weighs over 50 lbs. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting devices are required for lifting objects over the 50 lb. limit.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling	Use of other mechanical equipment	Only qualified personnel shall be permitted to operate equipment. Forklifts and mechanical equipment shall be inspected daily. Forklift inspections shall be documented on SAIC Procedure 26 "Powered Industrial trucks" Exhibit 26-1. Deficiencies in equipment shall be noted on the inspection form. Equipment found to be unsafe shall not be used. All equipment shall be operated at safe speeds and in a safe manner. Equipment operators shall wear safety belts and hearing protection, as necessary. Ground personnel shall not position themselves between equipment and stationary objects and shall only approach the equipment after the bucket/fork/load (if applicable) is on the ground and after receiving a signal from the operator. Personnel shall maintain eye contact with the operator when approaching equipment. Equipment load capacities shall not be exceeded. Personnel shall never stand under suspended loads No person is to operate a powered industrial truck (e.g., a forklift) until the training requirements of SAIC EC&HS Procedure 26 "Powered Industrial Trucks" Section 26.7 "Operators Training" and 29 CFR 1910.178 are satisfied. Personnel shall ensure all mechanical guards are in place and functioning properly. All equipment shall be shut down with energies dissipated prior to performing maintenance activities. Lockout/tagout procedures may apply. Only qualified mechanics shall work on or repair mechanical equipment.
	Overhead power lines	Equipment operators must remain aware of overhead power lines and maintain safe distances. Spotters shall be used as necessary.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling (Continued)	Local Vehicle/Pedestrian Traffic	Follow Traffic Control plan for lane blockage, rerouting traffic, flagmen, etc. Follow all Federal, state, and local permits
	Slips, trips, and falls	Personnel must follow EC&HS 170. Keep work areas clear and maintain proper housekeeping - mark, barricade, or eliminate trip/fall hazards. Personnel shall not jump from equipment or elevated surfaces. Unloaded equipment and materials shall be stored appropriately. Personnel trained in fall protection equipment use and inspection. Competent Person must inspect all fall protection systems and equipment. Provide and use fall protection at working heights > 6 ft. Install and use fall restraints or other appropriate controls when working on roof areas. Appropriate fall protection equipment shall be used while working in man-lifts. Only Type I ladders are permitted. Ladders shall be inspected before each use, be in good condition, and only used as intended by their design. Ladders shall be erected on level surfaces and tied off while being used. When tying off is impractical, then other personnel shall to used to steady the ladder. Personnel shall not overextend their reach while working on ladders.
	Hand injuries	Items to be handled shall be inspected for sharp edges prior to being handled. Personnel shall wear leather gloves when handling sharp materials. Personnel shall be aware of and avoid pinch point hazards.
	Fire	Engines shall be shut off before refueling. A fire extinguisher shall be available at refueling areas. Smoking shall not be permitted near fueling areas. Fuel will be stored in safety cans with flash arrestors.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling (Continued)	Excavation hazards (contact with underground utilities, excavation cave-in, work around heavy equipment, hazardous atmospheres)	Personnel must follow EC&HS 130 & 160. Underground utilities shall be located and marked prior to commencing excavation activities. Excluding personnel from trenches deeper than 4 feet will control cave-in hazards. Personnel will be kept at least 3 feet away from trenches deeper than 4 feet. Visual examination of excavation will be done from the trench ends, rather than the sides. If it becomes necessary for personnel to enter trenches deeper than 4 feet, the requirements of 29 *CFR* 1926.651 will be applied. This will include daily inspections of the excavation, shoring, benching or sloping of the trench sides.
	Noise	Noise surveys shall be performed to determine the extent and limits of hazardous noise areas. Engineering controls shall be implemented where feasible. Areas with noise that cannot be controlled shall be posted as such and personnel shall wear hearing protection to reduce exposures below the OSHA limits. Hearing protection is required for SAIC activities where noise levels exceed 85 dBA in an 8-hr TWA.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling (Continued)	Radiological/chemical contamination	Personnel shall wear Modified Level D (D+) PPE as required by the SSHP and outlined in the HSWP. Medical clearance in accordance with 29 CFR 1910.120 and EC&HS 12. TLDs shall be worn by personnel working in radiological areas or determined by the RPM and SAIC Procedure HP-40. Entry, routine, special, and exit bioassay samples shall be submitted to HP if working in radiological areas or determined by the RPM and SAIC Procedure HP-40. All employees and equipment shall be monitored for contamination prior to exit from radiological areas. The extent of personnel surveys (whole body, hand & foot, etc.) shall performed as listed on the HSWP. Minimize contact with radiological materials, survey and wash hands & face prior to taking anything by mouth (eating, drinking, smoking, chewing, etc.) No eating, drinking, smoking, chewing, etc. permitted in any radiological area. All incoming heavy equipment shall be surveyed for contamination prior to being allowed into radiological areas.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling (Continued)	Chemical hazards	Monitoring for chemicals is not anticipated to be necessary but shall be performed, if applicable. Copies of MSDSs for all hazardous chemicals on site will be maintained in the work area. MSDSs will be available to all employees for review. PPE requirements for work with or around hazardous chemicals (i.e., sample preservation or in the laboratory) shall be commensurate with hazards, chemical use and MSDS recommendations. No eating, drinking, smoking, chewing, etc. permitted in any chemical use area. Emergency eye wash (ANSI Z 358.1) will be available in the vicinity of chemical use area. Medical clearance in accordance with 29 CFR 1910.120 and EC&HS 12. Prevent contact with chemical, wash hands & face prior to taking anything by mouth (eating, drinking, smoking, chewing, etc.)
	Illumination	Site fieldwork will be conducted during daylight hours (no earlier than 15 minutes after sunrise and no later than 15 minutes before sunset) and natural illumination will be used. Work conducted in buildings will be illuminated to meet the minimums stated in 29 *CFR* 1910.120(m).
	Heat Stress	General controls will consist of making fluids readily available, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Principle Steps	Potential Safety/Health Hazards	Recommended Controls
	Cold Stress	General controls consist of adequate clothing, staying dry, use of the buddy system, and taking scheduled and unscheduled breaks in temperature controlled areas, as necessary. Move individuals who become wet to a sheltered, warm area.
	Biological hazards (bees, wasps, ticks, poison plants (poison ivy/oak/sumac)	Tape interfaces of clothing, use insect repellant, and perform self inspection for ticks as necessary. Personnel should inform supervisors of allergies to biological hazards. Wash hands and face when leaving areas where poison plants are present.
	Heavy equipment hazards associated with augers	Trained and qualified operators only. Operator manual available on site. Operators shall maintain awareness of others. Operators shall maintain a safe distance from electrical utilities. Loose clothing and long hair kept from rotating equipment.
	Hazardous Material Transport	Personnel must follow EC&HS 28.
	Inclement Weather (lightning, thunderstorms, tornadoes, etc.)	Personnel will be trained during Site Orientation Training (SOT) to follow SAIC Site Safety and Health Plan for St. Louis – FUSRAP activities concerning site requirements regarding inclement weather.

Soil Boring Using Manual or Power Auger, Surface/Subsurface Soil Sampling Activity Hazard Analysis (Continued)

Equipment To Be Used	Inspection Requirements	Training Requirements
Support vehicles Industrial trucks Generators Manual and electric hand tools Heavy-duty extension cords and GFCI Sampling and monitoring instruments.	Inspect drill rig each day of use. Inspect all industrial trucks each day of use. Inspect personal fall arrest system before each use. Inspect electric hand tools and extension cords each day of use. Inspect generators each day of use. Inspect H&S monitoring instruments for calibration each day of use. Inspect site each day.	Site Orientation Radiological Worker (if work is in radiological area) 40 Hr HAZWOPER & current refresher (if work is in chemically/radiologically contaminated area) Hazard Communication (if hazardous chemicals are used) Hearing Conservation (if noise exposures are > 85 dBA in 8 hr TWA)

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APPENDIX D

Santa Susana Field Laboratory Quality Assurance Project Plan

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DRAFT

SANTA SUSANNA FIELD LABORATORY RADIOLOGICAL INVESTIGATION

QUALITY ASSURANCE PROJECT PLAN

AUGUST 2010

DRAFT

SANTA SUSANNA FIELD LABORATORY RADIOLOGICAL INVESTIGATION

QUALITY ASSURANCE PROJECT PLAN

AUGUST 2010

Prepared for:
U.S. Department of Energy

Prepared by:
CDM with support from SAIC

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ACRONYMS AND ABBREVIATIONS

%R	percent recovery
CDM	Camp Dresser & McKee Inc.
COC	chain of custody
cpm	counts per minute
CSU	Combined Standard uncertainty, see TPU
DER	duplicate error ratio
DOE	Department of Energy
dpm	disintegration per minute
DQA	data quality assessment
DQO	data quality objective
EDD	Electronic Data Deliverable
EPA	U.S. Environmental Protection Agency
FCR	field change request
GC	gas chromatography
GFPC	Gas Flow Proportional Counting
H&S	health and safety
HPGe	High purity Germanium Gamma Detector
ICP	inductively coupled plasma
ID	identifier
LCS	laboratory control sample
LOR	Letter-of-Receipt
MARLAP	*Multi-Agency Radiological Laboratory Analytical Protocols* Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDL	method detection limit
MQO	measurement quality objective
MS/MSD	matrix spike/matrix spike duplicate
NAD	normalized absolute difference
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PQL	Project quantitation limits
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RI	Remedial Investigation
RL	Requirement Limit
RPD	relative percent difference
RSO	Radiation Safety Officer
SAIC	Science Applications International Corporation, Inc.
SAP	sampling and analysis plan
SDG	Sample Delivery Group
SOP	standard operating procedure
SOW	Statement of Work

1.0 INTRODUCTION

The overall objective of this Quality Assurance Project Plan (QAPP) is to provide guidance for development and implementation of procedures for field sampling, Chain of Custody, laboratory analysis of field samples, and result reporting, which provide data supporting risk analysis of radionuclides. Data must be technically sound and defensible.

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2.0 PROJECT ROLES AND RESPONSIBILITY

There are many personnel that will interact and aid each other in accomplishing the objectives of this QAPP. Their roles and responsibilities are defined here and used throughout this plan.

Field Supervisor: The person that ensures sampling equipment is available to properly sample, screen, label, and document the samples taken in the field.

Laboratory Coordinator/Data manager: Acts as a Liaison between the Laboratory Project Manager and the project personal. Coordinates sample container orders, notification to the lab of shipped samples, and data receipt.

Laboratory Manager: Manages the Analytical laboratory and ensures the Laboratory meets the recommended QA/QC requirements set out in the Laboratory Standard Operating Procedures and this QAPP.

Laboratory Project Manager: Acts as a Liaison between the Laboratory and Laboratory Coordinator/Data manager.

Project Chemist: The person that determines the acceptability of laboratory data of radiological nature, approves variances to QAPP for Laboratory QC, and recommends laboratories and/or analytical procedures for the Project Manager to approve.

Project Manager: The person that is in charge of coordinating Field, Analytical, and final reporting of data to the client.

QA/QC Officer: Person in charge of ensuring procedures are followed and documentation is provided for field, analytical, and data management purposes.

Validator: The person that ensures the lab provides the data for the project that meets the project needs.

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3.0 PROJECT QUALITY OBJECTIVES AND ELEMENTS OF QUALITY CONTROL

3.1 DATA QUALITY OBJECTIVES FOR QUALITY ASSURANCE FOR MEASUREDMENT DATA OF RADIOLOGICAL SAMPLES

All field radiological measurements will be conducted in accordance with approved protocols and following the direction of this QAPP. Laboratories shall be required to comply with all analytical methods as written and in accordance with the direction of this QAPP, or ask for a variance from the QAPP from the Project Chemist. If requested by the Project Manager, laboratories selected for the project will submit all project-relevant method standard operating procedures (SOPs) and minimum detectable activity (MDA) studies for review and inclusion with project records.

3.1.1 Level of Quality Control Effort

To assess whether Quality objectives are achieved, analyses of specific field and laboratory QC samples shall be required. These QC samples include field duplicates, equipment swipes or rinsates, analytical method blanks, laboratory control samples (LCSs), laboratory duplicates, and matrix spike (MS) samples; as appropriate.

Field duplicates shall be submitted for analysis to provide a means to assess the precision of the data from the sampling perspective. Field duplicates are analyzed to determine sample homogeneity and sampling methodology reproducibility. Field duplicates shall be collected and analyzed at a frequency of 5% per sample matrix, i.e. 1 duplicate sample for every 20 field samples. Soil field duplicate relative percent difference (RPD) calculations are expected to be within 50 RPD for the targeted analytes, or less than 1.96 by normalized absolute difference (NAD). When values are within five times the associated analyte reporting level, either the project quantitation limit or Laboratory reporting limit whichever is less, field duplicate comparisons are expected to be within three times the reporting level of each other.

Equipment swipe or rinsate samples may be submitted to assess the effectiveness of the decontamination process for reusable sampling equipment. Decontaminated equipment may be swiped or rinsed with deionized water. The swipe or rinsate water will be analyzed to ensure that all sampling equipment was effectively cleaned and did not cause cross-contamination of samples. A minimum of one equipment swipe or rinsate sample should be collected where reusable equipment is employed.

Analytical method blanks and LCSs are employed to determine the accuracy of the analytical method as implemented during the sample analysis. Matrix spikes provide information about the effect of the sample matrix in the measurement methodology on selected analytes. Analytical sample duplicates assist in determining the analytical precision of the analysis for a given sample and matrix. One MS and one analytical duplicate sample shall be analyzed for at least every 20 samples for those analytes where applicable.

The QC effort for in-field radiation measurements shall include calibration of instruments using National Institute of Standards and Technology (NIST)-traceable standards and implementation of approved SOPs. Calibration checks shall be performed on all radiation-detection field meters in accordance with approved SOPs. Field instruments are discussed further in Section A5 of this QAPP.

3.1.2 Defining Data Quality Indicators

The fundamental QA objectives for precision, accuracy, representativeness, comparability, completeness and sensitivity of laboratory analytical data are the QC acceptance criteria of the analytical protocols. A table of acceptable Statistical calculations is provided in Table 1 with the given parameter of Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity (PARCCS) it applies to, if any.

Table 1. Statistical Formulas and Uses

Statistic Reference	Symbol	Formula	Definition	Applicable PARCCS Parameter
Relative Percent Difference	RPD	$\frac{\lvert Sample - Duplicate \rvert}{\frac{(Sample + Duplicate)}{2}} \times 100$	Measure of variability that adjusts for the magnitude of observations	Used to assess total and analytical precision of duplicate measurements
Percent Recovery	%R	$\left(\frac{x_{measured}}{x_{true}}\right) \times 100$	Recovery of spiked compound in a Laboratory control spike	Used to asses accuracy
Percent Recovery	%R	$\left(\frac{Spiked - unSpiked}{Value\ of\ spike\ added}\right) \times 100$	Recovery of spiked compound in sample matrix	Used to assess matrix effects and total precision
Duplicate Error Ratio	DER	$\frac{\lvert Sample - Duplicate \rvert}{\sqrt{(U_{nc_{Sample}})^2 + (U_{nc_{Duplicate})^2}}}$	Performance indicator for Replicates/duplicates at 1 sigma standard deviation	Used to assess precision of the sample when uncertainty of the measurement is available

Note: Unc as uncertainty in the measurement from Combined Standard uncertainty (CSU) which is the same as Total propagated uncertainty (TPU) at the 1 sigma level.

3.1.3 Precision

Precision is the measure of the degree of reproducibility exhibited by a set of replicated results or the agreement among repeat observations made under the same conditions. Analytical precision can be determined through comparison of laboratory analytical duplicate responses. The RPD between two positive/detect results is calculated and used as a QC indication of the precision of the analyses performed. The duplicate error ratio (DER) between the sample and laboratory duplicate is also calculated and used to determine that the results do not differ significantly when compared to their respective one sigma uncertainty. The DER analysis of the data can only be used with data providing measurement uncertainty. When either the DER or the RPD calculations pass the acceptance criteria, then the duplicate comparison is acceptable.

Sample collection precision may be measured by the analyses of field duplicates. Precision may be assessed during data evaluation and recorded as the RPD and the DER for two measurements of a given analyte.

3.1.4 Accuracy

Accuracy is the nearness of a result, or the mean of a set of results, to the true or accepted value. Analytical accuracy is expressed as the percent recovery (%R) of an analyte added to a blank sample or environmental sample at a known concentration during sample preparation, or as the recovery of an analyte from a sample of known concentration. Accuracy should be determined

through the use of Laboratory Control Sample (LCS) and Matrix Spike (MS) analyses. The percent recoveries for specific target analytes may be calculated and used as a QC indication of the accuracy of the analyses performed.

3.1.5 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variation at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter dependent upon the proper design of the sampling program and proper laboratory protocol. The Measurement Quality Objective (MQO) for representativeness is met when proper sampling techniques are used, appropriate analytical procedures are selected and followed, sample size is appropriate, sub-sampling homogenization techniques and sub-sample size are appropriate, and holding times are not exceeded. Representativeness shall be determined by assessing the combined aspects of the QA Program, QC measures, and data evaluations.

3.1.6 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data expected under normal conditions. Overall project completeness goals take into consideration the potential for sample losses (e.g., due to breakage) and potential data losses (e.g., due to severe matrix interferences). Laboratory-generated data are expected to provide information meeting all system QC criteria for all samples analyzed.

3.1.7 Comparability

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data shall be comparable depends upon the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data.

3.1.8 Sensitivity

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. Sensitivity is usually set out in limits, e.g. Minimum Detectable Amount (MDA), Minimum Detectable Concentration (MDC), and Reporting limits. For Radiological measurements the Reporting limit is replaced by the customer required detection limit (RDL) for meeting the needs of the project sensitivity.

3.1.8.1 Required Detection Limit

The analytical laboratory shall optimize analysis parameters in order to achieve analyte MDAs, (as defined below) and corresponding MDCs less than or equal to the project required detection limits (RDLs), except when sample activities are significantly greater than the RDL. The analytical laboratory shall meet these limits when an analyte is a non-detect, i.e. less than decision level (DL) (as defined below and also known as critical level), unless the lab seeks approval for a variance to these requirements before the start of sample analysis. Due to the nature of Radiochemical data analysis, all radiochemical data values shall be reported based on the instrument(s) output, i.e. report values less than MDC whether the values are negative or positive.

3.1.8.2 Minimum Detectable Amount (MDA)

The MDA is the smallest amount (activity or mass) of an analyte in a sample that will be detected with a probability β of non-detection (Type II error) while accepting a probability α of erroneously deciding that a positive (non-zero) quantity of analyte is present in an appropriate blank sample (Type I error). For this project, the alpha (α) and beta β) probabilities are both set at 0.05. MDA is not comparable to Method Detection limits (MDLs) as defined by the EPA in 40CFR136, appendix B used for chemicals since both Type I and Type II errors are considered. The Minimum Detectable Concentration (MDC) is the MDA expressed in units of concentration. MDAs are determined based on the normal factors and conditions, which influence the measurement. The MDA is used to evaluate the capability of a method relative to the required RDLs. Sample size, count duration, tracer chemical recovery, detector background, blank standard deviation, and detector efficiency shall be optimized to result in sample MDAs less than or equal to the RDLs. If RDLs are not achieved, then the cause shall be addressed comprehensively in the Case Narrative.

MDA Calculation – The basic MDA calculation shall be based on concepts developed by L. A. Currie, "Limits for Qualitative Detection and Quantitative Determination", *Analytical Chemistry*, March, 1968, Vol.40, No.3, Pg. 586. The following general equations shall be used to calculate the MDA.

Without Blank Population –

$$MDA = \frac{4.65 * \sqrt{\frac{B}{T}}}{\varepsilon_i K} + \frac{3}{\varepsilon_i K T_g}$$

where:

B	=	background count rate (cpm);
T_g	=	count time of the sample (minutes);
ε_i	=	detector efficiency ;
K	=	aliquot fraction (fractional portion of the sample analyzed) * tracer recovery (efficiency of the analysis process as determined using tracer materials); and
T	=	count time (minutes) of both the sample and background

Use of the above equation requires that the background and sample count times are equivalent. When sample and background counts are different, the following adjustment to the equation is required.

$$MDA = \frac{3 + 3.29 * \sqrt{\frac{B}{T_g} + \frac{B}{T_b}}}{\varepsilon_i K * T_g}$$

where:

T_b	=	count time of the background (minutes).

The above equations for MDA have the units of dpm/sample. Any other units will require appropriate conversion.

With Blank Population –

$$MDA = \frac{3 + 3.29 * s_b}{\varepsilon_i K * T_g}$$

where:

s_b = standard deviation of the blank population where the blank population is in net blank counts in count time T_g.

Use of blank populations for calculation of MDAs requires the selection of an implementation method, which includes but is not limited to:

Identification of blanks to be used in the population

- The number of blanks to use in the population
- How the blank population changes
- Limitations on the deletion of blanks
- The method of implementation shall not introduce any statistical bias
- The appropriate blank subtraction shall be the mean blank value of the blank population

The definition of the MDA presupposes that an appropriate detection threshold (i.e., the decision level) has already been defined. The α probabilities assumed for the decision level shall also be used for the calculation of the MDA.

3.1.8.3 Decision Level Calculation

The Decision Level (DL) is the minimum measured value (e.g., of the instrument signal or the analyte concentration) required to give confidence that a positive (nonzero) amount of analyte is present in the material analyzed. The decision level is sometimes called the critical level or critical value (MARLAP). It is the quantity of analyte at or above which an a posteriori decision is made that a positive quantity of the analyte is present. The DL is comparable to Method Detection limits (MDLs) as defined by the EPA in 40CFR136, appendix B used for chemicals. For the purposes of this project and the equations below, the α probability are set to be 0.05. Decision levels are determined a posteriori based on sample specific sample size, count duration, tracer chemical recovery, detector background, blank standard deviation, and detector efficiency.

Decision Level (DL) Calculation - The basic DL calculation shall be based on concepts developed by L. A. Currie, "Limits for Qualitative Detection and Quantitative Determination", *Analytical Chemistry*, March, 1968, Vol. 40, NO.3, pg. 586.The following general equations shall be used to calculate the decision level.

The decision level can either be based on the CSU of the sample, or the standard deviation determined from a set of appropriate blanks.

Without Blank Population –

When determined from the CSU of the sample, the decision level evaluates the level where there is 95% confidence (or other specified level of confidence) that the true result is greater than zero and can be estimated by the following equation:

$$DL = 1.65 * CSU_R$$

where:

DL = decision level in disintegrations per minute per unit volume or weight (dpm/unit);

CSU_R = combined standard uncertainty (random component only) of the result, R (dpm/unit); and

1.65 = abscissa of the standardized normal distribution for a 1-sided 95% confidence.

With Blank Population –

When determined from the standard deviation of a set of appropriate blanks, the decision level evaluates the level where the blank results will not exceed more than 5% of the time (or other specified level of confidence) and may be estimated by the following equation:

$$DL = \frac{(t * s_b) + \overline{R_B}}{\varepsilon_i * K * W}$$

where:

s_b = standard deviation of a set of appropriate blank net count rate after background subtraction for blanks counted for the same length of time as the sample;

$\overline{R_B}$ = average blank count rate in counts per minute (cpm);

t = student t factor for appropriate degrees of freedom and confidence level;

ε_i = detector efficiency;

W = weight or volume of sample; and

K = aliquot fraction (fractional portion of the sample analyzed) * tracer recovery (efficiency of the analysis process as determined using tracer materials); and

DLs shall be used as the default detection threshold for making detection decisions.

4.0 SAMPLING PROCEDURES

In-situ radiation measurements shall be acquired for this sampling effort; in addition to direct sample collection. Two different types of field measurements (gamma walk-over and beta surface scans) will be performed during these studies. A description of the field instruments, associated calibration requirements and performance checks used for field measurements are presented in Section A5 of this QAPP.

4.1 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

Sample containers and holding times for solids, soils, and waters collected during the investigations are described in Table 2. Additional sample volumes shall be collected and provided, when necessary, for the express purpose of performing associated laboratory QC (e.g., laboratory duplicates and MSs).

Table 2. Analytical Sample Container, Preservation, and Holding Times

Analyte Group	Analytical Method	Container[a]	Recommended Sample		Preservative[a]	Holding Time
			Mass	Volume		
Solids and Soils						
Radiological parameters	Gamma Spec, Alpha Spec, or beta counting	1-L Plastic or 1qt paint can	1000 grams	Not applicable	None and Cooled to 4ºC	180 days
Waters						
Radiological parameters (H-3, C-14, I-129)	Gamma Spec, Alpha Spec, or beta counting	One 1-L amber glass	Not applicable	1 liter	None and Cooled to 4ºC	180 days
Radiological parameters (Other radionuclides)		One 4-L plastic cubitainer	Not applicable	4 liters	HNO_3 to pH<2 or Cool to 4ºC	180 days
Air Filter Analysis						
Gross Alpha/ Gross Beta	GFPC	Plastic Ziploc® bag	Not applicable	Not applicable	None	180 days

[a] Unless otherwise specified by the receiving laboratory.

In the event sample integrity, such as holding times, is compromised, re-sampling shall occur as directed by the Project Manager. Any affected data shall be flagged and qualified per data validation instructions and guidance.

4.2 FIELD DOCUMENTATION

4.2.1 Field Logbooks

Sufficient information shall be recorded in the field logbooks to permit reconstruction of all sampling activities conducted. It is important that the field logbook be present at the immediate site of sampling so that it can be filled out at the time of sampling and details of the event can be recorded accurately. Information recorded on other project documents shall not be repeated in the logbooks except in summary form where determined necessary. Upon completion of the field activities, all logbooks shall become part of the final project file.

Samples shall be collected following approved sampling procedures. When a sample is collected or a measurement is made, a description of the location shall be recorded with other information, as described in Section A4.3.2. A sample ID number shall be assigned before sample collection. Field duplicate samples, shall receive a unique sample ID number, which shall be noted under sample description in the field logbook. Equipment employed to make field measurements shall be identified, along with their calibration dates.

The field sampler is responsible for the care and custody of the samples until samples are transferred or properly dispatched from their custody. As few people as possible should handle the samples. Each sample container shall be labeled as described in Section A4.3.2. Sample labels are completed for each sample. A Chain of Custody (COC) is filled out at the time of sampling to document who sampled, what samples were taken, when where the samples taken, where the samples were taken, how much was sample was taken, for what analysis or reasons for the sampling, and to whom the samples were transferred out of the samplers custody. The Project Manager may audit field activities; determining whether proper custody procedures are followed during the fieldwork and deciding if corrective actions are needed or additional samples are required.

4.2.2 Field Variance System

If variances from the operating procedures occur, they shall be documented on a field change request (FCR) form or a Nonconformance Report (NCR), where appropriate. If a variance is anticipated (e.g., because of a change in the field instrumentation), the applicable procedure may be revised upon approval, approved by the Project Manager, and the change noted in the field logbooks.

FCRs and NCRs can be processed in accordance with the examples provided in Figures 1 and Section 9 Figure 15, respectively.

4.3 SAMPLE DOCUMENTATION, CHAIN OF CUSTODY, AND SHIPMENT TO THE LAB

Sample documentation shall extend from section A4.2.1.1.1 with the COC. The COC is intended to document a chain of people who possessed, and transferred the samples to its final purpose. Data collected cannot be considered complete without a valid chain of custody.

4.3.1 Sample Custody

It is the intent of these investigations, to follow EPA policy regarding sample custody and COC protocols, as described in *NEIC Policies and Procedures* (EPA 1985). This custody consists of three parts: (1) sample collection, (2) laboratory analysis, and (3) final evidence files. Final project files, including originals of laboratory reports and electronic files are maintained by the Project in a secure area. A sample is under custody when it is

- in your possession;
- in your view, after being in your possession;
- in your possession and you place it in a secured location; or
- in a designated secure area.

Field Change Order (FCO)

FCO No.	Date:

Requester Identification

Name:	Organization:	Phone:
Title:	Signature:	

Baseline Identification

Baseline(s) Affected O Cost O Scope O Milestones O Method of Accomplishment

Description of Change/Justification

FCO Approval Signatures

Field Supervisor _____	Date:
Project Manager_____	Date:
QA/QC Officer, H&S Officer, or other (as appropriate) _____	Date:

Figure 1. Example of a Field Change Order Form

4.3.2 Sample Labeling

Labels shall be affixed to all sample containers during sampling activities. Some information may be pre-printed on each sample container label. Information not preprinted shall be recorded on each sample container label at the time of sample collection. The information recorded on the labels shall be as follows:

- sample ID number,
- site name and station,
- analysis to be performed,
- type of chemical preservative present in container or preservation method (if applicable),
- date and time of sample collection, and
- sampler's name and/or initials.

Sample logbooks and COC records shall contain the same information as the labels affixed to the containers, although the station name may be omitted on the COC. The sample location measurements should also be recorded in the sample logbook. All information related to the sampling effort and the process employed shall be recorded and maintained.

4.3.3 Sample Documentation for Shipping to the Laboratory

The sample packaging and shipment procedures shall ensure that samples arrive at the laboratory with the COC intact. A protocol for site-specific sample numbering, ID, and transportation tracking shall be followed.

Samples shall be accompanied by a properly completed COC form. The sample numbers and collection dates/times shall be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving shall sign, date, and note the time on the record. This record shall document transfer of custody of samples from the sampler to the designated laboratory.

SAIC will coordinate the transportation of project samples as required to assure compliance with the requirements of Title 49 Code of Federal Regulations. Special consideration will also be given to assuring compliance with common carrier requirements. Sample transportation will be performed in accordance with SAIC corporate procedure Environmental Compliance & Health and Safety 28.

A COC record identifying the contents shall accompany all shipments. The original record shall accompany the shipment, and the originator shall retain a copy for return to project management and the project file.

Custody procedures and holding time requirements for samples should be described in laboratory QA Plans. These documents should identify the laboratory custody procedures for sample receipt and log-in, sample storage, tracking during sample preparation and analysis, and laboratory storage of samples and data. The original completed COC should be transmitted with the final analytical results from the laboratory. All discrepancies, errors, or problems with sample receipt should be communicated to the Laboratory Coordinator/Data Manager immediately upon discovery.

The laboratory should confirm sample receipt and log-in information through transmission of a Letter-of-Receipt (LOR) to the Laboratory Coordinator/Data Manager. This includes returning a copy of the completed COC and confirmation of the analytical log-in indicating laboratory sample numbers within 24 hours of receipt by the laboratory.

4.4 FINAL PROJECT FILE CUSTODY PROCEDURES

The project file shall include all relevant records, reports, logs, field notebooks, pictures, subcontract reports, correspondence, laboratory logbooks, and COC forms. The project file shall be stored in a secure, limited-access area until relevant information may be transferred to the Project Manager.

The analytical laboratory should retain all results, supporting QC, COCs, and original raw data for 7 years (both hardcopy and electronic) in a secure, limited-access area and under custody of the Laboratory Project Manager or designee.

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5.0 ANALYSIS PROCEDURES

All samples collected during this investigation shall be analyzed by laboratories approved to perform the designated analyses. Each laboratory supporting this work may be requested to provide statements of qualifications, including organizational structure, QA Manual, and SOPs for approval by the Project Chemist.

5.1 FIELD SCREENING SAMPLES

The Field Supervisor shall ensure that required field instrument calibration and QC functions are performed. Calibrations will be performed in accordance with guidance contained in American National Standards Institute N323A-1997. Calibration of field instruments shall be performed annually, with calibration dates clearly identified on each instrument.

5.1.1 Field Measurement

QC procedures for radiological field measurements are daily response checks, as described earlier and in approved procedures. To ensure the usability and reproducibility of the data, check source acceptance criteria will be established for survey instruments prior to use during field operations. Each survey meter will be evaluated against check-source acceptance criteria as described in the approved procedure and at any time the instrument response appears questionable, this will be conducted using a check source in a reproducible geometry. Instrument response will be verified with a check-source prior to the survey. Only data obtained using instruments that satisfy the performance requirements will be accepted for use. All response check information shall be documented and retained for future reference in the project files.

5.1.2 Field Sample Collection

The assessment of field sampling precision and accuracy should be accomplished by analyzing field duplicates to verify the consistency of sample collection and associated tasks.

These samples are collected concurrently with primary environmental sample(s) and equally represent the sampled medium at a given time, location, and possibly depth. Duplicate samples for each medium will be collected at an approximate 5% frequency within each of the areas addressed by this Project and submitted to the laboratory for analysis. The primary purpose of the field duplicate is to check the precision of the sampling effort and assess the heterogeneity of the matrices being sampled. If there are significant differences between the duplicates, their potential effect on the data set should be examined.

5.2 LABORATORY ANALYSIS

Laboratory facilities shall establish and document operational procedures that are consistent with currently accepted analytical protocols of the EPA, DOE, ATSM, or NRC. Sample analysis may require modifications to defined methodologies depending on analytical through put, and project sensitivity goals. All analytical procedures and method variations should be identified in SOPs, and these procedures should be available for review by the Laboratory Coordinator/Data Manager.

Laboratory SOPs should be adapted from standard industry accepted methods and specify the following:

- protocol for sample preparation,
- instrument start-up and performance check,

- initial and continuing calibration check requirements,
- procedures to establish minimum detectable activities for each parameter,
- specific analytical protocols, and
- required QC elements.

Laboratory facilities should not subcontract or transfer any portion of this work to another facility, unless expressly permitted to do so in writing by the Project Manager or the Laboratory Coordinator/Data Manager

Standard analytical protocols may be inadequate when contaminant concentrations are high or for difficult matrices. In these cases, sample analysis may require modifications to standard methodology. Any proposed changes to analytical methods should not be implemented without written approval from the project radiological chemist. All analytical method variations should be identified within the sample delivery group's (SDG) case narrative.

5.2.1 Measurement Quality Objectives

A summary of the MQOs for this work are presented in Table 3. These objectives will be evaluated during validation of individual SDG or as requested by the Project Manager. Validated results that do not meet the objectives will be qualified and designated by the validator with the appropriate qualification codes. Further actions may be appropriate if data are deemed unusable by the validator, such as requesting re-analysis of Laboratory analytical data by the same or another Laboratory.

Table 3. Analytical Measurement Quality Objective Summary

Sample Type	Analytical Method	Precision for Duplicates [a]			Analytical Accuracy (LCS and MS)[a]		Completeness (%)
		Field	Analytical				
		All Phases	Aqueous	Solid	Aqueous	Solid	
Discrete or composite	Gamma spec radioisotopes ASTM Std C 1402-98	<50 RPD *or* ≤3 DER	<20 RPD *or* ≤3 DER	<30 RPD *or* ≤3 DER	80 to 120% recovery	70 to 130% recovery	90
	Liquid Scint EPA 900 series.	<50 RPD *or* ≤3 DER	<20 RPD *or* ≤3 DER	<30 RPD *or* ≤3 DER	80 to 120% recovery	70 to 130% recovery	90
	Alpha spec radioisotopes EPA 900 series	<50 RPD *or* ≤3 DER	<20 RPD *or* ≤3 DER	<30 RPD *or* ≤3 DER	80 to 120% recovery	70 to 130% recovery	90
	Gas flow proportional counting isotopes EPA 900 series	<50 RPD *or* ≤3 DER	<20 RPD *or* ≤3 DER	<30 RPD *or* ≤3 DER	80 to 120% recovery	70 to 130% recovery	90

[a] These objectives will be evaluated during hard-copy validation of analytical data packages by the Project Chemist or as requested by the Program Manager. Validated results that do not meet the objective will be qualified by the validator, as appropriate. Further actions may be appropriate if data are deemed unusable by the validator.
LCS = laboratory control sample

5.2.2 Required Detection Limits

Maximum required sensitivities (Required Detection Limits [RDL]) for project analyses are provided in Table 4.

Table 4. Parameters, Analytical Methods, and Required Detection Limits

Isotope	Method	Required Detection Limit (pCi/sample)
Am-241	Chemical Separation and Alpha Spectroscopy	50
Ba-133	Gamma Spectroscopy	50
Be-10	Chemical Separation and Liquid Scintillation Counting	50
Cd-113m	Chemical Separation and Liquid Scintillation Counting	50
Cm-244	Chemical Separation and Alpha Spectroscopy	50
Co-60	Gamma Spectroscopy	50
Cs-137	Gamma Spectroscopy	50
Eu-152	Gamma Spectroscopy	50
Eu-154	Gamma Spectroscopy	50
Eu-155	Gamma Spectroscopy	50
H-3	Liquid Scintillation Counting	10,000
Np-237	Chemical Separation and Alpha Spectroscopy	50
Pm-147	Chemical Separation and Liquid Scintillation Counting	50
Pu-238	Chemical Separation and Alpha Spectroscopy	50
Pu-239/240	Chemical Separation and Alpha Spectroscopy	50
Pu-241	Chemical Separation and Liquid Scintillation Counting	50
Sr-90	Chemical Separation and Gas Flow Proportional Counting	50
Th-228	Chemical Separation and Alpha Spectroscopy	50
Th-230	Chemical Separation and Alpha Spectroscopy	50
Th-232	Chemical Separation and Alpha Spectroscopy	50
U-233/234	Chemical Separation and Alpha Spectroscopy	50
U-235	Chemical Separation and Alpha Spectroscopy	50
U-238	Chemical Separation and Alpha Spectroscopy	50

5.2.3 Quality Assurance Program

The analytical laboratory should have a written QA Program that provides rules and guidelines to ensure the reliability and validity of work conducted at the laboratory. For this work, support laboratory QA Plans should be referenced and implemented in their entirety.

Minimum elements of a laboratory QA Program are to include:

- Sample receipt and processing;
- properly sub-sample, preserve, prepare, and store all samples and extracts;
- maintain adequate custody records from sample receipt through reporting and archiving of results;
- use properly trained analysts to analyze all samples by approved methods, and maintain the training and qualification records of those analysts;
- produce scientifically sound and defensible data with associated documentation to show that each instrument was calibrated and operating within laboratory control limits;
- accurately calculate, check, report, and archive all data;
- analyze analytical blanks, Laboratory control spike, analytical duplicate, and matrix spike samples, as required, within required intervals of 1 in 20 samples;
- document all the above activities so that all data can be independently validated; and

- All laboratory procedures are documented in writing as SOPs and approved, revised, and controlled by Laboratory Management, and available upon request by the Project Chemist or Laboratory Coordinator/Data Manager.

Internal QC measures for analysis should be conducted in accordance with their SOPs and as specified in the individual method requirements. Laboratories should provide sufficient documentation in each data package to ensure that both initial and ongoing instrument and analytical QC functions have been met.

5.2.4 Calibration Requirements

This section describes procedures for maintaining the accuracy of the instruments and measuring equipment used for conducting field tests and laboratory analyses. The calibration of these instruments and equipment shall be checked before each use or on a scheduled basis according to instrument manufacturer instructions or industry standard practices. The calibrations, efficiency and energy should be performed at least yearly or when the instrument has changes that may affect efficiency and energy calibrations. The radiochemical laboratory shall have documentation with-in the SOP(s) for calibration of instrumentation used in measurement of radionuclides.

5.3 INTERNAL QUALITY CONTROL CHECKS

Implementation of QC procedures during sample collection, analysis, and reporting ensures that the data obtained are adequate for their intended use. Analytical QC measures are used to determine if the analytical process is within accepted tolerance, as well as to determine the sample matrix effects on the data being generated. Both field and laboratory QC checks are performed throughout the project to document potential bias in the data and to establish a basis for using the results with confidence.

Specifications include the types of QC required (i.e., duplicates, controls, blanks, etc.), the frequency for implementation of each QC measure (i.e. 1 in 20 samples for each type of QC), compounds used for sample spikes and isotopic tracers, and the acceptance criteria for the QC results.

5.3.1 Analytical Process Quality Control

To ensure the production of analytical data of known and documented quality, laboratories associated with these evaluations should implement all applicable QC measures to verify the quality of analysis. Analytical QC procedures for this work are specified in the individual method descriptions. These specifications include the types of QC checks normally required such as method blanks, LCSs, MSs, calibration standards, chemical carrier evaluation, tracer standards, calibration check standards, and laboratory duplicate analysis. Laboratories should also follow specific quality processes as defined by the method.

5.3.1.1 Method Blanks

A method blank is a sample of an analyte-free substance similar to the matrix of interest (usually distilled/deionized water or silica sand) that is subjected to all of the sample preparation and analytical methodology applied to the samples. The purpose of the method blank is to check for contamination, from within the laboratory, introduced during sample preparation and analysis that would adversely affect analytical results. A method blank should be analyzed with each analytical sample batch for applicable laboratory procedures. The acceptance criteria for the method blank is the method blank result shall be less than 2 times the blank CSU (or TPU), Blank result MDC less than RL, and if the blank does not meet the first two requirements then

Sample results must be greater than five times the blank result. In the event none of the acceptance criterion can be met, reanalysis of the analytical batch should be performed.

5.3.1.2 Laboratory Control Sample

The LCS contains known concentrations of target analytes and is carried through the entire preparation and analysis process. Commercially available LCSs or those from EPA may be used. LCS standards prepared in-house must be made from a NIST traceable source. The primary purpose of the LCS is establishing and monitoring the laboratory's analytical process control. An LCS should be analyzed with each analytical sample batch for applicable laboratory procedures, and analytes with the maximum batch size being no larger than 20 analytical samples. The acceptance criterion for the LCS is listed in Table 3 for Analytical Accuracy.

5.3.1.3 Laboratory Duplicates

Laboratory duplicates are separate aliquots of a single sample prepared and analyzed concurrently at the laboratory. The duplicate sample shall be selected from one of the Project's environmental media samples (not a blank or rinsate), with one sample in 20 analytical samples being the duplicate. The primary purpose of the laboratory duplicate is to check the precision of the laboratory analyst, the sample preparation methodology, and the analytical methodology. If there are significant differences between the duplicates, i.e. Precision requirements of Table 3 not met, the affected analytical results should be re-examined, or re-analyzed at the direction of the laboratory manager with notes in the case narrative.

5.3.1.4 Isotopic Tracers and Chemical Carriers

An isotopic tracer or chemical carrier is prepared by adding a known NIST traceable source of a unique isotope or chemical of the same or similar element to a sample before preparation and analysis. The purpose of this isotopic tracer or carrier is to determine the efficiency of recovery of the targeted isotope or isotopes in the sample preparation and analysis. The percent of recovery of the tracer or carrier is then used to compensate for the efficiency and chemical recovery variations on the quantification of radiochemical activity for that sample. This correction should be employed during alpha spectroscopy and other types of determinations where they apply. The following Table 5 provides the recommended tracers or carriers for sample specific chemical recovery for analyses requiring tracers or carriers.

Table 5. Recommended Tracers or Carriers for Sample-Specific Chemical Recovery

Radionuclide of Interest	Recommended Tracer or Carrier
Total Radioactive Sr	Sr-85 or stable Sr
Tc-99	Tc-99 or Tc-95m
Th-228/230/232	Th-229
U-234/235/238	U-232
Np-237	Np-239
Pu-238/239/240	Pu-242 or Pu-236
Am-241	Am-243

5.3.1.5 Matrix Spikes

A Matrix Spike (MS) is an aliquot of a sample spiked with known quantities of specified target analyte(s) and subjected to the entire analytical procedure. It is used to measure method accuracy and to indicate matrix effects. However, it is not a requirement in analyses that are non-

destructive or use isotopic tracers. Matrix Spikes are analyzed at a minimum frequency of 1 per 20 samples of a similar matrix, with acceptance criteria listed in Table 3.

5.4 SAMPLE DELIVERY GROUP REQUIREMENTS

The SDG shall contain all necessary information to reconstruct the analytical process within the Laboratory from Sample Receipt to final Data Reduction to the Electronic Data Deliverable (EDD). Items included but not limited to:

- Title Page,
- Case Narrative,
- Analytical Summary,
- Chain of Custody,
- Method Blanks,
- Laboratory Control Samples,
- Duplicate Sample data,
- Matrix Spike,
- Raw data,
- Calibrations, initial and continuing,
- Background, initial and continuing,
- Standard certificates to verify traceability, and
- Logbook copies pertaining to project samples.

The following forms provide the expected information required for each analysis and each analyte. Not all the information will be appropriate for every analysis and the format is not as important as the content of the SDG, hence laboratory derived forms that provide the same information may be utilized for reporting.

SAMPLE DELIVERY GROUP
PROJECT SAMPLE IDENTIFICATION
TO
LABORATORY SAMPLE IDENTIFICATION
FOR THIS
DATA ANALYSIS PACKAGE

Lab Name: _____ Case No.: _____

Method Type: _____ SDG No.: _____

Matrix: _____

Sample Numbers	
Client ID	Lab ID No.

Comments: _____

Release of the data contained in this data package has been authorized by the laboratory manager or the manager's designee, as verified by the following signature:

_____
Manager, Radiological Laboratory

Date: _____

Figure 2. Project to Laboratory Sample ID Cross Reference

RADIOMETRIC ANALYSIS RESULTS

FORM 1

Date: _____

Lab Name: _____ Case No.: _____

Method Type: _____ SDG No.: _____

Client Sample No.	Lab ID No.	Sample Type	Radio-nuclide	Result	Lab Q	Combined Standard Uncertainty	Units	Analysis Date	Method No.	Instrument ID	Val Q

Legend shall be attached.

Comments:_____
_____
_____
_____

Figure 3. Analytical Results by Method

BLANK SUMMARY
FORM 2

Lab Name: _____ Contract: _____

Lab Sample: _____ SDG No.: _____

Blank Matrix (soil/water): _____ Case No.: _____

Concentration Units (pCi/L or pCi/g): _____

Radiochemical Determination	Method Blank Result	Method Blank 2σ Uncertainty	Field Blank Result	Field Blank 2σ Uncertainty	Trip Blank Result	Trip Blank 2σ Uncertainty

Comments:_____
_____
_____
_____

Figure 4. Blank Summary Form

CHEMICAL RECOVERY
FORM 3

Lab Name: _____ Contract: _____

Radiochemical Determination: _____ SDG No.: _____

Sample Matrix (soil/water): _____ Case No.: _____

$$CT\%R = \frac{CT_{Found}}{CT_{True}} \times 100$$

Spike Units (pCi or mg) _____

Sample Identification	Chemical Tracer	Chemical Tracer/Carrier Result (CT_{Found})	Gross Counts/ Gross Mass	Chemical Tracer/Carrier Added (CT_{True})	Net Counts/ Net Mass	CT%R	Val Q

Comments:_____
_____
_____
_____

Figure 5. Chemical Recovery of Tracer/Carrier

LABORATORY CONTROL SAMPLE
FORM 4

Lab Name: _____ Contract: _____

Lab Sample ID: _____ Case No.: _____

Solid LCS Source: _____ SDG No.: _____

Aqueous LCS Source: _____

$$LCS\%R = \frac{LCS_{Found}}{LCS_{True}} \times 100$$

Radiochemical Determination	Aqueous (pCi/L)			Solid (pCi/g)		
	True	Found	LCS %R	True	Found	LCS %R

Comments:_____

_____

_____

Figure 6. LCS Analysis Form

MATRIX SPIKE SAMPLE RECOVERY
FORM 5

SAMPLE NO.

Lab Name: _____ Contract: _____

Lab Sample ID: _____ Case No.: _____

Matrix (soil/water): _____ SDG No.: _____

% Solids for Sample: _____

$$MSS\%R = \frac{(SSR - SR)}{SA} \times 100$$

Concentration Units (pCi/L or pCi/g):_____

Radiochemical Determination	Spiked Sample Result (SSR)	Sample Result (SR)	Spike Added (SA)	MSS %R	Val Q

Comments:_____

_____

_____

Figure 7. Matrix Spike Analysis Form

DUPLICATES
FORM 6

SAMPLE NO.

Lab Name: _____ Contract: _____

Lab Sample ID: _____ Case No.: _____

Matrix (soil/water): _____ SDG No.: _____

% Solids for Sample: _____ % Solids for Duplicate: _____

$$DER = \frac{|S - D|}{\sqrt{(\sigma_s)^2 + (\sigma_D)^2}} \qquad RPD = \frac{|S - D|}{(S + D)/2} \times 100\%$$

Radiochemical Determination	Sample Result (S)	Sample Uncertainty ($2\sigma_S$)	Duplicate Result (D)	Duplicate Uncertainty ($2\sigma_D$)	DER	RPD	Val Q

Comments:_____

_____

_____

Figure 8. Duplicate/Replicate Analysis Form

PREPARATION LOG
FORM 7

Lab Name: _____ Contract: _____

Case No: _____ SDG No.: _____

Method: _____

Sample No.	Preparation Date	Weight (gram) or Volume (ml) of Sample Homogenized	Weight (gram) or Volume (ml) Aliquot of Homogenized Sample Processed	Dilution Factor (Fraction of aliquot counted)

Comments:_____
_____
_____
_____

Figure 9. Laboratory Sample Preparation Form

5.4.1 Data Reporting

5.4.1.1 Significant Figures

All data reported in electronic format and in the SDG will use no more than 3 significant figures when finalized into the above forms. The exception will be given to the raw data obtained from the instrument(s) at the time of analysis.

5.4.1.2 Combined Standard Uncertainty

Combined Standard Uncertainty shall be reported with all radiochemical analysis of samples, and analytical QC submitted to the laboratory. The value shall be noted if it is a 1-sigma or 2-sigma standard deviation (1.96) so that the data can be evaluated and used correctly.

5.4.1.3 Negative Results

All negative activities shall be reported as such with any investigation or corrections made by the lab stated within the Case Narrative.

5.4.1.4 Minimum Detectable Activity and Detection Limit

The minimum detectable activity and detection limit will be reported for each sample.

5.4.1.5 Data Checklists

To aid in ensuring all requested Laboratory analysis information is included in the SDG the following checklists have been included. In SDGs with multiple analyses, some items will overlap with other analyses.

5.4.1.6 MDA and DL

Although both the MDA and DL are reported, determining if a sample result is a detection or a non-detect shall be based on it relation to the DL rather than to the MDA.

GENERAL INFORMATION ANALYSES

DATA PACKAGE CHECKLIST

Reportable Item Description	CK
Case Narrative: The case narrative shall discuss what samples were analyzed along with customer and laboratory identification numbers. It also should contain information on sample matrix, sample preparation method description, sample chemical method description, any analysis problems, and any other unusual characteristics or notations during analysis.	
Lab logbooks sheets, Preparation log sheets, Run logs, and Sample logging data;	
Chain of Custody (Internal and External)	
FORMS (Not all of the forms listed below are applicable for all analyses. Use only the appropriate forms for the analyses that were performed.)	
1. Form 1's: The Analytical Results Form contains the customer identification, laboratory identification, sample matrix, SDG number, case number, sample mass or volume used in the analysis, sample type, sample receipt date, sample analysis date, batch identification, analyte, analytical method, net result, combined standard uncertainty, MDA, DL, units, laboratory data qualifier, and instrument identification.	
2. Form 2's: The Blank Summary Form contains blank identification, blank matrix, SDG number, case number, the net result, and the associated total propagated uncertainty for each analysis type for each blank and blank type in the package, and units.	
3. Form 3's: Sample Specific Chemical Recovery Summary Form contains the customer identification, laboratory identification, sample matrix, SDG number, case number, chemical tracer used, amount of chemical tracer added, chemical tracer result and associated total propagated uncertainty, chemical tracer percent recovery, units, and laboratory qualifier. For isotopic tracers: gross counts of tracer and net counts of tracer. For gravimetric carriers: tare weight for carrier, gross weight for carrier, and net weight for carrier.	

Figure 10. General Sample Delivery Group Checklist

Reportable Item Description	CK
4. Form 4's: The Laboratory Control Sample Summary Form contains laboratory control sample identification, SDG number, case number, laboratory control sample is true value (not process average value), laboratory control sample is true value associated error, the laboratory control sample result and associated total propagated uncertainty, laboratory control sample matrix, and laboratory control sample percent recovery.	
5. Form 5's (if applicable): The Matrix Spike Sample Summary Form contains matrix spike sample identification, SDG number, case number, radionuclide of interest, matrix spike added, original sample result and its associated total propagated uncertainty, matrix spike sample result and its associated total propagated uncertainty, matrix spike sample percent recovery, units, and laboratory qualifier. **(If there is sample specific chemical recovery used in the analysis, a MSS is not required for that analysis.)**	
6. Form 6's: The Duplicate Summary Form contains duplicate sample identification, SDG number, case number, radionuclide of interest, original sample result and associated total propagated uncertainty, duplicate sample result and associated total propagated uncertainty, sample matrix, and laboratory qualifier. Calculate DER and RPD.	
7. Form 7's: The Preparation Log Form contains sample identification, preparation date, preparation method, sample mass or volume homogenized, Aliquot mass or volume of homogenized sample processed, dilution factor of aliquot analyzed.	
STANDARDS AND TRACERS	
1. Standard, LCS, MS, and Tracer Certifications showing NIST traceability.	
2. Laboratory Standard, LCS, MS, and Tracer Solutions dilution information showing NIST traceability.	
3. Standard, LCS, MS, and Tracer Solutions Calculation Sheets.	
CALIBRATION	
1. Initial Calibration results: original calibration counting results, calibration curve plots and data points, and calibration uncertainty.	
2. Initial count of the continuing calibration check standard and continuing calibration data and/or continuing calibration control charts.	

Figure 10. General Sample Delivery Group Checklist (Continued)

ALPHA SPECTROMETRY ANALYSES

DATA PACKAGE CHECKLIST

Reportable Item Description	CK
CALIBRATION	
1. Initial (annual) Efficiency, Resolution, and Energy Calibration including all data points, calibration calculations, efficiency curves, and standard used for each geometry used in data package. Plus the initial count of the continuing calibration standard.	
2. Initial (annual) background calibration	
3. Efficiency, Resolution, Energy, and Background Continuing calibration count with control charts.	
4. Background checks with control charts	
RAW DATA (for all samples and QC)	
1. Alpha Spectroscopy Report	
2. Nuclide Activity Summary	
3. Spectrum Plot	
4. Channel by Channel Report	
5. Gross Sample Counts Within Peak Regions Report	
6. Nuclide Identification Report	
CALCULATIONS	
1. Example Computations [Analytical Result and Associated Total Propagated Uncertainty (multiplier specified)]	
2. Background Subtractions Identified	

Figure 11. Sample Delivery Group with Alpha Spectroscopy Checklist

GAMMA SPECTROMETRY ANALYSES

DATA PACKAGE CHECKLIST

Reportable Item Description	CK
CALIBRATION	
1. Initial (annual) Efficiency, Resolution, and Energy Calibration including all data points, calibration calculations, efficiency curves, and standard used for each geometry used in data package. Plus the initial count of the continuing calibration standard.	
2. Initial (annual) background calibration	
3. Efficiency, Resolution, Energy, and Background Continuing calibration count with control charts.	
4. Background checks with control charts	
RAW DATA (for all samples and QC)	
1. Peak Search Report	
2. Background Corrected Peak Search Report	
3. Unidentified Energy Line Report	
4. Summary of Nuclide Activity Report	
5. Nuclide Line Activity Report	
6. Summary of Nuclide Activity Report	
7. Rejected Report	
8. Full Combined Activity-MDA Report	
9. Spectrum Plot	
10. Channel by Channel Report: Note: If the energy range of the spectra is provided and the discriminator settings are set below the energy range, the channel by channel report is not needed.	
CALCULATIONS	
1. Example Computations [Analytical Result and Associated Total Propagated Uncertainty (multiplier specified)]	
2. Background Subtractions Identified	

Figure 12. Sample Delivery Group with Gamma Spectroscopy Checklist

GAS FLOW PROPORTIONAL COUNTING ANALYSES

DATA PACKAGE CHECKLIST

Reportable Item Description	CK
CALIBRATION	
1. Current Instrument Plateaus and cross talk factors.	
2. Current Self-absorption curves.	
3. Current Initial Efficiency Calibration	
4. Current Initial (annual) Background Calibration	
5. Continuing calibration counts with control charts.	
6. Background checks with control charts	
RAW DATA	
1. Instrument Printouts for all samples and QC.	
CALCULATIONS	
1. Example Computations [Analytical Result and Associated Total Propagated Uncertainty (multiplier specified)]	
2. Background Subtractions Identified	

Figure 13. Sample Delivery Group with GFPC Spectroscopy Checklist

LIQUID SCINTILLATION COUNTING ANALYSES

DATA PACKAGE CHECKLIST

Reportable Item Description	CK
CALIBRATION	
1. Efficiency and Background Quench Curves complete with acceptance limits.	
2. Continuing calibration counts with control charts.	
3. Background checks with control charts	
RAW DATA	
1. Instrument Printouts	
2. Spectrum Plot	
CALCULATIONS	
1. Example Computations [Analytical Result and Associated Total Propagated Uncertainty (multiplier specified)]	
2. Background Subtractions Identified. If background quench curves are used they must be provided complete with acceptance limits.	

Figure 14. Sample Delivery Group with LSC Checklist

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6.0 DATA MANAGEMENT AND EVALUATION

6.1 DATA VERIFICATION/VALIDATION

The greatest uncertainty in a measurement is often a result of the sampling process and inherent variability in the environmental media rather than the analytical measurement. A systematic process for data verification and validation should be performed to ensure that precision and accuracy of the analytical data are adequate for the intended use. Data review of the data set may be performed by the project team, or a selected independent reviewer.

Data verification/validation is accomplished by formally assessing and determining if the data packages and QA/QC results meet the requirements of the requested analytical methods and MQO's of the project.

The project validation support staff shall conduct, at the direction of the Project Manager, a review of selected laboratory data for compliance with the established QC criteria based on the following categories:

- LOR,
- holding times,
- blanks,
- LCSs,
- isotopic tracers (radionuclide methods),
- Duplicate/replicate analysis,
- Matrix spike/Matrix spike duplicate (if applicable),
- Any tentatively identified compounds not listed in this QAPP,
- Chemical separation required for any method listed in this QAPP,
- calibration,
- Daily checks including Blank/background,
- Daily checks of calibration,
- sample re-analysis,
- secondary dilutions, and
- laboratory case narrative.
- proper calculations and reporting
- spectral interferences and identification

Consistent with the data quality requirements, project data and associated QC should be evaluated on these categories and qualified as per the outcome of the review. During the review, laboratory-applied data qualifiers should be evaluated, defined, and explained. Project verification/validation checklists containing documentation consistent with the above review categories should be completed and presented with the Data Validation report. The Laboratory will provide SDG data that can receive a full validation (Level 4 data package). Validation of at least 10% of the analytical data, selected at random, will receive a full validation (Level 4) at a minimum and the remaining data will receive a review of all QC data (Level 3) data a minimum, the Project Manager can set the Validation effort higher if the data requires it or the Project Chemist recommends the higher level. The following functional guidelines for data validation shall be followed:

Rucker, T. L., Johnson, C. M. Jr., *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses*, Rev. 7.2, SAIC report 143-ARCS-00.08, Oak Ridge, TN (September 2004).

Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual, NUREG-1576, EPA 402-B-04-001A, NTIS PB2004-105421, (July 2004).

6.1.1 Data Validation Report

Data Validation report shall include information:

- SDG(S) the report is for,
- Specific Project,
- Reference for QC criteria,
- Project sample identification,
- Project sample analytical methods,
- Analytical methods grouped for listing of specific analytes per group,
- Discrepancies listed per sample and analytes, and
- Any key to help define qualifiers used in the report.

6.2 PROJECT ANALYTICAL DATA SET

Decisions to repeat sample collection and analyses may be made by the Laboratory Coordinator/Data Manager, in concert with the Project Manager, based on the extent of the deficiencies and their importance in the overall context of the project.

All data generated should be computerized in a format organized to facilitate data review, evaluation, and reporting. The electronic data set should include data flags in accordance with the analytical procedures. The associated data flags should include items such as (1) estimated concentration below the required reporting limit; (2) estimated concentration due to chemical or tracer recoveries; (3) non-detect analytes also present in associated field or laboratory blanks; and (4) rejected data for QC problems.

An evaluation of data accuracy, precision, sensitivity, and completeness, based on criteria in section A3 of this QAPP, should be performed by a data validator and presented in the DQA. This DQA should indicate that data are (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable.

Project data sets will be available for controlled access by the Project Manager and authorized personnel.

6.3 CALCULATION OF DATA QUALITY INDICATORS

6.3.1 Field Measurements Data

Field data shall be assessed by the Field Supervisor and Project Manager. Field results shall be reviewed for compliance with the established QC criteria specified in this QAPP and approved project procedures. Accuracy of the field measurements shall be assessed using daily instrument response checks.

6.3.1.1 Field Sampling Precision

The precision of the field sampling process should be determined through evaluation of field sample duplicate analyses. This data may not be analyzed until after validation of data has occurred.

$$RPD = \frac{|S-D|}{\frac{(S+D)}{2}} \times 10 \quad \textbf{(1)}$$

where:

S = first sample value (original); and
D = second sample value (field duplicate).

If RPD acceptance criteria from Table 3 cannot be met then DER should be used to determine acceptability of the precision of the data. Equation 2 is used when the CSU is at the 1-sigma level for the uncertainty.

$$DER = \frac{|S-D|}{\sqrt{\sigma_S^2+\sigma_D^2}} \quad \textbf{(2)}$$

where:

S = first sample value (original);
D = second sample value (duplicate);
σ_S = CSU of the first sample value (original uncertainty); and
σ_D = CSU of the second sample value (duplicate uncertainty).

6.3.1.2 Field Sample Collection Completeness

Sample collection completeness shall be calculated using Equation 3 below.

$$Completeness = \frac{Number\ of\ Sample\ Points\ Samples}{Number\ of\ Samples\ Points\ Planned} \times 100\% \quad \textbf{(3)}$$

6.3.1.3 Field Sensitivity

Field sensitivity will be assessed with Equipment Rinsate Blanks, and Swipes/Smears to determine if in-field decontamination of reusable equipment was adequate for reducing cross-contamination of samples.

6.3.1.4 Laboratory Data

Laboratory results should be assessed for compliance with required precision, accuracy, completeness, and sensitivity as follows.

6.3.1.5 Precision

The precision of the laboratory analytical process should be determined through evaluation of sample duplicate analyses. The laboratory should assess precision by using procedures established and documented in their QA Plans. The procedure followed generally conforms to the *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP) document (NRC et al. 2004) and meets or exceeds that guidance. These measurements should establish the precision of the laboratory analytical process.

$$RPD = \frac{|S-D|}{\frac{(S+D)}{2}} \times 100 \quad \textbf{(4)}$$

Investigative sample matrix precision should be assessed by comparing the analytical results between laboratory duplicate pairs. The RPD should be calculated for each pair of duplicate analysis using Equation 4 and should produce an absolute value for RPD. This precision

measurement is impacted by variables associated with the analytical process, influences related to sample matrix interferences, consistent implementation of sampling procedures, and degree of sample homogeneity.

where:

S = first sample value (original); and
D = second sample value (duplicate).

If RPD acceptance criteria from Table 3 cannot be met then DER should be used to determine acceptability of the precision of the data. Equation 5 is used when the CSU is at the 1-sigma level for the uncertainty.

$$DER = \frac{|S-D|}{\sqrt{\sigma_S^2+\sigma_D^2}} \quad \textbf{(5)}$$

where:

S = first sample value (original);
D = second sample value (duplicate);
σ_S = CSU of the first sample value (original uncertainty); and
σ_D = CSU of the second sample value (duplicate uncertainty).

6.3.1.6 Accuracy

The accuracy of the laboratory analytical measurement process should be determined by comparing the %R for the LCS versus its documented true value utilizing Equation 6 below.

$$\%R = \frac{anzlyzed\ value}{true\ value} * 100 \quad \textbf{(6)}$$

Investigative sample accuracy should be assessed for compliance with the established QC criteria described in Table 3 of this QAPP using the analytical results of method blanks, reagent/preparation blanks, and MS samples. The %R of MS samples shall be calculated using Equation 7 below. This accuracy measurement is impacted by variables associated with the analytical process, influences related to sample matrix interferences, consistent implementation of sampling procedures, and degree of sample homogeneity.

$$\%R = \frac{A-B}{C} * 100 \quad \textbf{(7)}$$

where:

A = the analyte concentration determined experimentally from the spiked sample;
B = the background level determined by a separate analysis of the unspiked sample; and
C = the amount of the spike added.

6.3.1.7 Representativeness

Representativeness is the term most concerned with the proper design of the sampling program. Representativeness qualitatively expresses the degree to which data accurately reflect site

conditions. Factors affecting the representativeness of analytical data include appropriate sample population definitions, proper sample collection techniques, analytical holding times, use of standard analytical methods, and determination of matrix or analyte interferences. Sample collection, analytical holding time, analytical method application, and matrix interferences shall be evaluated by reviewing project documentation and QC analyses.

6.3.1.8 Completeness

Data completeness of laboratory analyses should be assessed for compliance with the amount of data required for decision-making. The completeness is calculated using Equation 8 below.

$$Completeness = \frac{Number\ of\ Valid\ Laboratory\ Measurements\ Made}{Number\ of\ Laboratory\ Measurements\ Planned} \times 100\% \quad \textbf{(8)}$$

6.3.1.9 Project Completeness

Project completeness should be determined by evaluating the planned versus actual data. Adjustments should be made if project field changes alter planned sample numbers during field implementation. All data not flagged as rejected by the review, verification, validation, or assessment processes shall be considered valid. Overall, the project completeness should be assessed relative to media, analyte, and area. Completeness objectives are listed in Table 3.

6.3.1.10 Comparability

Comparability is a qualitative term relating one project data set to other data sets. This investigation shall employ narrowly defined sampling methodologies, site audits/surveillances, use of standard sampling procedures and devices, uniform training, documentation of sampling, standard analytical protocols/procedures, QC checks with standard control limits, and universally accepted data reporting units to ensure comparability to other data sets. Through proper implementation and documentation of these standard practices, the Project should establish confidence that data shall be comparable to other project and programmatic information.

Additional input to determine representativeness and comparability may be gained through statistical evaluation of data populations, compound evaluations, or dual measurement comparisons.

6.3.1.11 Sensitivity

The sensitivity of radiological analytical methods should be assessed by the laboratory using established procedures and following the MARLAP document guidance.

It is important to monitor instrument sensitivity through calibration blanks and low concentration check standards to ensure consistent instrument performance. It is also critical to monitor the analytical method sensitivity through analysis of method blanks, calibration check samples, and LCSs.

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7.0 PERFORMANCE AND SYSTEM AUDITS

Audits of both field and laboratory activities may be conducted, at the discretion of the Field Supervisor, Project Manager or QA/QC Officer, verifying that sampling and analysis are performed in accordance with the procedures established in the QAPP. Audits of laboratory activities may include both internal and external audits.

7.1 FIELD AUDITS

Audits of field activities (sampling and radiation measurements) may be conducted by the QA/QC Officer (or designee) or the Field Supervisor or designee. The audits may include examination of field sampling records, field instrument operating records, sample collection, sample handling and sample packaging, maintenance of QA procedures, and COC. These audits ideally occur at the onset of the project to verify that all established procedures are in place and are being followed.

Performance assessments should follow initial audits to ensure that any initial deficiencies have been corrected and to verify that QA practices/procedures are being maintained throughout the duration of the project. These audits should involve reviewing field measurement records, instrumentation calibration records, and sample documentation.

7.2 LABORATORY AUDITS

A laboratory system audit includes examination of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, instrument operating records, and sample analysis. Performance audits consist of sending blind test samples to laboratories for ongoing assessment of laboratory precision and accuracy. The analytical results of the analysis of performance evaluation samples are evaluated to ensure that laboratories maintain an acceptable level of performance. Laboratories shall be selected for this project that have been audited and approved by the Department of Energy Consolidated Audit Program (DOECAP).

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8.0 PREVENTIVE MAINTENANCE PROCEDURES

8.1 FIELD INSTRUMENTS AND EQUIPMENT

Field survey equipment for this Project will include beta and gamma survey meters. Field instruments shall be calibrated, and instrument-specific QC parameters shall be established before meters are used. Each field instrument shall be checked against a traceable standard or reference with a known value to ensure that the instrument is operating properly. Instruments with lapsed calibration or that have undergone maintenance (except battery change, etc.) shall be recalibrated before use in the field.

If an instrument cannot pass required QC checks, it shall be taken out of service and tagged for repair/recalibration. Non Conformance reports shall be generated indicating the cause of the instrument deficiency and the impacts. A back-up instrument shall be used in its place. Daily QC checks, instrument maintenance, and calibrations shall be documented.

8.2 LABORATORY INSTRUMENTS

As part of their QA/QC Programs, a routine preventive maintenance program should be conducted by all associated laboratories to minimize occurrences of instrument failures and other system malfunctions, as recommended per industry standards and/or manufacturers' recommendations.

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9.0 CORRECTIVE ACTIONS

Corrective actions may be required for two major types of problems: (1) analytical and equipment problems and (2) noncompliance with criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

9.1 SAMPLE COLLECTION & FIELD MEASUREMENT

Technical staff and project personnel shall be responsible for reporting all suspected technical and QA nonconformance, or suspected deficiencies of any activity or issued document, by reporting the situation to their direct supervisors or managers. Upon notification, the Field Supervisor or designee shall be responsible for assessing the suspected problems, in consultation with the QA/QC Officer and Laboratory Coordinator/Data Manager, as applicable, making a decision based on the potential for the situation to impact the quality of the data. When it is determined that the situation warrants a reportable nonconformance and corrective action, the QA/QC Officer shall ensure an NCR is initiated and approved by the Project Manager.

The Project Manager and the QA/QC Officer shall be responsible for ensuring that corrective actions for nonconformance are initiated by

- evaluating all reported nonconformance(s),
- controlling additional work on nonconforming items,
- determining and approving disposition or action to be taken,
- maintaining a log of nonconformance,
- reviewing NCRs and verifying corrective actions taken, and
- ensuring that NCRs are included in the final site documentation project files.

If appropriate, the Project Manager shall ensure that no additional work dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include

- repeating the measurement to check the error;
- checking for all proper adjustments for ambient conditions, such as temperature;
- checking the batteries;
- recalibrating equipment;
- checking the calibration;
- modifying the analytical method, including documentation and notification (i.e., standard additions);
- replacing the instrument or measurement devices; and
- stopping work (if necessary).

The Field Supervisor or designee is responsible for all site sampling and analysis activities. In this role, he/she may, at times, be required to adjust site activities to accommodate activity-specific needs. When it becomes necessary to modify an activity, the responsible person implements the necessary changes after obtaining verbal or written approval of the Project Manager. All such changes shall be documented on an FCR signed by the initiator, the Field Supervisor, the Project Manager, and any other appropriate person (QA/QC, H&S, RSO, etc.). The FCR for each document shall be numbered serially, as required. The FCR shall be attached to the file copy of the affected document. If unacceptable, the action taken during the period of

deviation shall be evaluated to determine the significance of any departure from established program practices and action taken.

The QA/QC Officer is responsible for controlling, tracking, and implementing the identified changes as appropriate. Reports on all changes shall be distributed to all affected parties, including the Project Manager.

9.2 LABORATORY ANALYSES

Laboratory QA Plans shall provide systematic procedures to identify out-of-control situations and document corrective actions. Corrective actions should be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel should receive QA training and be made aware that corrective actions are necessary when

- QC data are outside warning or control windows for precision and accuracy;
- blanks contain target analytes above acceptable levels and must be investigated;
- undesirable trends are detected in LCS recoveries, MS recoveries, RPDs or DERs between duplicates;
- there are unusual changes in detection limits;
- deficiencies can be detected by internal audits, external audits, or from performance evaluation samples results; or
- inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors and/or checks the instrument calibration, spike and calibration mixes, and instrument sensitivity, etc. Once resolved, full documentation of the corrective action should be documented with laboratory records, and the information should be summarized within case narratives, as applicable.

Corrective actions may include, but are not limited to, the following:

- re-analyzing the samples;
- evaluating blank contaminant sources, elimination of these sources, and re-analysis;
- modifying the analytical method (i.e., standard additions) with appropriate notification and documentation;
- re-sampling and analyzing;
- evaluating and amending sampling procedures; or
- accepting data and acknowledging the level of uncertainty.

If re-sampling is deemed necessary due to laboratory problems, the Laboratory Coordinator/Data Manager should identify the sample(s) for re-sampling, and submittal to the laboratory for analysis.

The following corrective action procedures may be required:

- Problems noted during sample receipt should be documented in the laboratory's Letter of Receipt (LOR) to the Laboratory Coordinator/Data Manager.

- When analytical holding times are not within method-recommended criteria, the Laboratory Coordinator/Data Manager should be notified immediately to determine problem resolution. All corrective actions shall be thoroughly documented.
- All initial and continuing calibration sequences not meeting method requirements shall result in a review of the calibration. When appropriate, re-analysis of the standards and/or the affected samples using the previous or newly acceptable calibration check is warranted.
- All appropriate measures should be taken to prepare and clean up samples in an attempt to achieve the project-required reporting levels as stated. When difficulties arise in achieving these levels, the laboratory should notify the Laboratory Coordinator/Data Manager to determine problem resolution. All corrective actions should be thoroughly documented.
- Any dilutions impacting the required reporting levels should be documented in case narratives, along with revised reporting levels for those analytes.
- Failure of method-required QC to meet the requirements specified in this Project QAPP may result in review of all affected data. Resulting corrective actions may encompass those identified earlier. The Laboratory Coordinator/Data Manager should be notified as soon as possible to discuss possible corrective actions, particularly when unusual or difficult sample matrices are encountered.
- When calculation and reporting errors are noted within any given data package, reports should be re-issued with applicable corrections. Case narratives should clearly state the reasons for re-issuance of reports.

	DATE OF NCR	NCR NUMBER	
	LOCATION OF NONCONFORMANCE		PAGE __ OF __
INITIATOR (NAME/ORGANIZATION/ PHONE)	FOUND BY	DATE FOUND	
RESPONSIBLE ORGANIZATION/INDIVIDUAL			

DESCRIPTION OF NONCONFORMANCE

INITIATOR DATE QA/QC OFFICER DATE

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

PROPOSED BY: NAME DATE

JUSTIFICATION FOR ACCEPTANCE:

PROJECT MANAGER: NAME DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION REQUIRED YES ☐ NO ☐ IF YES: DATE RESULT

QA/QC OFFICER: NAME DATE

Figure 15. Example of a Nonconformance Report

10.0 REFERENCES

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EPA 1991. *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80, Washington, D.C.

EPA 1994. *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, EPA QA/R-5, Washington, D.C., January.

NRC et al. (NRC, EPA, DOE, and DoD) 2000. *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), Rev. 1, DOE/EH-0624, Rev. 1; EPA 402-R-97-016, Rev. 1; and NUREG-1575, Rev. 1; August (available online at http://www.epa.gov/radiation/marssim/).

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Rucker, T. L., Johnson, C. M. Jr., *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analyses*, Rev. 7.2, SAIC report 143-ARCS-00.08, Oak Ridge, TN (September 2004).

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APPENDIX E

Consolidated Materials Sampling Addendum

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BACKGROUND

It is anticipated that U.S. Environmental Protection Agency radiological walkover and driveover surveys of Santa Susana Area IV will result in the identification of areas of potentially elevated radioactivity on the surfaces of consolidated materials such as roads, parking lots, etc. These areas of elevated radioactivity will subsequently be investigated to confirm that elevated activity exists at the specified location and to identify the associated radionuclides and quantify the isotopic content. The information obtained from these investigations will be used for a variety of purposes including risk assessment and waste characterization pursuant to identification and evaluation of disposal alternatives. The information will also be expected to provide information relative to whether elevated radioactivity is the result of the presence of:

- surficial radioactivity;
- naturally occurring radioactive material present volumetrically within the consolidated materials;
- contamination that may exist between layers of asphalt or other consolidated materials; or
- subsurface radioactive material below consolidated surface materials.

TECHNICAL APPROACH

Radiological investigations will generally consist of:

- Detailed analysis of walkover/driveover data pursuant to the identification of potentially elevated areas. Elevated areas, as used herein, are instrument-specific areas in which count rates exceed background by more than the standard fluctuation inherent in that instrument.
- Determination of the global positioning sensor (GPS) coordinates from walkover/driver over survey graphical information system data.
- Investigation to identify utilities present in the vicinity of the elevated area of activity. (Coring will not proceed in any area until utility clearances are completed.)
- Field mobilization using GPS and radiation measurement equipment to confirm both the precise location of areas of elevated activity and the presence of elevated radioactivity in the area of interest.
- Coring of consolidated material to obtain a representative sample of the area of elevated activity.
- Evaluating the core and residual material present adjacent to and below the core to determine the extent to which the core is representative of media adjacent to and under the point of excavation.
- Dividing the core into the requisite number for samples, if required. A given sample may consist of the entire core, a portion of the core or residual material (i.e., gravel and soil) present under the sample location. Division of the core into three or more segments may also be performed to statistically evaluate whether elevated activity is the result of naturally occurring radioactive materials present introduced into the concrete at the time of manufacture. To perform such assessment, cores are commonly divided into three or more portions with radioanalytical results of the outer-most intervals being compared statistically to the center interval. Division of the core, if required, may be accomplished in the field or by the laboratory performing the analysis.
- Obtaining a sample of unconsolidated material (e.g., soil and gravel) from the first interval immediately below the consolidated material if radiological survey results indicate that elevated activity may be the result of such material.
- Packaging and transmittal of samples to a properly accredited radioanalytical laboratory for analysis. Unless otherwise specified due to unusual circumstances, analytes will consist of those specified in Table 4-1, “Radiological Potential Contaminants of Concern for the SSFL”.

SAMPLE COLLECTION

OVERVIEW

Samples will be collected using coring and normal hand-auger methods. Each sample will be collected, labeled, logged, and analyzed for appropriate radiological parameters. QC samples (e.g., duplicates, split, matrix spike, and matrix split duplicates) will be obtained at the frequency stated in the Sampling and Analysis Plan. All coring and sampling will be accomplished in accordance with the project Health and Safety Plan.

OBTAINING A SAMPLE

To the extent appropriate and practicable, soil samples will be identified and classified according to the Unified Soil Classification System (USCS). At a minimum, the location identification, depth interval, sample texture, color, moisture content, plasticity, and estimated percentage (by volume) of coarse fragments, if applicable, will be recorded on the logging form.

SAMPLING METHODS

- Disposable equipment will be utilized for sampling to the maximum extent practicable.
- Using a pre-cleaned or decontaminated stainless steel soil coring tool collect a sample. Soil (i.e., unconsolidated materials) will be composited in a stainless steel bowl.
- Collect a minimum of 600 grams of material for both soil and consolidated material samples.
- Label the sample using a unique identification number (ID). A sequential sample number will follow the Site Designator code to identify the samples for collection and delivery to the laboratory.
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after each use and between sampling locations.

Hand Auger/Tube Sampler – Subsurface Soil Samples

- Assemble a decontaminated/clean auger and advance the auger bit into the soil to the depth of six inches (15 centimeters) below the base of the consolidated material.
- Withdraw auger
- Remove the soil sample.
- Collect a minimum of 600 grams of soil.
- Label the sample using an unique identification number. A sequential Sample Number will follow the Site Designator code to identify the samples for collection and delivery to the laboratory.
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after each use and between sampling locations.

Decontamination of Equipment

- Remove all visible dirt/debris or sample residue from sampling equipment.
- Wipe sampling equipment with dry towel or baby wipe.
- If required, scrub equipment with a non-phosphate detergent and water, rinse, and allow to dry.
- Perform a loose surface contamination measurement on sampling equipment.
- Insure loose surface contamination levels are less than 20 disintegrations per minute (dpm)/swipe (alpha contamination).

FIELD LOGBOOK ENTRIES

The survey supervisor (or designee) will maintain logbooks to document project information and a daily written record of survey and sampling activities. Logbooks will be maintained in accordance with SAIC *Field Technical Procedure-1215, Use of Field Logbooks* (SAIC, 2007). Logbook entries will include, but are not limited to:

- Project personnel;
- Personnel contacts;
- Training activities;
- Daily tailgate meetings;
- Samples collected;
- Sample description;
- Sample IDs;
- Radiological screening parameters of sample;
- Instrument serial number and Surveyor performing radiological screen;
- Sample/Surveyor Signature;
- Chain of Custody numbers;
- Weather conditions;
- Nonconformances, issues and concerns; and
- IDW tracking.

SAMPLE ANALYSIS

All samples collected will be submitted to a properly accredited commercial radiochemistry laboratory for analysis. Analysis of both soil and consolidated materials will include drying, crushing, and homogenization of the entire sample volume. Consistent with the Sampling and Analysis Plan and Quality Assurance Project Plan, samples will be analyzed for the presence of site radiological potential contaminants of concern. Specific analysis methods will include a variety of radioanalytical methods including assay of gamma emitting radionuclides using a gamma spectroscopy system equipped with a high purity germanium (HPGe) detector and analysis of applicable constituents using alpha spectrometry. Gamma spectroscopy analysis will take place after 21 days to allow sufficient time for in-growth of radon daughters such that relative equilibrium is achieved.

SAMPLE AND WASTE DISPOSITION

The SAIC Health Physicist/Field Radiation Protection Manager will be responsible for proper handling of all collected samples. Samples will be surveyed, packaged, sealed in strong, tight containers and shipped to the appropriate laboratory. Some samples will likely not exceed the concentration and total quantity limits for classification as Class 7 (Radioactive) Materials as defined by Department of Transportation (DOT) and Nuclear Regulatory Commission. If the sample manager determines that the sample activity is such that the material meets the Class 7 definition, the samples will be surveyed, packaged, sealed, and shipped as a Limited Quantity shipment in accordance with SAIC health physics program procedures. Sample containers will be verified free of loose contamination and the dose rate to the outside of the shipping container will be verified as being less than 0.5 millirem per hour (mrem/hr). No samples will be obtained that would require a manifest due to the radiological contamination (e.g., the materials are not excepted from requirements for shipping papers by 49CFR173). Rather, the area will be noted, not sampled, and re-addressed at a later date using appropriate procedures.

Radioactive waste generated during the sampling effort will be minimized. Disposable sampling equipment will be used to the maximum extent practicable. Waste will generally be surveyed to confirm the absence of contamination and disposed of as ordinary trash. If radioactive wastes are generated during the survey, they will be bagged/contained and relinquished at the end of survey activities, for dispositioning in accordance with established site procedures. A sample of wastes may be submitted for laboratory analysis if needed for waste characterization.

Table E-1. Overview of Consolidated Areas Potentially Subject to Radiological Investigation

Site	Released By	Released Date	Building Demolished	Demolition Date	Historical Use Impacting COCs
4074			Yes	1995	Constructed in 1958, Building 4074 served as a storage and film processing building used to process photographic oscillograph paper for the KEWB. Building 4074 had a ground sampling station for measuring ambient air radioactivity concentration on a quarterly basis. No radioactive materials were reported to have been used in Building 4074. Rocketdyne conducted radiological surveys within this building, releasing the final report in March 1986. There are no Use Authorizations and no Incident Reports associated with Building 4453. Building 4074 was demolished in 1995, but the concrete slab remains as of 2005.
4083/ 4103			Yes	No later than 1995	Constructed in 1958, Building 4083/4103 served as the office and control room building for the FEWB reactor in Building 4073. Physically separated from the KEWB reactor building by about 200 feet. Aerial photographs show the building present in 1988 thus it appears that the building was demolished sometime between 1988 and 1995.
4425			NA	NA	Site 4425 originally contained a solar concentrator facility with a mirrored parabolic dish concentrator with a 31-foot diameter swing area, a solar receiver, and a 25 kilowatt Sterling engine generator, and subsequently a weather station and a small astronomical observatory. The EPA HSA has assigned a preliminary MARSSIM Classification for the Site 4425 area as Class 3 except in the area of the uranium slug drop zone, where the area is Class 1.
4453			Yes	1995	This building was constructed about 1958 and is assumed to have a similar construction history as Building 4093. Building 4453 served as the fuel handling building for the L-85 reactor between August 1957 and August 1959. In 1984, Building 4453 is listed as a neutron radiography storage facility. Building 4093 was released for unrestricted use by the NRC and the NRC license terminated March 19, 1987. The research team assumes Building 4453 was also released at this time (HSA 2011). There are no Use Authorizations and no Incident Reports associated with Building 4453. This building was demolished between October 1988 and June 1995.
4461			Yes	2009 photo shows only foundation	Built in 1977 and served as the Sodium Pump Test Facility (SPTF) Motor Generator Building. There has been no evidence found that radioactive materials were used or stored in Building 4461 however due to its location within the ETEC the presence of radioactive contamination cannot be ruled out. There are no Use Authorizations and no Incident Reports associated with Building 4461. Building 4461 was demolished in 2007, but the concrete slab remains. Radiological surveys specific to Site 4502 have not been conducted. (HSA)
4463			No	Pending Demolition	Building 4463 was constructed in 1974 to clean pumps and other mechanical parts of the Sodium Pump Test Facility (STPF). All utility connections were severed in 2007 and in 2010 the building was awaiting demolition. The preliminary MARSSIM Classification for this building is Class 1 based on its location within ETEC and because of the proximity of the site to the storm drain that carried waste water from Buildings 4009, 4020, and 4100.

Table E-1. Overview of Consolidated Areas Potentially Subject to Radiological Investigation (Continued)

Site	Released By	Released Date	Demolished	Demolition Date	Historical Use Impacting COCs
4501			No		Site 4501 Parking Lot, Includes Building 4823, Time Clock. Constructed prior to 1962, Site 4501 was a parking lot at the corner of G Street and 17th Street. On the 1987 Industrial Planning Map the site is referred to as "Coil Storage." Site 4501 is now used as a storage yard. There are no Use Authorizations and no Incident Reports associated with Building 4501. Radiological surveys specific to Site 4501 have not been conducted. (HSA)
4504			No		Classified Scrap and Salvageable Steel (SS) Material Storage Area used to store classified scrap and SS. There are no incidents that could have resulted in releases to the environment associated with Building 4504. A final survey of the total facility conducted in 1988 after D&D was completed verified contamination levels were below acceptable limits. (HSA)
4506			No		Constructed in the 1960s, Site 4506 serves as a parking lot used by personnel working in Building 4006, 4005, 4024, 4025 and the adjacent facilities. Site 4506 is still in use. There are no Use Authorizations and no Incident Reports associated with Site 4506. Radiological surveys specific to Site 4506 have not been conducted. (HSA)
4509			No		Site 4509 served as a parking lot for personnel working in Building 4009 and the surrounding area. (HSA)
4511			No longer in use		Site 4511 Parking Lot At Main Gate, Includes Building 4113, Guard Shack; Includes Building 4623, Guard Shack; Constructed prior to 1962, Site 4511 served as a parking lot for personnel working in the Old Conservation Yard (OCY) and adjacent areas. The parking lot is no longer in use. There are no Use Authorizations and no Incident Reports associated with Parking Lot 4511. A radiological survey of the Old Energy Systems Group (ESG) Salvage Yard (Old), Rocketdyne Barrel Storage/Conservation Yard and New Salvage Yard was conducted in 1988. Scope/ Purpose: In 1988, the ESG Salvage Yard (also known as the OCY), Barrel Storage/Conservation Yard and former location of 4113 were surveyed for fixed and removable alpha/beta contamination. Ambient gamma exposure rate measurements were taken in the Storage Yards. Soil samples were collected because radioactivity was indicated by exposure rate measurements in the southwest corner of the Barrel Storage/Conservation Yard. Background: 15 µR/hr. Acceptable Limit: Less than 5 µR/hr above background. Average Ambient Gamma: 14.3 µR/hr. Survey results were below the acceptable limits.
4513			Parking lot still in use		Asphalt Parking lot between Buildings 4064 and 4030. All the facilities surrounding the parking lot handled radioactive material or radiologically contaminated equipment. No known contamination incidents occurred. A radiological survey in 1988 by Rocketdyne showed survey results were below the acceptable limits. (HSA)
4514					See 4814

Table E-1. Overview of Consolidated Areas Potentially Subject to Radiological Investigation (Continued)

Site	Released By	Released Date	Demolished	Demolition Date	Historical Use Impacting COCs
4536			No		Site 4536 Parking Lot Includes Building 4836, Time Clock Includes Building 4636, Guard Shack. Constructed prior to 1962, Site 4536 was a parking lot for personnel working in the SNAP facility. Site 4536 is now used for storage of non-radiological equipment. There are no Use Authorizations and no Incident Reports associated with Site 4536. Radiological surveys specific to Site 4536 have not been conducted. This site was included in the Area IV Radiological Characterization Survey, conducted in 1994 through 1995. Scope/Purpose: Designed to locate and characterize any previously unknown areas of elevated radioactivity in Area IV. Background: 15.6 µR/hr. Acceptable Limit: Less than 5 µR/hr above background. The survey found the area to be below acceptable limits. (HSA)
4537			No		Site 4537 Parking Lot. Constructed prior to 1962, Site 4537 served as a parking lot for personnel working in the SNAP facility. Site 4537 is now used for storage of non-radiological equipment. There are no Use Authorizations and no Incident Reports associated with Site 4537. Radiological surveys specific to Site 4537 have not been conducted. This site was included in the Area IV Radiological Characterization Survey, conducted in 1994 through 1995. Scope/Purpose: Designed to locate and characterize any previously unknown areas of elevated radioactivity in Area IV. Background: 15.6 µR/hr. Acceptable Limit: Less than 5 µR/hr above background. The survey found the area to be below acceptable limits. (HSA)
4540			No longer in use		Site 4540, Parking Lot. Parking Lot 4540 was located directly south of Building 4040 and was used by personnel working in the building. Following the demolition of Building 4040 in 1997, Parking Lot 4540 was no longer used. There are no Use Authorizations and no Incident Reports associated with Parking Lot 4540. Radiological surveys specific to Building 4540 have not been conducted. (HSA)
4553			No longer in use		Site 4553 served as a parking lot for personnel working in Building 4353 and the surrounding areas. It was constructed prior to 1962 and is no longer in use. (HSA)
4563			No		Site 4563, Building 4633 Storage Yard; Covered Storage Area Neighboring Building 4075. Constructed in 1958, Site 4563 was a paved storage area at RMHF. The area is still in use as a storage area today, but no longer is designated as Building 4563. Instead, it is referred to as the "covered storage area neighboring Building 4075." Radioactive waste was stored here pending shipment to a disposal facility. The most probable contaminants of concern are uranium, plutonium, thorium isotopes and mixed fission products. There are no Incident Reports associated with Building 4563. There have been several surveys of the entire RMHF complex, including Building 4563, during its operation. The results of these surveys are summarized in the 4021 site summary. Routine quarterly radiological surveys are conducted in the area to verify that Building 4563 has not become contaminated above the limits established by 10 CFR 835.5. (HSA)

Table E-1. Overview of Consolidated Areas Potentially Subject to Radiological Investigation (Continued)

Site	Released By	Released Date	Demolished	Demolition Date	Historical Use Impacting COCs
4575			Site removed		Site 4575 was a parking lot located west of Building 4375. Building 4375 was used as a non-nuclear control center for testing SNAP control rod assemblies. Building 4375 was used to support the SNAP program, but was not involved in nuclear work. After the building was abandoned, barrels that may have contained radioactive material were stored in the surrounding area, which may have included Parking Lot 4575. Site 4575 has been removed. (HSA)
4704			NO	Pending demolition	Building 4704 was constructed prior to March 1962 as an Electrical Substation and was scheduled for demolition in 2004 but is still standing. It has been assigned MARSSIM Class 2 in the EPA HSA based on the potential for surface water flow or airborne release from Buildings 4005, 4006, 4010, 4012, and 4024 and on the lack of site investigation data.
4814			Yes	Between 1988 and 1995	Site was constructed in about 1964 and was dominated by the Sodium Water Reactor Test Structure. Aerial photographs from 1988 show Site 4814, the Sodium Water Reactor Test Structure (which was a tall open metal structure three stories high topped by a crane) and the equipment located to the right of the tower (Site 4514). Radiological Use Authorization No. 83 was issued for Site 4814 to permit the use of Cs-137 sealed source in a DD electronics gamma densitometer. There are no Incident Reports associated with Site 4814. Site 4814 was demolished between 1998 and 1995, but the concrete foundations and road pavement remains.
4874			Yes	No longer present in 1980 aerial photo	Building 4874 was an outside Control Rod Test Tower constructed in the late 1960s. Adjacent to the Building 4375 area and reported to have been used for non-nuclear testing of SNAP control rod assemblies.
4875			Yes	No longer present in 1980 aerial photo	Building 4875 was an outside Control Rod Test Tower constructed in the late 1960s. Adjacent to the Building 4375 area and reported to have been used for non-nuclear testing of SNAP control rod assemblies.
4885			NA	NA	This site was constructed in approximately 1962 as a pistol range and consisted of an asphalt pad, a target area with multiple shooting stations on a concrete pad, and a downfield berm located against a rock outcrop. It appears to subsequently have been used for temporary storage after the 1970s. The EPA HSA has designated the site as MARSSIM Class 1 based on proximity to Site 4886.

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