N00217_005396
HUNTERS POINT
SSIC NO. 5090.3.A

Base Realignment and Closure
Program Management Office West
33000 Nixie Way, Bldg. 50
San Diego, California 92147

CONTRACT NO. N62473-13-D-4808
CTO NO. 0003

FINAL

WORK PLAN

August 2015

DCN: ECSD-4808-0003-0003

BASEWIDE RADIOLOGICAL SUPPORT
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

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August 2015

BASEWIDE RADIOLOGICAL SUPPORT
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: ECSD-4808-0003-0003

Prepared by:

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, California 92101-8536

Reviewed by: _____
Steven Adams, CHP
Corporate Radiation Safety Officer

Reviewed by: _____
Shanti Montgomery
Project Manager

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Attachment 2 Basewide Radiological Management Plan

Attachment 3 Abbreviated Sampling and Analysis Plan

Attachment 4 Standard Operating Procedures

Attachment 5 Work Instructions

ABBREVIATIONS AND ACRONYMS

CTO	Contract Task Order
DON	Department of the Navy
EPA	U.S. Environmental Protection Agency
HASL	Health and Safety Laboratory
HPNS	Hunters Point Naval Shipyard
HRA	Historical Radiological Assessment
LLRW	low-level radioactive waste
MOU	Memorandum of Understanding
NRC	U.S. Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
RCA	Radiologically Controlled Area
RCT	Radiological Control Technician
ROC	radionuclide of concern
RPP	Radiation Protection Plan
RSO	Radiation Safety Officer
RSOR	Radiation Safety Officer Representative
RWP	Radiation Work Permit
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TtEC	Tetra Tech EC, Inc.
WI	Work Instruction

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1.0 INTRODUCTION

The Department of the Navy (DON) has contracted with Tetra Tech EC, Inc. (TtEC) to provide basewide radiological support at Hunters Point Naval Shipyard (HPNS), San Francisco, California. The work will be executed under Contract No. N62473-13-D-4808, Contract Task Order (CTO) No. 0003.

The radiological support will be provided under TtEC's United States Nuclear Regulatory Commission (NRC) Service Provider, and California Agreement State License Radioactive Material Licenses. Radiological support includes maintaining radiological control and postings, and supporting other contractors while performing both chemical and radiological removal and remediation work at radiologically impacted sites at HPNS. Figure 1-1 depicts the Radiological Areas under Contract. A Memorandum of Understanding (MOU) among the contractors working at radiologically impacted sites throughout HPNS defines TtEC's roles and responsibilities for basewide radiological support under this task order. Radiological sites are categorized as: 1) sites that have potential for radioactive contamination based on historical information, or 2) sites that are known to have radioactive contamination. Revisions to the MOU will be made in the event of changes to radiological boundaries and/or changes in the responsibilities of individual contractors.

The work will be performed in accordance with the site-specific Accident Prevention Plan/Site Safety and Health Plan (TtEC 2014), the Radiation Protection Plan (RPP), the Basewide Radiological Management Plan, the Sampling and Analysis Plan (SAP), and the applicable Standard Operating Procedures (SOPs). The RPP, Basewide Radiological Management Plan, SAP, and SOPs are included as attachments to this Work Plan.

1.1 PROJECT ORGANIZATION CHART

The Organization Chart in Figure 1-2 presents the organizational project structure and identifies the personnel responsible for the execution of site activities and program oversight. Figure 1-2 also shows the chain of command for providing basewide support at HPNS. The Radiation Safety Officer (RSO) has overall responsibility for ensuring that non-radiological work will be performed in a safe manner, from a radiological health and safety perspective. He will direct the Radiation Safety Officer Representative (RSOR) in conducting the assessment of potential contaminant releases, identifying monitoring needs, and reviewing the documented recommendations and applicable work instructions before implementation. The RSO is also responsible for ensuring that all radiological support work is conducted by trained staff in accordance with applicable plans and procedures.

1.2 PROJECT SCHEDULE

Figure 1-3 presents the overall project schedule for this CTO through the current Period of Performance, which extends through July 22, 2015.

1.3 PLAN ORGANIZATION

This Work Plan is organized as follows:

- **Section 1.0** provides the introduction, project points of contact, project schedule, and plan organization.
- **Section 2.0** describes the work implementation for basewide radiological support.
- **Section 3.0** lists the references cited in the text.
- **Tables** and **Figures** are included after the text.
- **Attachment 1** presents the RPP. This plan identifies the day-to-day management of radiologically impacted sites, surveys, training requirements, health and safety concerns, and material handling requirements for this project.
- **Attachment 2** presents the Basewide Radiological Management Plan. This plan describes survey procedures and methodologies that will be implemented in support of the radiological basewide support activities at HPNS.
- **Attachment 3** provides an abbreviated SAP that addresses radiological sampling that may be needed to support non-radiological contractors.
- **Attachment 4** presents the SOPs for the basewide radiological support.
- **Attachment 5** presents the Work Instructions (WIs) that have been approved by the DON for use on this CTO.

2.0 WORK IMPLEMENTATION

The following sections summarize the radiological support activities that TtEC will provide to other contractors performing chemical removal and remediation work in radiologically impacted areas. Detailed information on the procedures referenced below, and summarized in Table 2-1, are provided in the RPP (Attachment 1) and associated SOPs (Attachment 4).

2.1 RADIOLOGICAL CONTROLS AND POSTINGS

TtEC will implement and maintain radiological controls for radiologically impacted areas that are not identified as the responsibility of an on-site radiological remediation contractor by updating the MOU to ensure that its listing of sites that require radiological support remains current. The MOU identifying these radiologically impacted areas will be posted, along with updated maps, in the on-site trailer. For radiologically impacted sites, radiological postings will be placed and maintained every 30 meters along perimeter fencing. Postings and fencing will be maintained and inspected on a quarterly basis, at a minimum. The current Radiologically Controlled Areas (RCAs) are shown in Figure 2-1, and the stockpiles within the RCAs are shown in Figure 2-2.

It should be noted that contractors are required to declare the status of any waste material to the RSOR prior to staging it in the RCA. Status categories are: 1) radiologically impacted, 2) potentially radiologically impacted, or 3) cleared. Contractors will not be allowed to stage their non-radioactive waste in TtEC's RCAs.

Radiological controls and postings of impacted areas are further described in Section 3.14 of the RPP (Attachment 1) and SOP-012, *Radiologically Controlled Areas Posting and Access Control* (Attachment 4).

2.2 RADIOLOGICAL SURVEYS

Routine weekly, monthly, and quarterly surveys will be performed in those areas that are radiologically impacted but not currently controlled by another licensed radiological contractor. The purpose of the surveys is to ensure that no change in dose readings has occurred at perimeters to controlled areas that could negatively impact human health or the environment. In addition to dose rate measurements, alpha and or beta surface surveys of equipment and structures will be conducted as needed at each site. Gamma surveys of open areas will also be performed as appropriate. The type of survey performed will depend, in part, on the radionuclides of concern (ROCs). ROCs identified at HPNS are listed in the Historical Radiological Assessment (HRA) (NAVSEA 2004). Non-routine radiological surveys will be performed in the event of breaches in RCA or Radioactive Materials Area fence lines, or due to trespassing incidents.

Survey activities may include: exposure rate measurements; scan and static survey measurements for alpha, beta, and gamma; or collection of swipe samples for quantification of loose surface

contamination. These activities are described further in SOP-001, *Radiation and Contamination Surveys*, and SOP-006, *Sampling Procedures for Radiological Surveys* (Attachment 4).

2.3 RADIOLOGICAL SUPPORT TO OTHER CONTRACTORS

Prior to providing radiological support to other contractors, the RSOR must review the proposed work to determine the level of effort required to provide coverage. The RSOR will identify the potential ROCs for the area and evaluate the type of work being performed to determine appropriate levels of control, including, but not limited to, using personal protective equipment, providing instrumentation, performing surveys, and conducting air sampling and dosimetry.

TtEC will provide radiological control technicians (RCTs) to support non-radiological remediation contractors performing work in the radiologically impacted areas shown on Figure 1-1. The RCTs will be responsible for:

- Conducting radiological awareness briefings for non-radiological remediation contractors
- Providing appropriate dosimeters and training on how to properly wear and return the dosimeters
- Escorting personnel into and out of an impacted area
- Surveying equipment entering an impacted area
- Surveying personnel and equipment exiting an impacted area
- Operating a portal monitor for surveying non-low-level radioactive waste (LLRW) dispersible materials
- Conducting radiological sampling and analysis for waste characterization of soil and water

2.3.1 Radiological Awareness Briefings

Radiological awareness briefings will be conducted for all non-radiological remediation contractors working in impacted areas. The briefings will cover radiation basics and safety and will be conducted on an as-needed basis. Radiological awareness briefings are further described in Section 3.5 of the RPP (Attachment 1).

2.3.2 Radiological Monitoring

Upon notification from another contractor of a need for radiological support, TtEC will assess whether the activity is addressed in existing plans and procedures and identify any needs for updates or issuance of specific work instructions (see Section 2.4). Any modifications or revisions will be provided to the DON for approval before proceeding with the work.

Prior to entry into an impacted area, the RCT, as required, will ensure that non-radiological remediation contractors entering the area have the required dosimetry, have completed the

radiological awareness briefing, and have been briefed on the requirements established in the Radiation Work Permit (RWP), in accordance with SOP-010, *Issue and Use of Radiation Work Permits* (Attachment 4). All persons entering an impacted area will sign in and out on an access log and comply with requirements established in the RWP. In addition, all personnel exiting an impacted area will be subject to a personnel survey by an RCT in accordance with SOP-005, *Radiological Protective Clothing Selection, Monitoring, and Decontamination* (Attachment 4).

2.3.3 Incoming and Outgoing Surveys

Equipment and materials brought to an impacted area will be subject to an incoming survey by the RCT prior to entry into the area. Surveys of incoming equipment will be performed in accordance with SOP-001, *Radiation and Contamination Surveys* (Attachment 4). Equipment being removed from an impacted area will be surveyed for free release. Free release surveys will be performed in accordance with SOP-003, *Release of Materials and Equipment from Radiologically Controlled Areas* (Attachment 4).

2.3.4 Portal Monitor Operation

As required, TtEC will operate a portal monitor for outgoing trucks loaded with non-radiologically dispersible material, such as soil and debris. Prior to conducting a portal monitor survey, the RSOR, or his/her designee, will ensure documented confirmation from the Radiological Affairs Support Office verifying that the material is non-LLRW is provided. The purpose of the portal monitor is to prevent the inadvertent shipment of materials or equipment exhibiting elevated radiation levels onto or off of HPNS. The portal monitor will be operated in accordance with SOP-011, *Gamma Screening of Truckloads Using the Stationary Portal Monitor and Using Portable Survey Instrumentation* (Attachment 4). If the portal monitor malfunctions or is otherwise unavailable, hand surveys described in SOP-011 will be conducted.

The DON will be provided a monthly summary report of portal monitor activities. The report will include the following:

- Origin of the load
- Whether it passed or failed both portal and hand screening (if applicable)
- Quantification of the net increase in portal alarms from the previous month

If significant increases in portal alarm rates occur in any given month, the RSOR will attempt to identify the root cause, and will work with the DON to find solutions to reduce the recurrence of false alarms from the portal monitor system.

2.3.5 Personal Dosimetry

As part of the radiological health and safety program, occupational whole-body radiation exposures will be monitored, tracked, and recorded. TtEC will provide non-radiological

remediation contractors who are working in impacted areas with personal dosimetry. In addition, all basewide support personnel entering or surveying impacted areas will wear personal dosimetry. Visitors entering impacted areas under RCT escort will not require dosimetry as long as they do not perform or supervise hands-on work.

Only National Voluntary Laboratory Accreditation Program (NVLAP)-approved dosimeters from an NVLAP-certified provider will be used. Personnel issued dosimeters will complete and sign an NRC Form 4. The official Form 4 will be maintained by the TtEC RSOR, with a copy of the original kept at the project field office.

2.3.6 Waste Characterization

TtEC will perform sampling and analysis of potentially radiologically contaminated waste at HPNS for waste characterization purposes. All waste characterization sample results will be provided to the DON for assessment of final waste disposition. Samples will be collected at a frequency determined in the field, and will be analyzed for the ROCs identified in the HRA (NAVSEA 2004). The radiological analyses may be conducted in accordance with one or more of the following methods:

- Gamma spectroscopy by U.S. Environmental Protection Agency (EPA) Method 901.1 Modified/Health and Safety Laboratory (HASL) 300
- Total strontium by EPA Method 402-R-10-001c
- Alpha spectroscopy by EPA Method HASL 300

Samples will be analyzed at TestAmerica's St. Louis, Missouri laboratory. TestAmerica has successfully completed the Department of Defense Environmental Laboratory Accreditation Program certification, and also is certified by the California Department of Public Health under the California National Environmental Laboratory Accreditation Program.

Sampling and analytical procedures are included in the SAP (Attachment 3).

Radioactive material will be identified and classified as radioactive or non-radioactive waste in accordance with SOP-008, *Control of Radioactive Material* (Attachment 4). Radioactive waste will be packaged or stockpiled, posted, controlled, inventoried, documented, and disposed in accordance with SOP-008, *Control of Radioactive Material* (Attachment 4).

2.4 WORK INSTRUCTIONS

TtEC will develop WIs, on an as-needed basis, for task-specific activities that require radiological oversight. WIs will be reviewed and approved by the DON prior to finalization. Provided in Attachment 5 are copies of the WIs that have been approved by the DON for use under this CTO. No other WIs may be used while performing basewide radiological support functions without DON approval, including those previously approved by the DON under prior CTOs. Additional

WIs developed during the course of this project will be added to this Work Plan via the Field Change Request process.

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3.0 REFERENCES

NAVSEA (Naval Sea Systems Command). 2004. Historical Radiological Assessment, Hunters Point Annex, Volume II. History of the Uses of General Radioactive Material 1939-2003. August.

TtEC (Tetra Tech EC, Inc.). 2014. Accident Prevention Plan/Site Safety and Health Plan, Basewide Radiological Support at Hunters Point Naval Shipyard, San Francisco, California. December.

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TABLES

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TABLE 2-1

APPLICATION AND DESCRIPTION OF HPNS STANDARD OPERATING PROCEDURES

SOP Number	SOP Title	Application and Purpose
SOP-001	Radiation and Contamination Surveys	Specifies methods and requirements for radiological surveys, and the documentation required for the acquired survey data.
SOP-003	Release of Materials and Equipment from Radiologically Controlled Areas	Specifies the process for accepting material into a RCA and the radiological survey requirements for releasing materials and equipment from an RCA. Materials and equipment meeting release criteria at the conclusion of this procedure need not be controlled as radioactively contaminated material.
SOP-005	Radiological Protective Clothing Selection, Monitoring, and Decontamination	Specifies how to select, don, and remove PPE and conduct monitoring and decontamination of personnel during field activities.
SOP-006	Sampling Procedures for Radiological Surveys	Identifies and describes the sampling protocols and required records for swipes, and sampling of soil, sediment, other solids, pipes and drain lines, ventilation systems, and liquids and procedures for packaging and transport of the samples.
SOP-008	Control of Radioactive Material	Specifies the methods and requirements for tracking and controlling RAM collected or generated during survey, characterization and remediation activities at client facilities by TtEC and its subcontractors. Procedure governs control of RAM and shall be implemented by TtEC staff and subcontractor personnel when handling RAM.
SOP-010	Issue and Use of Radiation Work Permits	Provides direction on the requirements on the application, preparation, approval, issuance, and use of general and specific radiation work permits.
SOP-011	Gamma Screening of Truckloads Using the Stationary Portal Monitor and Using Portable Survey Instrumentation	Provides guidelines for performing gamma radiation screening of truckloads with non-LLRW dispersible material using a Ludlum Model 3500-1000RMW portal monitor or equivalent. The purpose of the portal scan is to protect against the inadvertent shipment of materials exhibiting elevated radiation levels, i.e., the scan serves only to release the contents of the truck and not the truck itself. This procedure also covers hand screening of truck loads using portable survey instruments.
SOP-012	Radiologically Controlled Areas Posting And Access Control	Identifies the types of postings necessary and requirements to clearly identify radiological conditions in a specific area or location within an area for consistent posting and control of RCAs. It also specifies the requirements for access into and egress from radiologically controlled areas.

Abbreviations and Acronyms:
HPNS – Hunters Point Naval Shipyard
LLRW – low-level radioactive waste
PPE – personal protective equipment
RAM – radioactive material
RCA – radiologically controlled area
SOP – standard operating procedure
TtEC – Tetra Tech EC, Inc.

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FIGURES

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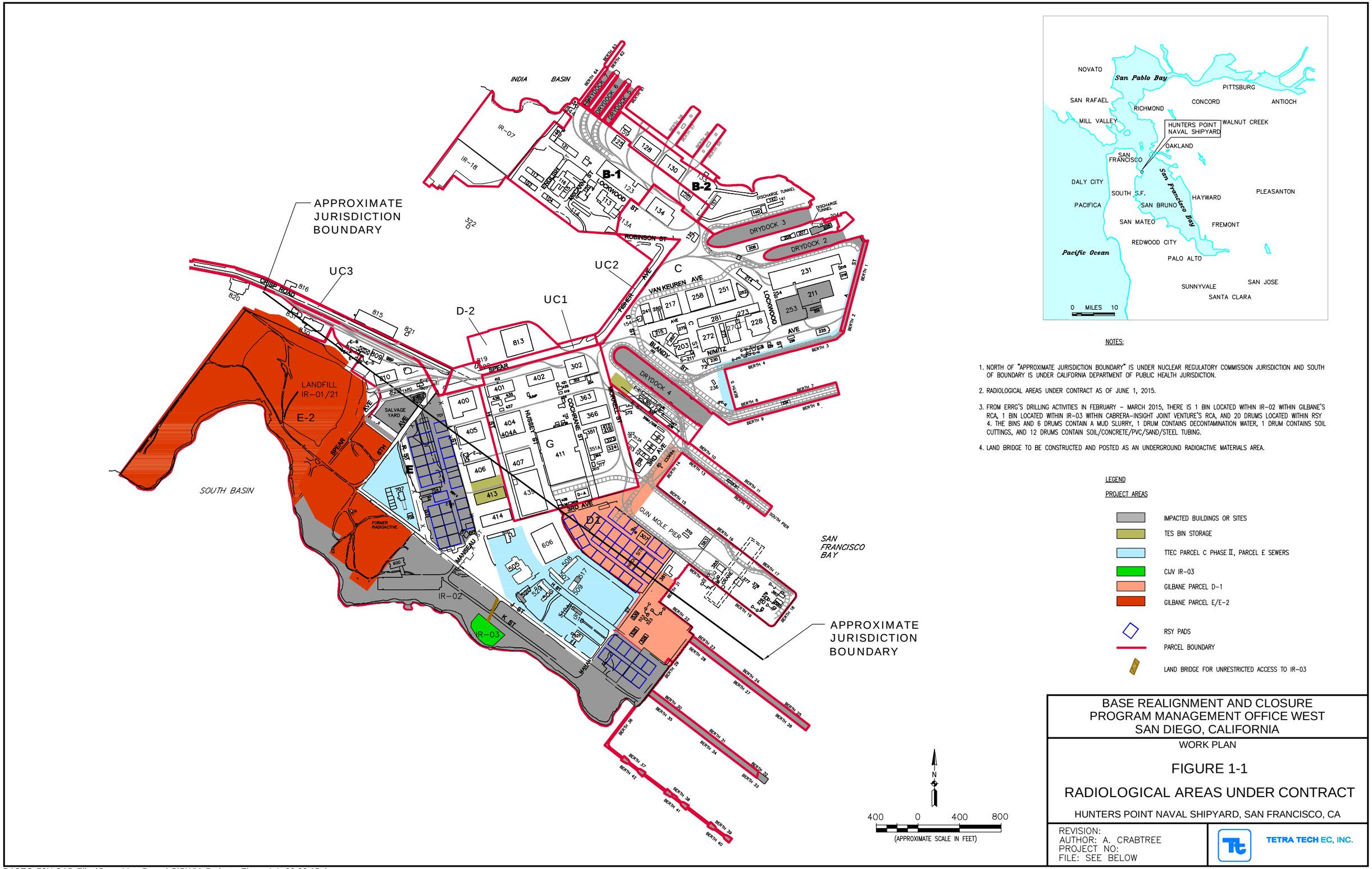


NOTES:

1. NORTH OF "APPROXIMATE JURISDICTION BOUNDARY" IS UNDER NUCLEAR REGULATORY COMMISSION JURISDICTION AND SOUTH OF BOUNDARY IS UNDER CALIFORNIA DEPARTMENT OF PUBLIC HEALTH JURISDICTION.
2. RADIOLOGICAL AREAS UNDER CONTRACT AS OF JUNE 1, 2015.
3. FROM ERRG'S DRILLING ACTIVITIES IN FEBRUARY – MARCH 2015, THERE IS 1 BIN LOCATED WITHIN IR-02 WITHIN GILBANE'S RCA, 1 BIN LOCATED WITHIN IR-03 WITHIN CABRERA-INSIGHT JOINT VENTURE'S RCA, AND 20 DRUMS LOCATED WITHIN RSY 4. THE BINS AND 6 DRUMS CONTAIN A MUD SLURRY, 1 DRUM CONTAINS DECONTAMINATION WATER, 1 DRUM CONTAINS SOIL CUTTINGS, AND 12 DRUMS CONTAIN SOIL/CONCRETE/PVC/SAND/STEEL TUBING.
4. LAND BRIDGE TO BE CONSTRUCTED AND POSTED AS AN UNDERGROUND RADIOACTIVE MATERIALS AREA.

LEGEND

PROJECT AREAS

- IMPACTED BUILDINGS OR SITES
- TES BIN STORAGE
- TTEC PARCEL C PHASE II, PARCEL E SEWERS
- CJV IR-03
- GILBANE PARCEL D-1
- GILBANE PARCEL E/E-2
- RSY PADS
- PARCEL BOUNDARY
- LAND BRIDGE FOR UNRESTRICTED ACCESS TO IR-03

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

WORK PLAN

FIGURE 1-1

RADIOLOGICAL AREAS UNDER CONTRACT

HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

REVISION:
AUTHOR: A. CRABTREE
PROJECT NO:
FILE: SEE BELOW

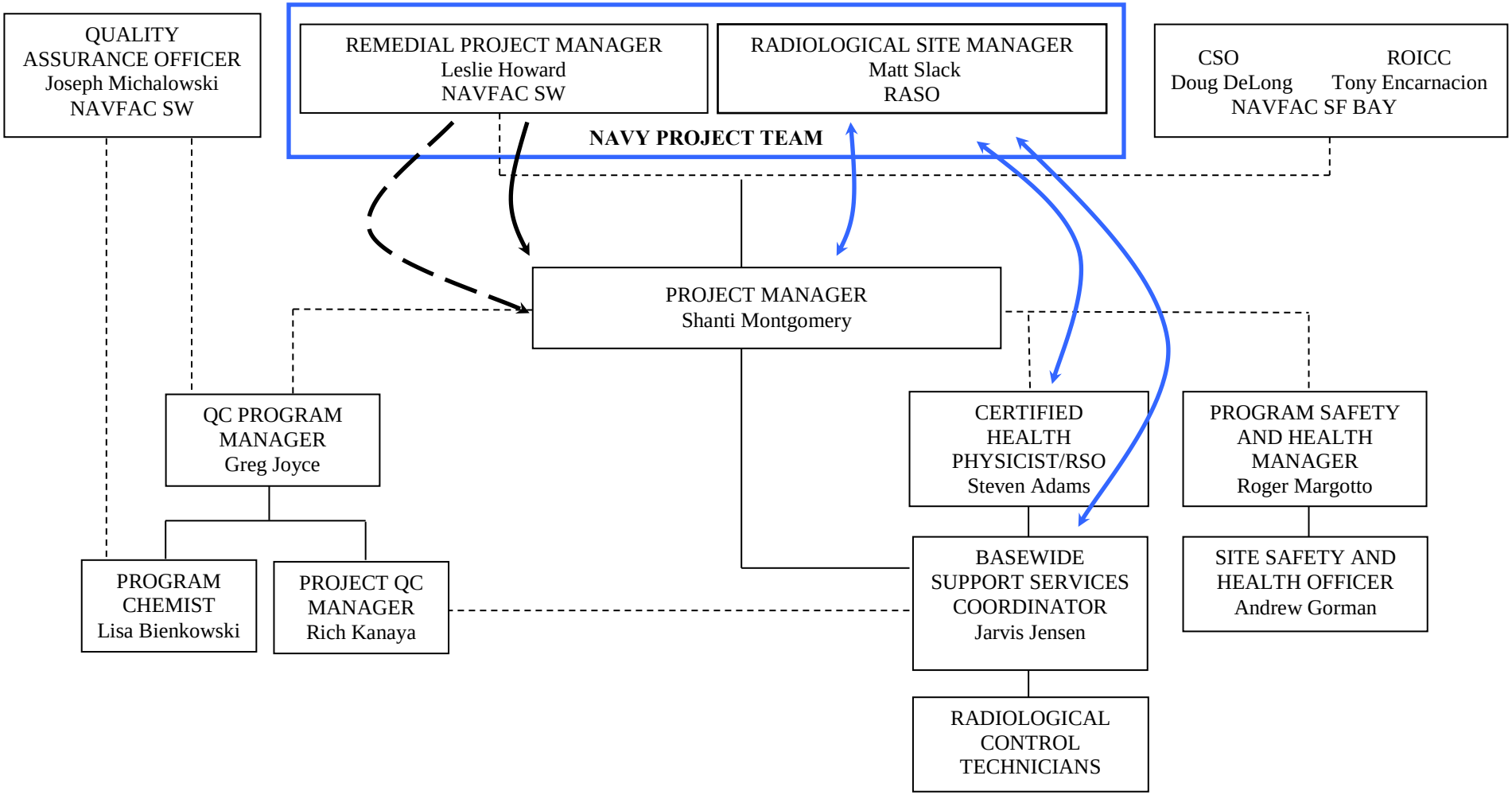
TETRA TECH EC, INC.

P:\CTO-72X CAD Files\Base Map Parcel G\BWM_Projects_Figure 1-1_06-08-15.dwg

6/8/15

FIGURE 1-2

PROJECT ORGANIZATION CHART



Abbreviations and Acronyms:
CSO – Caretaker Site Office
NAVFAC SW – Naval Facilities Engineering Command Southwest
RASO – Radiological Affairs Support Office
ROICC – Resident Officer in Charge of Construction
RSO – Radiation Safety Officer
QC – Quality Control
SF – San Francisco

Legend

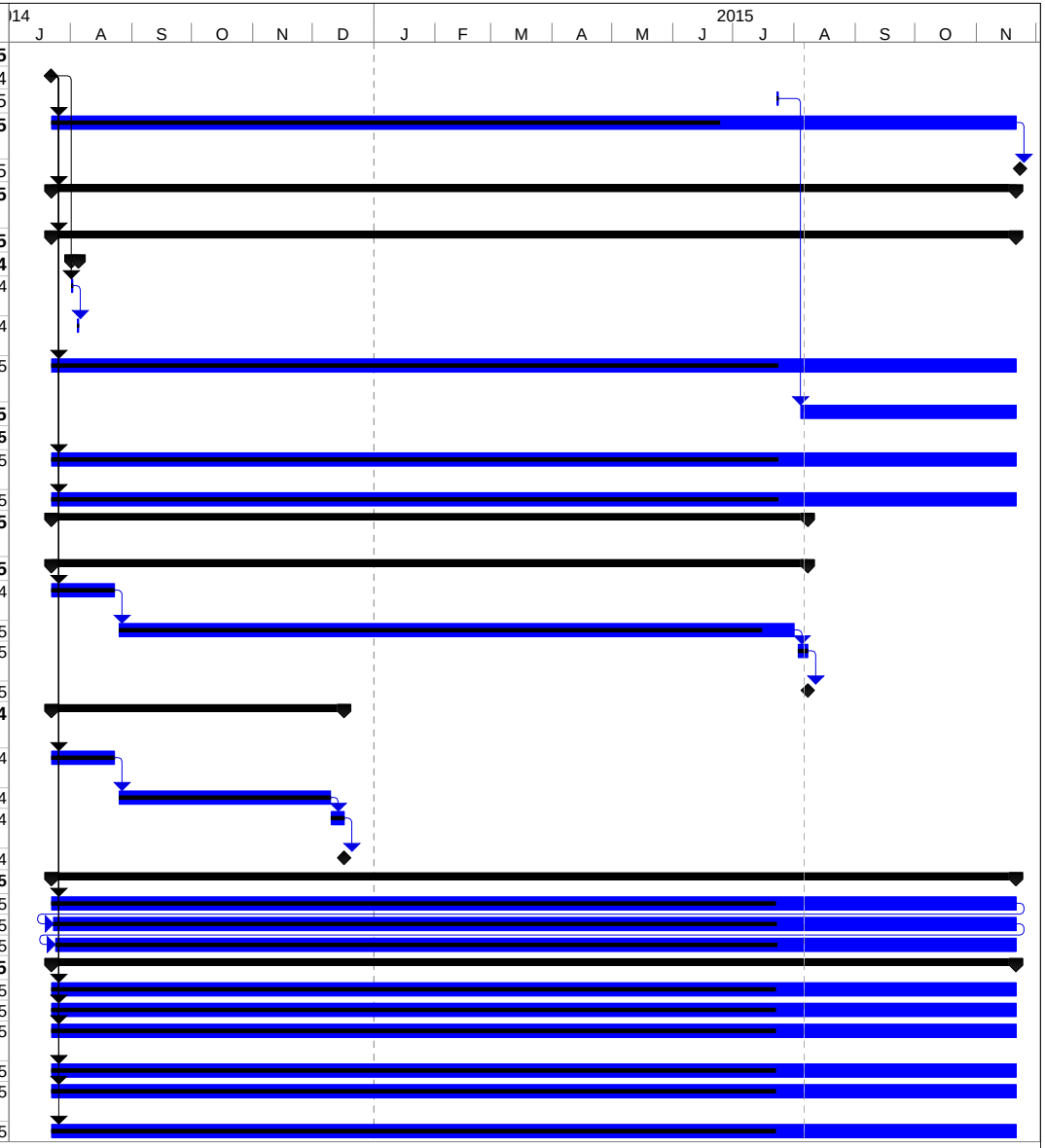
Formal reporting relationship

Supporting relationship

Primary lines of technical communication

Line of technical direction (alternate where dashed)

ID	Task Name	Duration	Start	Finish
1	**GENERAL**	**350 days**	**Tue 7/22/14**	**Sun 11/22/15**
2	Contract Start	0 days	Tue 7/22/14	Tue 7/22/14
3	**Modification 3 (4-month extension)**	1 day	Thu 7/23/15	Thu 7/23/15
4	**Project Management (includes 4 MOU revisions)**	**349 days**	**Tue 7/22/14**	**Fri 11/20/15**
5	Project Complete	0 days	Sun 11/22/15	Sun 11/22/15
6	**CTO 0003 Basewide Radiological Support at HPNS**	**349 days**	**Tue 7/22/14**	**Fri 11/20/15**
7	**Project Meetings**	**349 days**	**Tue 7/22/14**	**Fri 11/20/15**
8	**Kick off Meeting**	**2 days**	**Fri 8/1/14**	**Mon 8/4/14**
9	Attend Meeting (Meeting within 14 cal days of award)	1 day	Fri 8/1/14	Fri 8/1/14
10	Meeting minutes (within 10 cal days of meeting)	1 day	Mon 8/4/14	Mon 8/4/14
11	**Contractor Integration Meeting (3 meetings)**	349 days	Tue 7/22/14	Fri 11/20/15
12	**Weekly QC Meetings**	**79 days**	**Tue 8/4/15**	**Fri 11/20/15**
13	**Coordination Meetings**	**349 days**	**Tue 7/22/14**	**Fri 11/20/15**
14	Coordination Meetings with Others (as needed)	349 days	Tue 7/22/14	Fri 11/20/15
15	Weekly BRAC and RASO Call	349 days	Tue 7/22/14	Fri 11/20/15
16	**Planning Documents (SOPs, RPP, APP/SSHP)**	**274 days**	**Tue 7/22/14**	**Fri 8/7/15**
17	**SOPs and RPP**	**274 days**	**Tue 7/22/14**	**Fri 8/7/15**
18	Submit Draft (within 45 days after Kick-Off Meeting)	24 days	Tue 7/22/14	Fri 8/22/14
19	Navy Review of Draft (3 revisions)	245 days	Mon 8/25/14	Fri 7/31/15
20	Develop Final (30 days after Navy comments)	5 days	Mon 8/3/15	Fri 8/7/15
21	Submit Final	0 days	Fri 8/7/15	Fri 8/7/15
22	**Accident Prevention Plan/Site Safety and Health (APP/SSHP)**	**106 days**	**Tue 7/22/14**	**Tue 12/16/14**
23	Submit Draft (within 45 days after Kick-Off Meeting)	24 days	Tue 7/22/14	Fri 8/22/14
24	Navy Review of Draft	77 days	Mon 8/25/14	Tue 12/9/14
25	Develop Final (30 days after Navy comments)	5 days	Wed 12/10/14	Tue 12/16/14
26	Submit Final	0 days	Tue 12/16/14	Tue 12/16/14
27	**Work Instructions/Revisions (8 total)**	**349 days**	**Tue 7/22/14**	**Fri 11/20/15**
28	Submit Draft (within 15 days of request)	349 days	Tue 7/22/14	Fri 11/20/15
29	Navy Review of Draft	348 days	Wed 7/23/14	Fri 11/20/15
30	Submit Final (within 5 days of Navy comments)	347 days	Thu 7/24/14	Fri 11/20/15
31	**Site Support Activities**	**349 days**	**Tue 7/22/14**	**Fri 11/20/15**
32	Radiological Controls and Postings	349 days	Tue 7/22/14	Fri 11/20/15
33	Radiological Surveys	349 days	Tue 7/22/14	Fri 11/20/15
34	Radiological Support to Other Contractors (25 water & 25 soil samples; 2 briefings/month)	349 days	Tue 7/22/14	Fri 11/20/15
35	Incoming and Outgoing Surveys	349 days	Tue 7/22/14	Fri 11/20/15
36	Portal Monitor (continuous 1st 6 months; as needed remaining 6 months; 2 re-locations)	349 days	Tue 7/22/14	Fri 11/20/15
37	Personal Dosimetry (60 visitors/quarter)	349 days	Tue 7/22/14	Fri 11/20/15

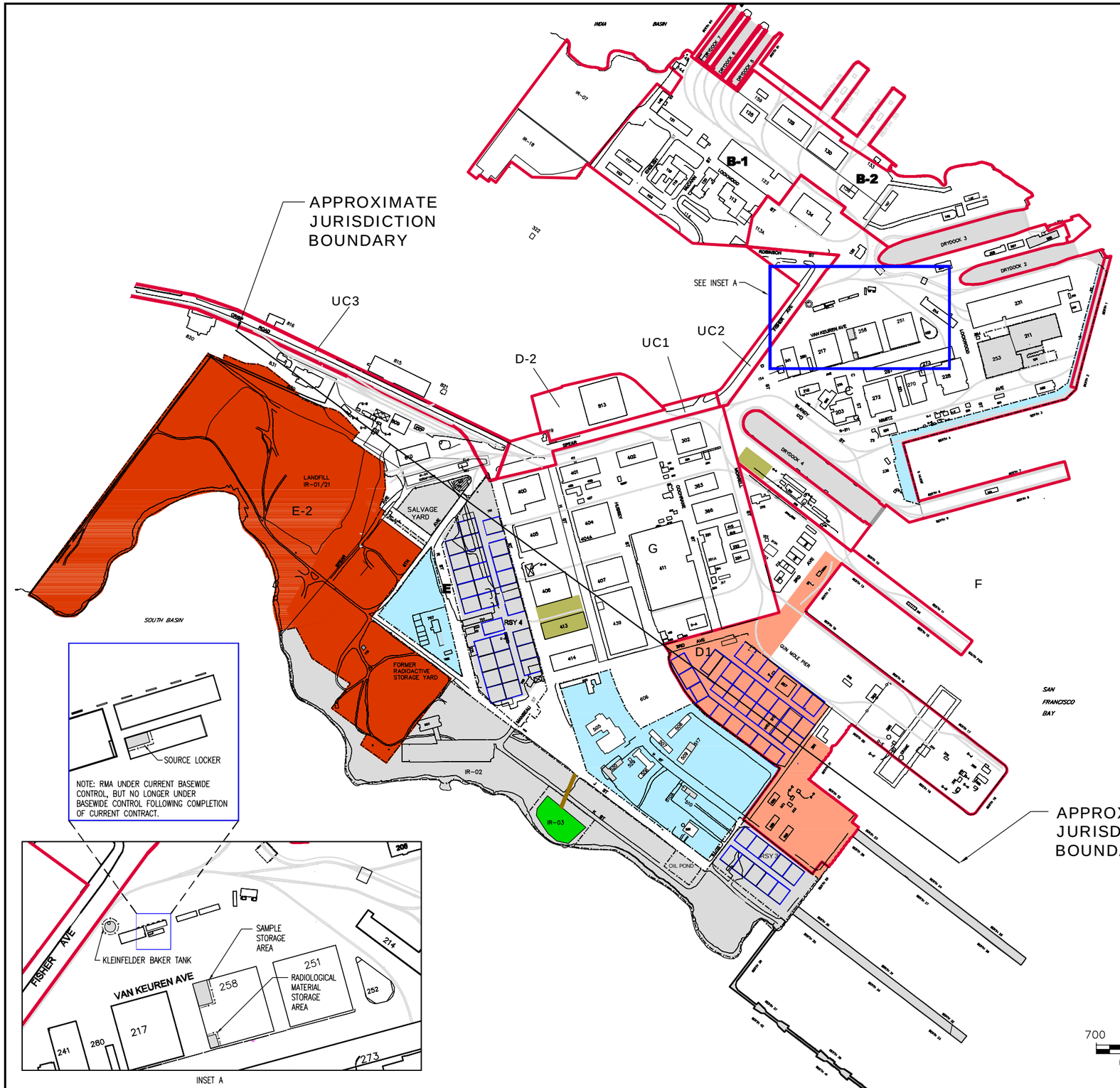


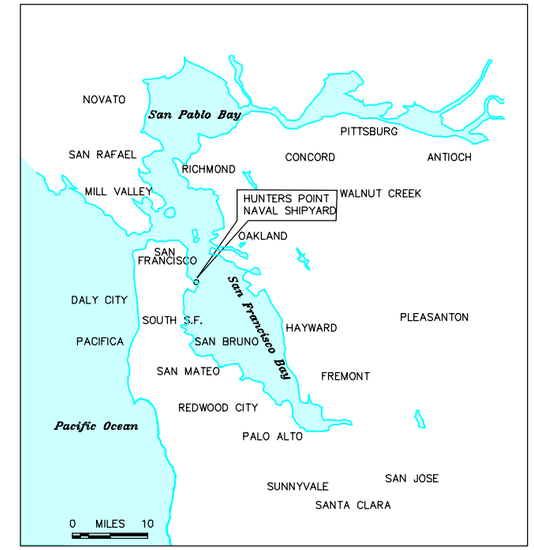
Project: X004
Date: Thu 8/6/15

Task | Critical Task | Milestone | Summary | Group By Summary | Progress

Basewide Radiological Support
Hunters Point Naval Shipyard, San Francisco, CA

Figure 1-3
Project Schedule





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2. RADIOLOGICAL AREAS UNDER CONTRACT AS OF JUNE 1, 2015.
3. THE BASEWIDE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING CONTROL OF ALL IMPACTED BUILDINGS AND SITES NOT COVERED BY ANOTHER RADIOLOGICAL CONTRACTOR.
4. LAND BRIDGE TO BE CONSTRUCTED AND POSTED AS AN UNDERGROUND RADIOACTIVE MATERIALS AREA.

LEGEND

PROJECT AREAS

- IMPACTED BUILDINGS OR SITES
- TES BIN STORAGE
- TTEC PARCEL C PHASE II, PARCEL E SEWERS
- CIJV IR-03
- GILBANE PARCEL D-1
- GILBANE PARCEL E/E-2
- RSY PADS
- PARCEL BOUNDARY
- —X— RCAs
- LAND BRIDGE FOR UNRESTRICTED ACCESS TO IR-03

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

WORK PLAN

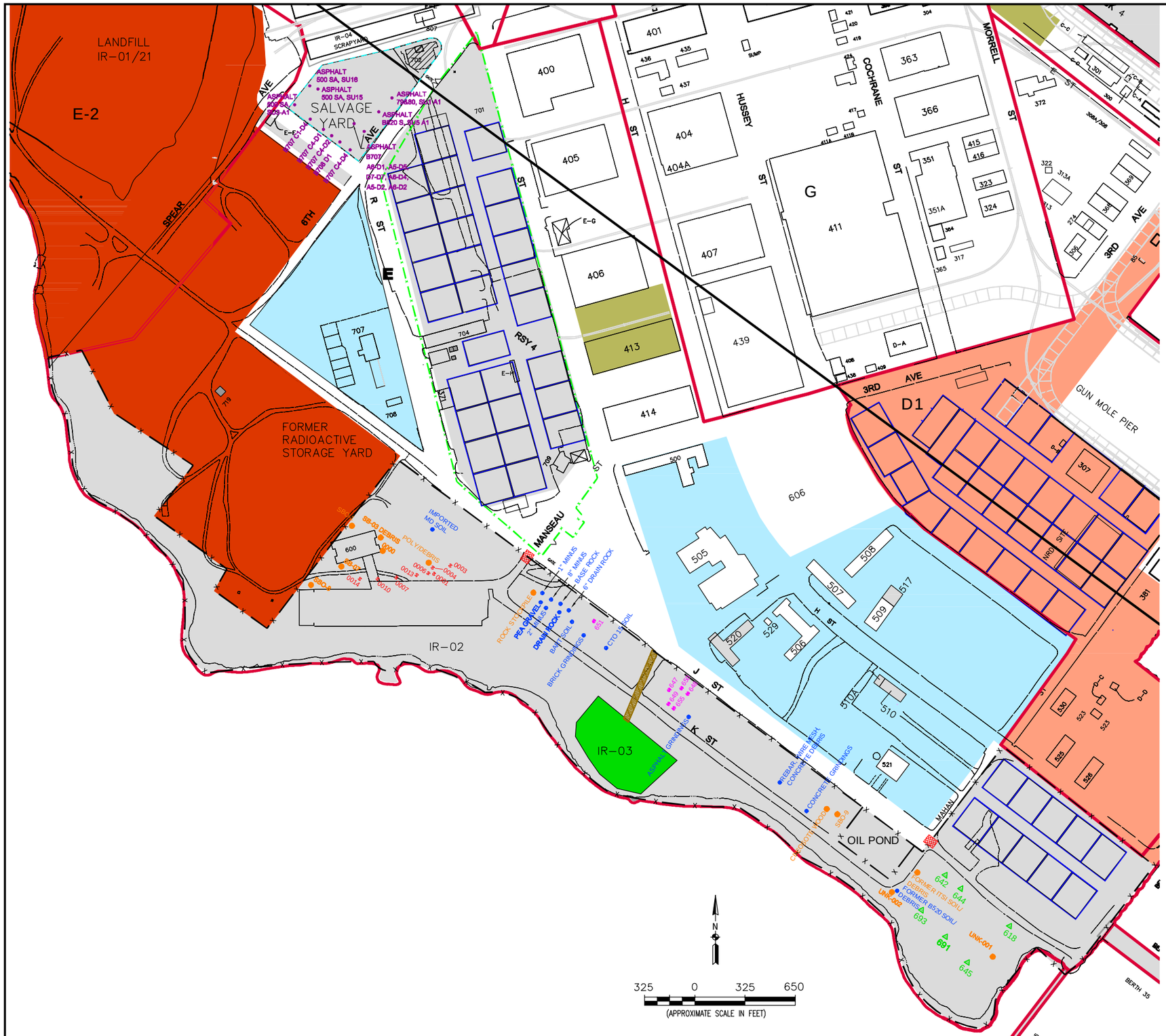
FIGURE 2-1

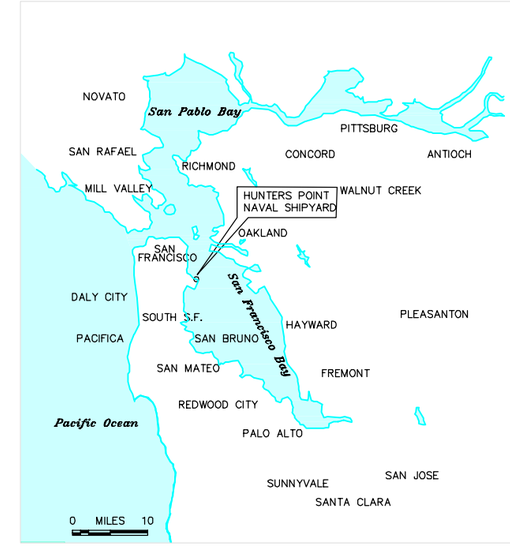
RADIOLOGICALLY CONTROLLED AREAS

HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

REVISION:
AUTHOR: A. CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.





NOTES:

1. NORTH OF "APPROXIMATE JURISDICTION BOUNDARY" IS UNDER NUCLEAR REGULATORY COMMISSION JURISDICTION AND SOUTH OF BOUNDARY IS UNDER CALIFORNIA DEPARTMENT OF PUBLIC HEALTH JURISDICTION.
2. RADIOLOGICAL AREAS UNDER CONTRACT AS OF JUNE 1, 2015.
3. STOCKPILE LOCATIONS ARE APPROXIMATE.
4. LAND BRIDGE TO BE CONSTRUCTED AND POSTED AS AN UNDERGROUND RADIOACTIVE MATERIALS AREA.

LEGEND

PROJECT AREAS

- IMPACTED BUILDINGS OR SITES
- TES BIN STORAGE
- TTEC PARCEL C PHASE II, PARCEL E SEWERS
- CIJV IR-03
- GILBANE PARCEL D-1
- GILBANE PARCEL E/E-2
- RSY PADS
- PARCEL BOUNDARY
- RSY4 RCA
- SALAVAGE YARD RCA
- IR-02 BASEWIDE RCA
- CONTROL POINT
- LAND BRIDGE FOR UNRESTRICTED ACCESS TO IR-03

STOCKPILES

- GILBANE STOCKPILES
- POTENTIALLY RADIOLOGICALLY IMPACTED STOCKPILES
- NON-IMPACTED STOCKPILE
- SANDY (NORM) MATERIAL FROM FORMER BUILDING 518
- STOCKPILES PENDING RADIOLOGICAL CLEARANCE
- IR-28 STOCKPILE (PARCEL C)

BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
SAN DIEGO, CALIFORNIA

WORK PLAN

FIGURE 2-2

STOCKPILES LOCATED WITHIN BASEWIDE RADIOLOGICALLY CONTROLLED AREAS

HUNTERS POINT NAVAL SHIPYARD, SAN FRANCISCO, CA

REVISION:
AUTHOR: A. CRABTREE
PROJECT NO:
FILE: SEE BELOW

TETRA TECH EC, INC.

ATTACHMENT 1

RADIATION PROTECTION PLAN

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Base Realignment and Closure
Program Management Office West
33000 Nixie Way, Bldg. 50
San Diego, California 92147

CONTRACT NO. N62473-13-D-4808
CTO NO. 0003

ATTACHMENT 1

FINAL

RADIATION PROTECTION PLAN

August 2015

BASEWIDE RADIOLOGICAL SUPPORT
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: ECSD-4808-0003-0003

Prepared by:

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, California 92101-8536

Steven Adams, CHP
Corporate Radiation Safety Officer

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APPENDICES

Appendix A Radiation Protection Plan Acknowledgment Form

ABBREVIATIONS AND ACRONYMS

ALARA	as low as reasonably achievable
APP	Accident Prevention Plan
CDPH	California Department of Public Health
CFR	*Code of Federal Regulations*
CHP	Certified Health Physicist
CHPM	Corporate Health Physics Manager
DAC	derived air concentration
DOT	U.S. Department of Transportation
EHS	environmental health and safety
HRA	Historical Radiological Assessment
MOU	Memorandum of Understanding
NRC	U.S. Nuclear Regulatory Commission
PjM	Project Manager
PPE	personal protective equipment
QC	quality control
^{226}Ra	radium-226
RASO	Radiological Affairs Support Office
RCA	Radiologically Controlled Area
RCT	Radiological Control Technician
RMA	Radioactive Materials Area
RML	Radioactive Material License
RPP	Radiological Protection Plan
RRPT	Registered Radiation Protection Technologist
RSO	Radiation Safety Officer
RSOR	Radiation Safety Officer Representative
RTS	Radiological Task Supervisor
RWP	Radiation Work Permit
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan
TEDE	total effective dose equivalent
TIP	Task Initiation Procedure
TtEC	Tetra Tech EC, Inc.
WI	Work Instruction

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1.0 PURPOSE/INTRODUCTION

The purpose of this Radiation Protection Plan (RPP) is to detail Tetra Tech EC, Inc.'s. (TtEC's) requirements for activities conducted under Radioactive Material License (RML) No. 29-31396-01 and State of California RML 7909-01, issued and subject to regulatory enforcement by the U.S. Nuclear Regulatory Commission (NRC) and the California Department of Public Health (CDPH), respectively. The following activities are subject to this RPP: project activities that involve the use and/or handling of licensed by-product, source, and/or special nuclear material (hereafter referred to as radioactive material); tasks with the potential for radioactive material to be present based on available data and historical records; and work in locations posted and controlled because of radioactive material. Project activities will incorporate the requirements within to maintain compliance with the current version of corporate procedure RP1-1, Radiological Protection Program.

Project activity performance steps are detailed in site-specific Work Plans, Standard Operating Procedures (SOPs), Work Instructions (WIs), etc. (Agencies that may have jurisdiction or an interest in project activities are also identified in such documents.) Project staff tasked to perform assignments involving the presence of radioactive material (e.g., those identified in the applicable portions of Section 2.0) will complete a review of this document and indicate an understanding of all requirements by completing a Radiation Protection Plan Acknowledgement Form (Appendix A).

1.1 POLICY

It is TtEC's policy that work with radioactive material be purposeful and performed in a manner that protects project staff, members of the general public, and the environment. Radiologically oriented work may not begin unless it can be performed in a safe and reliable manner that is compliant with the exposure reduction rules, regulations, and principles described in Section 1.3.

1.2 PROJECT-SPECIFIC RADIATION PROTECTION PLAN

Corporate procedure RP1-1, Radiological Protection Program, provides the foundation for the RPP and its use for any project or activity that involves the possession or use of radioactive materials, including the subsequent potential for exposure to ionizing radiation. Content provided within this RPP reflects corporate policy and provides the guidance needed for project management to execute the scope of work in a safe manner. Site-specific guidance for radiological safety and control is further detailed in SOPs. SOPs are subject to approval by the Radiation Safety Officer (RSO) or designee and may be revised separately from the RPP. The RSO is also the company's Corporate Health Physics Manager (CHPM).

1.3 AS LOW AS REASONABLY ACHIEVABLE

Work involving radioactive material and any corresponding exposure to ionizing radiation must be purposeful and performed in a manner sufficient to ensure the protection of staff, members of

the public, and the environment. TtEC applies industry recognized principles to radiological work so that exposure to ionizing radiation is maintained in accordance with corporate procedure NLP-01, As Low As Reasonably Achievable (ALARA) Program.

1.4 AUTHORIZATION TO STOP WORK

In accordance with corporate procedure RP1-1, Radiological Protection Program, and as detailed in Section 2.9, employees are authorized to stop work if an unsafe condition exists or safety protocol is being violated, and immediately report the condition to project management.

Work performed under a Radiation Work Permit (RWP) will stop, and the Radiological Affairs Support Office (RASO) will be notified if any of the following atypical work site conditions are encountered:

- An individual total effective dose equivalent (TEDE) exceeding 500 millirem
- The collective TEDE for the job exceeding 1 rem
- Individual airborne exposures exceeding 10 derived air concentration (DAC) hours in a 7-day period
- General area exposure rates exceeding limits of current radiological posting
- Contamination levels exceeding 100 times the limits requiring classification of an area as a Contaminated Area

In cases where the Navy must be notified, the license RSO, with concurrence from the Navy, must approve the RWP prior to restarting work.

1.5 SCOPE OF WORK

The project-specific scope of work involves the following activities:

- Task-specific training of personnel
- Site controls and establishment of work zones at sites with, or having the potential for, radioactive commodities or contaminants
- Handling and management of collected radioactive commodities, radiologically contaminated soil, or other radiologically contaminated material
- Site investigation and remediation including characterization surveys and sampling, excavation, screening for and removal of commodities, and surveys and sampling to document final conditions

1.6 QUALITY CONTROL AND AUDITING

To maintain continued compliance and evaluate overall RPP effectiveness, quality control (QC) measures including self-assessment and management reviews will be used. Formal audits, including those conducted at field projects, will be coordinated and tracked to completion by the RSO as will any need for adjustments to audit frequencies.

1.6.1 Self-Assessment, Management Reviews, and Audits

A self-assessment and management review of RPP use, as detailed in corporate procedure NLP-08, Radiation Protection Program Audits, will be conducted. Project personnel including the Project Manager (PjM), project Radiation Safety Officer Representative (RSOR), and on-site personnel will support and cooperate with any audit conducted.

1.6.2 Responses and Corrective Actions

Radiological deficiencies must be responded to in a timely fashion. Deficiencies that represent an imminent threat to radiological control or safety (e.g., compromise of procedural protocol) will be immediately reported to the RSOR, RSO, and PjM or designee(s). Subsequent corrective actions will be tracked to completion by the RSO or designee. Radiological deficiencies, including corrective actions, will be promptly reported by the RSO to the project client (e.g., the Navy; for the purposes of this RPP, Navy means U.S. Department of the Navy, Naval Facilities Engineering Command Southwest; U.S. Department of the Navy, Base Realignment and Closure, Program Management Office; and Naval Sea Systems Command Detachment, RASO). Responses to findings will be submitted to the RSO or designee for review, approval, and final disposition.

1.6.3 Daily Instrumentation Check

As addressed in Section 3.16, survey instruments procured for field use will have proof of current calibrations in accordance with the manufacturers' procedures, employing applicable standards and sources traceable to the National Institute of Standards and Technology. Copies of instrument calibration certificates will be maintained on-site for reference. Instruments will be response-checked daily in accordance with applicable SOPs.

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2.0 RADIATION PROTECTION PERSONNEL

This section details the radiological safety responsibilities vested with key personnel within the project. (Nonradiological safety responsibilities will be detailed in a separate project-specific Accident Prevention Plan [APP]/Site Safety and Health Plan [SSHP].)

2.1 PRESIDENT OF TETRA TECH EC, INC.

The President of TtEC has overall responsibility for TtEC's safety operations. The President of TtEC is responsible for:

- Ensuring proper maintenance of the RPP consistent with applicable regulatory mandates, TtEC corporate policy, and recognized industry practice
- Establishing and maintaining all necessary management oversight specific to the RPP
- Implementing a management review process to ensure applicable use of RPP requirements

2.2 LICENSE RADIATION SAFETY OFFICER (CORPORATE HEALTH PHYSICS MANAGER)

The CHPM (also referred to as the RSO) is appointed by the President of TtEC as the senior health physicist and the Health Physics Resource Manager for TtEC. The CHPM is responsible for:

- Reviewing and making recommended revisions to:
  - The RPP, RML procedures, radiation protection guidelines, and supporting documents
  - Project plans involving the use or handling of radioactive materials, or access to areas of radiological concern to ensure compliance with RPP requirements and supporting guidelines
- Acting as the Health Physics Resource Manager, also referred to as the corporate-level or license RSO
- Designating a Project Health Physicist, also referred to as the project-level RSOR, to provide day-to-day guidance on radiological protection issues
- Compliance as the license RSO, with RML No. 29-31396-01 and No. 7909-01, including:
  - Primary point of contact for all communications to the NRC and CDPH
  - Identification and training of RML authorized users
  - Assignment of project RSOR
  - Coordination of investigations involving radiological occurrences to include review and approval of a resulting Corrective Action Plan

- Advance NRC and/or CDPH notification in writing at least 14 days before initiating at a temporary job site under TtEC RML jurisdiction any activity, or change to scope involving new activities, in areas of radiological concern (excluding routine packaging or repackaging for purposes of transporting and not requiring a job- or site-specific work package, and characterization and/or final surveys where radioactive materials and/or radiation are not likely to be detected)
- Refrain from taking ownership of licensed materials in excess of possession limits without prior notification and written NRC and/or CDPH approval
- Advance NRC and/or CDPH notification in writing within 30 days of the temporary job site completion status involving decontamination and decommissioning activities, and disposition of any licensed material as related to RML jurisdiction
- Maintenance of radiological exposure records
- Development and/or approval of radiation safety training materials and/or courses
- Performance of program audits as detailed in corporate procedure NLP-08, Radiation Protection Program Audits
- Providing guidance on radiological protection issues
- Identification of appropriate project staffing needs to implement RPP requirements
- Assistance with the development of site Environmental Health and Safety (EHS) plans and approval of EHS plans for projects that involve the use or handling of radioactive materials or access to areas of radiological concern
- Resource Specialist review for Task Initiation Procedures (TIPs) for proposed projects involving exposure to radiation or radioactive materials

- Delegating project responsibilities to other company health physicists (also referred to as RSORs), as necessary

2.3 PROJECT RADIATION SAFETY OFFICER REPRESENTATIVE (PROJECT HEALTH PHYSICIST)

The project RSOR, also referred to as the Project Health Physicist, is assigned by the RSO and vested with corporate-level authority to implement the RPP and the TtEC RMLs at a project site. Whenever radiological work is actively ongoing under the TtEC RML, the RSOR or designee identified as an authorized user will be present at the project site. The RSOR is vested with the following responsibilities at projects subject to jurisdiction involving the TtEC RMLs:

- Providing health physics guidance on an as-needed basis
- Conducting required radiological safety training
- Reviewing and approving project field procedures that involve the handling of radioactive materials or access to areas of radiological concern
- Conducting radiation incident investigations and project inspections

- Maintaining a project site file that details radiological protection training provided, dosimetry records generated, radiological surveys performed, and other documentation pertinent to the RPP, RML procedures, radiation protection guidelines, and supporting documents; copies of these will be provided to the CHPM at the conclusion of the project
- Arranging for and assisting in program radiation protection audits as detailed in the most current version of corporate procedure NLP-08, Radiation Protection Program Audits
- Assisting in the development and approval of the site EHS plan
- Helping in the identification of project radiological analysis needs and selection of analytical support contractors
- Coordinating required ALARA reviews
- Ensuring appropriate staff work practices are employed to maintain occupational radiation exposures ALARA
- Ensuring items needed to perform work in accordance with the RPP, RMLs, and supporting documents are available, such as appropriate instrumentation, protective devices, dosimetry, etc.
- Directing the preparation of, and performing the review and approval of, RWPs
- Stopping work if necessary to ensure radiological safety
- Communicating with the PjM and RSO as needed to ensure the RPP is implemented correctly
- Ensuring proper operation of radiation-measuring equipment, including the performance of daily function and QC tests, and removing out-of-compliance instruments from service
- Maintaining radiation-measuring equipment in accordance with manufacturers' recommendations
- Directing and supervising the performance of radiological surveys and sampling in accordance with the most current version of this RPP and supporting TtEC SOPs
- Reviewing survey reports and instrument performance data for accuracy, completeness, and compliance with project, procedural, and regulatory requirements
- Ensuring work is performed in accordance with current versions of project plans, procedures, and the RPP

The project RSOR reports to and receives technical direction from the RSO, advises the PjM on radiation protection and radiological operation matters, coordinates with the PjM on day-to-day project activities, and communicates and coordinates radiation protection and radiological operation activities with the RSO and the client. Company Health Physicists (also referred to as RSORs) may delegate project responsibilities to other staff members deemed qualified for the task assigned.

2.4 PROJECT MANAGER

The PjM is responsible for:

- Ensuring implementation of and compliance with the RPP requirements and current versions of the following support documents applicable to the project:
  - TtEC RML procedures (i.e., applicable NRC License Procedures)
  - TtEC Radiation Protection Guidance (RPG) documents
  - TtEC SOPs
- Forwarding any TIP or modified TIP involving exposure to ionizing radiation or radioactive material to the RSO or designee for input and review (involvement includes the use of subcontractors who may use radioactive materials or radiation-generating devices in the course of corresponding work such as field radiography, soil density gauges, well logging, etc.)
- Determining with the assistance of the RSO or designee if the project is required to use the TtEC RML or if activities will fall under a Department of Energy, NRC, Agreement State, or other license
- The safe conduct of work in compliance with all permits, client contracts, and other controlling documents that apply
- Exposure to radiation ALARA by project staff
- Adequate resources and staffing to develop and implement this RPP in compliance with applicable regulations and requirements

The PjM reports to the TtEC Program Manager.

2.5 CONSTRUCTION MANAGER/PROJECT SUPERINTENDENT

Responsibilities for the Construction Manager/Project Superintendent include:

- Ensuring assigned personnel comply with radiological requirements
- Supplying relevant information to the RSOR regarding planned work activities and proposed applications necessary to maintain occupational radiation exposures ALARA
- Timely RSOR and PjM notification of radiological problems or issues encountered
- Verifying staff is sufficiently prepared for assigned tasks (e.g., appropriate tools and equipment needed to minimize the time spent in areas of radiological concern)
- Confirming that escorted visitors accessing areas of radiological concern are properly supervised and exhibiting safe work practices in accordance with RPP protocol

The Project Superintendent/Construction Manager reports to the PjM. For Contract Task Order 0003, the Project Superintendent/Construction Manager is the Basewide Support Services Coordinator.

2.6 RADIOLOGICAL TASK SUPERVISOR

The Radiological Task Supervisor (RTS) is the TtEC representative responsible for Radiological Control Technician (RCT) oversight and corresponding field operations conducted in areas of radiological concern. Designated as an authorized user at projects subject to jurisdiction under the TtEC RML, the RTS is vested with the following responsibilities:

- Supporting required ALARA reviews
- Coordinating plans for field activities with the Construction Manager/Project Superintendent to ensure exposure to radiation is maintained ALARA and in accordance with corresponding RWPs
- Supervising the preparation of, and performing review of, RWPs
- Stopping work if necessary to ensure radiation safety
- Maintaining communication with the RSO, RSOR, PjM, Construction Manager, and Project Superintendent as needed to ensure the RPP is fully implemented
- Confirming proper operation of radiation survey instruments, including the validation of daily function and QC checks, and removing noncompliant instruments from service
- Ensuring radiation survey instruments are maintained in a way that complies with manufacturer instructions and recommendations
- Directing and supervising the performance of radiological survey and sampling practices in accordance with the RPP, current versions of applicable SOPs, and corresponding RWPs
- Validating field survey reports and instrument performance data for accuracy, completeness, and compliance with the RPP, applicable SOPs, and corresponding RWPs
- Participating in periodic internal and external reviews of RPP content and implementation
- Supporting self-assessments and management reviews as needed and correcting identified deficiencies within the allotted time frame

The RTS reports to and receives technical direction from the RSOR.

2.7 RADIOLOGICAL CONTROL TECHNICIANS

The RCTs are responsible for:

- Ensuring occupational exposure to radiation is maintained ALARA
- Preparing, using, and adhering to RWPs
- Stopping work if necessary to ensure radiological safety
- Performing radiation surveys and other radiological safety tasks in accordance with the RPP, applicable SOPs, and corresponding RWPs

- Confirming proper operation of assigned radiation survey instruments prior to field use to include verification of daily function and QC performance checks, and removing noncompliant instruments from service
- Using radiation survey instruments in accordance with the RPP, applicable SOPs, and corresponding RWPs and maintaining the instruments in a way that complies with manufacturers' instructions and recommendations

The RCTs report to and receive technical direction from the RSOR and RTS, as applicable.

2.8 RADIATION WORKERS (FIELD PERSONNEL)

Project staff (including the general labor force associated with the company and subcontractors) who have the potential to receive occupational exposure to radiation while on the job site, and who are expected to work under the requirements of this RPP as radiation workers, will:

- Receive sufficient training, prior to beginning work, in accordance with the most current version of corporate document RPG 2-5, Radiation Safety Training.
- Report to the RTS or RCT non-occupational radiation exposures that result from the use of medical or dental applications more aggressive than a standard X-ray.
- Comply with requirements of all procedures and guidelines applicable to the project.
- As required, exercise stop work authority and report radiological safety issues or concerns, including incidents and unplanned events, immediately to project management and Environmental Safety and Quality staff in writing, verbally, or with a Zero Incident Performance® slip; respond promptly to any stop-work and/or evacuate orders.
- Display use of industry recognized radiological work practices when inside areas of radiological concern, and conform promptly to instructions when provided by RCTs.
- Strictly adhere to radiological control procedures, guidelines, and postings including information provided in RWPs.
- Immediately report lost dosimetry devices to the RCT.
- Report planned medical radiation treatments in advance to supervision and the project RSOR and prior to entering areas of radiological concern or wearing dosimetry.
- Periodically confirm personal radiation exposure status and ensure that administrative dose guidelines are not exceeded.
- Notify the RCT of faulty or alarming radiological protection equipment.

When in areas of radiological concern, workers report to the RSOR or RTS, as applicable.

2.9 STOP WORK AUTHORITY

Company and subcontractor personnel will have the responsibility and authority to stop work when controls are inadequate or imminent danger exists.

In any situation in which stop work authority is used, the following requirements will apply:

- Exercise stop work authority in a justifiable and responsible manner.
- Once work is stopped, do NOT resume until proper controls have been established.
- Resumption of work will require concurrence by the PjM or designee, as well as the RSO if the work stoppage was related to radiation safety.

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3.0 TASK-SPECIFIC HAZARD ANALYSIS/CONTROLS

A task-specific hazard analysis is performed on a daily basis to allow for risk identification associated with site work, including physical, chemical, and radiological components. (Radiation exposures that result from naturally occurring background sources and medical applications conducted under the care of a physician are examples of dose that is independent of occupational monitoring requirements but considered when planning task assignments. In instances of verifiable therapeutic applications, employee-furnished notifications will be used as an informational reference and included as part of a corresponding radiation exposure file.) Risk-based hazards and controls are defined in a site-specific Activity Hazard Analysis. Anticipated physical and chemical risks are described in detail in the project-specific APP/SSHP. Radiological risk controls are categorized in the sections to follow, and protective measures apply as defined in task-specific RWPs and corresponding SOPs.

3.1 IDENTIFICATION OF RADIATION RISKS

Project tasks subject to RPP protocol indicate a known or suspected likelihood of activities occurring in radiologically impacted areas (e.g., locations with sources of radium-226 [^{226}Ra], areas with similar radionuclides of concern as identified in the site-specific Historical Radiological Assessment [HRA]).

3.2 CONTROLLING DOCUMENTS

Unless indicated otherwise in Section 1.0, work conducted under the RPP will be subject to requirements detailed in TtEC RML No. 29-31396-01 and RML 7909-01 and in accordance with any project-specific Memorandum of Understanding (MOU) criteria and applicable radiological control work documents (e.g., site-specific Basewide Radiological Plan, SOPs). TtEC will incorporate site-specific versions of SOPs as needed to implement and satisfy license commitments. Title 10 of the *Code of Federal Regulations* (CFR) Section 20 applies to the RPP standards used. In parallel, industrial safety requirements and U.S. Environmental Protection Agency regulations detailed in 29 and 40 CFR also have applicability for a variety of regulatory subjects including Comprehensive Environmental Response, Compensation, and Liability Act; the Resource Conservation and Recovery Act; and the National Emission Standards for Hazardous Air Pollutants.

3.3 EVALUATION OF POTENTIAL EXPOSURE TO WORKERS

RPP dose limits for the control of occupational exposure to ionizing radiation are listed in 10 CFR 20.1201–1208. Dose limits for individual members of the pubic are detailed in 10 CFR 20.1301–1302. In accordance with company policy, all exposures will be minimized to the extent practical. Administrative guidelines, established below the federal limits, will be used as detailed in the current version of corporate procedure NLP-01, ALARA Program. Occupational exposures for project personnel will be maintained below TtEC administrative values for annual TEDE.

Occupational dose, if any, is expected to originate from external sources (e.g., ^{226}Ra, cesium-137, strontium-90, or similar known radionuclides of concern as listed in a site-specific reference document [e.g., HRA]). Dose resulting from internal exposures is not anticipated. External exposure controls are addressed in Section 3.8, and controls to prevent or limit internal exposures are detailed in Section 3.9. Dose rates for general area work sites are expected to reflect naturally occurring background values.

3.4 EVALUATION OF PUBLIC DOSE

Based on the scope of planned work, the limited activity of radionuclides expected, and low concentration of naturally occurring radioactive material anticipated, public dose associated with tasks performed under this RPP is not projected. To validate the maintenance of public dose goals, TtEC will implement necessary survey and sampling protocols in areas of intrusive work, conspicuously post and restrict access to intrusive work locations that require monitoring (e.g., areas where soil excavations and/or handling, etc., may disturb sources of radioactive material), and validate survey and sampling results and frequencies with the client, RSO, RSOR, and RTS representatives to ensure established controls are effective.

3.5 TRAINING PROGRAM

Site personnel tasked to conduct project-oriented activities must satisfy corresponding APP/SSHP training requirements. Persons subject to assignments involving a known or suspected potential for occupational radiation dose will receive additional training commensurate with radiological awareness requirements as defined in 10 CFR 19.12, Instructions to Workers. Visitors and escorted persons must receive a site briefing and will be assigned to a qualified radiation worker aide when in an area of radiological concern.

3.5.1 Site Briefing

An RPP site briefing is designed for an escorted person and is presented when access is needed to radiologically impacted locations. Specific to the area(s) of concern where access is needed, the RPP brief will cover at a minimum:

- Applicable portions of 10 CFR 19, 10 CFR 20, the RPP, RWPs, site-specific reference documents (e.g., HRA), and supporting SOPs
- A description of radiation exposure risks and monitoring requirements
- Access and egress protocol specific to the radiologically impacted location(s) requiring entry
- Radiation exposure reduction techniques for an embryo/fetus

- Completion of applicable briefing/exposure monitoring documentation
- Notification of contacts as needed to complete training requirements

3.5.2 Radiation Worker Training

RPP training for the radiation worker is provided when unescorted access is needed to impacted site locations subject to radiological control. Inclusive of material that may be required by project-specific Work Plans and documents (e.g., APP/SSHP,), training may be presented in the form of a group overview, video presentation, etc., with use of printed handouts approved by the RSOR. Training will address at a minimum:

- Applicable portions of 10 CFR 19, 10 CFR 20, the RPP, site-specific reference documents (e.g., Hunters Point Naval Shipyard HRA), and supporting SOPs specific to task performance
- A description of radiation exposure risks, monitoring requirements, and techniques
- Access and egress protocol specific to radiologically impacted locations
- Required contacts and expected actions in the event of an emergency (in accordance with the current version of corporate procedure NLP-06, Managing Radiological Emergencies)
- Expected actions and contacts if radioactive material is discovered in an area where it is not expected
- Understanding “hands and feet” and “whole body” monitoring requirements
- Risks with radioactive material and radiation-producing devices unique to the site
- ALARA work principles and techniques
- Understanding the requirements for and compliance with RWPs including protocol for dosimetry and personal protective equipment (PPE)
- Radiation exposure reduction techniques for the embryo/fetus
- Completion of applicable training and exposure monitoring documentation
- Notification of contacts as needed to complete training requirements

3.5.3 Radiological Control Technician Training Qualification

As coordinated between the RSO and RSOR, TtEC will evaluate and ensure acceptable qualification of RCTs. When selected for project assignment, RCT qualifications are evaluated between the RSO and RSOR in accordance with the requirements detailed in RML No. 29-31396-01 and No. 7909-01. Project-specific training is provided to RCTs commensurate with anticipated duties and assignments.

3.6 DECLARED PREGNANT FEMALE WORKER

To maintain embryo/fetus radiation exposure ALARA, female employees who are pregnant or attempting to become pregnant are encouraged to declare this information to project management in writing to allow for criteria to be exercised as detailed in:

- 10 CFR 20.1208, Dose Equivalent to an Embryo/Fetus
- NRC Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure, Revision 3, Washington, DC (NRC 1999)
- NRC Regulatory Guide 8.29, Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1, Washington, DC (NRC 1996)

Because of the small anticipated annual dose for workers associated with project activities (i.e., less than 10 millirem/year) it is unlikely in instances of pregnancy that separate dose tracking for the embryo/fetus will be necessary. Managing occupational exposures for all staff within annual TtEC administrative TEDE guidelines is expected to satisfy the requirement of less than 500 millirem total dose for any declared pregnant female worker over the course of an entire gestation period.

3.7 AS LOW AS REASONABLY ACHIEVABLE PROGRAM

TtEC is committed to maintaining radiation exposure to workers and the public as far below company guidelines and regulatory limits as practical. RPP requirements are established for field operations in an effort to meet that commitment in accordance with the current version of corporate procedure NLP-01, ALARA Program.

3.8 EXTERNAL EXPOSURE CONTROL

The following steps will be taken to control external radiation exposure to levels that are ALARA:

- Employ basic dose reduction strategies as detailed in corporate procedures and site-specific SOPs using the ALARA concepts of time, distance, and shielding.
- Use instruments at frequencies sufficient to accurately determine the level and extent of radiation fields.
- Present adequate staff training to ensure the ability to recognize situations involving objects that might be radioactive, to be wary of objects that are unfamiliar, and to rely on valid instrument readings to limit and safely manage external exposure.

3.9 INTERNAL EXPOSURE CONTROL

Internal exposure is expected to be below all the recognized DAC values as specified in 10 CFR 20. Should the potential for internal dose be confirmed during fieldwork (e.g., due to the nature of the planned activity such as remediation efforts), the activity will be temporarily suspended and the work area secured pending determination and use of corrective protocol as decided among the RSO, RSOR, and PjM.

3.10 MONITORING AND MEASURING EXTERNAL EXPOSURE

A vendor accredited by the National Voluntary Laboratory Accreditation Program will be used to provide project-related dosimetry services. Dosimetry applications and considerations will apply to field staff designated as radiation workers (i.e., personnel needing unescorted access to impacted site locations subject to radiological control). Prior to dosimetry issue, a radiation worker will have satisfactorily completed requirements as detailed in Section 3.5.2.

3.11 MONITORING AND MEASURING INTERNAL EXPOSURE

The monitoring of work practices conducted in areas of radiological concern will be coordinated among the RCTs, RTSs, and members of project management designated as radiation workers using frequencies necessary to confirm the application of correct techniques and PPE to minimize potential transfer of external contaminants inside the body.

Air sampling will be performed during intrusive activities conducted in areas of radiological concern. Air sample results will be reviewed and tracked among the RSO, RSOR, RTS, and designated RCTs to determine whether trends (e.g., concentrations greater than 10 percent of DAC) exist that require work stoppage and/or re-engineering of task-specific contamination controls.

3.12 SURVEYS AND MONITORING

A project-based summary of historic survey and monitoring information is typically available in site-specific documentation (e.g., an HRA manual or Basewide Radiological Work Plan). Protection of workers, the public, and the environment depends on accurate assessment and interpretation of past historic information as compared to present-day survey data collected in accordance with prescribed procedures and project support documents.

In situations subject to this RPP, guidance for determining survey frequency and technique is detailed in applicable portions of corporate procedures NLP-04, Radiological Entry Control Program, NLP-05, Radioactive Contamination Control, and RPG 2-9, Radiological Surveys and Operational Checks. Further detail is contained in SOP-001, Radiation and Contamination Surveys, SOP-002, Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use, and SOP-006, Sampling Procedures for Radiological Surveys.

3.12.1 Surveys of Equipment and Materials

Equipment and material passing through areas controlled for radiological concern will be subject to survey criteria and techniques detailed in applicable portions of corporate procedure NLP-05, Radioactive Contamination Control. Further detail is contained in SOP-003, Release of Materials and Equipment from Radiologically Controlled Areas, and SOP-007, Decontamination of Equipment and Tools.

3.13 ACTION LEVELS

Action levels represent transition points at which concentrations of radioactivity require additional response and/or investigation (e.g., PPE upgrades or increased work technique controls). Action levels for radiological controls are detailed in corporate procedure NLP-01, ALARA Program, and NLP-04, Radiological Entry Control Program. Further detail is contained in SOP-010, Issue and Use of Radiation Work Permits, and SOP-012, Radiologically Controlled Area Posting and Access Control.

3.14 RADIOLOGICALLY CONTROLLED AREAS AND POSTING

Site structures, outdoor locations, and/or perimeter boundaries posted with yellow and magenta markings are established to identify areas designated for radiological control, prevent (to the extent practical) access by unauthorized persons, and protect members of the public from exposure to radiation. A description of scenarios and postings employed for control purposes are detailed in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program. Further detail is contained in SOP-012, Radiologically Controlled Area Posting and Access Control.

3.14.1 Controlled Area

A Controlled Area may be established where access to impacted portions of a work site requires specialized qualification and approval. A Controlled Area (which may also be called a Restricted Area) is intended to serve as the outermost boundary around planned and established work zones.

Controlled Area access requires prior authorization and use of PPE as defined in a project specific APP/SSHP. Visitors must have requisite training as specified in an SSHP. Personnel who enter a Controlled Area may not cross into more restrictive areas posted within unless prior authorization is obtained.

Where the perimeter to a Controlled Area is first encountered for radiological purposes, posting applications will have the wording “Caution Controlled Area” (or Restricted Area) and provide a contact phone number. (Supplemental information as specified by the RSOR or designee may also be included as magenta [preferred], purple, or black markings on a yellow [preferred] or white background). A minimum of one sign will be posted on each straight run of the Controlled Area (or Restricted Area) boundary. Note that areas not typically accessed by pedestrians (e.g., windows) need not be posted. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.14.2 Access Control Point

When used, an Access Control Point is part of a Controlled Area (or Restricted Area) boundary. Intended to serve as a transition corridor, an Access Control Point allows for the accountability of personnel, tools, and equipment that pass through. When established as a radiological control mechanism, an Access Control Point RCT will be present any time activities within are ongoing. During periods of inactivity, control point gates (part of the contiguous area boundary) are closed and locked.

3.14.3 Radiologically Controlled Area

A Radiologically Controlled Area (RCA) represents an area in which a person who works for 1 year might receive a whole body dose in excess of 100 millirem from all pathways (excluding natural background and medical exposures). For external sources, the RCA is typically posted when the dose rate at 30 centimeters exceeds 50 microrem per hour, although this may be modified at the discretion of the license RSO based on accurately assessed occupancy factors. Intended to include (for posting purposes) the nearest boundary or perimeter associated with the affected area, RCA restrictions and corresponding access protocol can be located in site-specific documentation (e.g., Hunters Point Naval Shipyard Action Memorandum) and authorized by the RSO for use if more restrictive.

When used, a minimum of one sign will be posted on each straight run of the RCA boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary. For waterfront areas, signs should be posted at areas accessible by watercraft.

3.14.4 Radioactive Materials Area

A Radioactive Materials Area (RMA) identifies any area or room in which there is used or stored an amount of licensed material exceeding 10 times the quantity of such material specified in Appendix C, Title 10 Part 20 of the CFR. Intended to warn of the potential for occupational dose, a description of RMA scenarios and postings employed for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-012, Radiologically Controlled Area Posting and Access Control. When used, a minimum of one sign will be posted on each straight run of the RMA boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.14.5 Contaminated Area

A Contaminated Area is any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors (AEC 1974), but do not exceed 100 times those values. Contamination is radioactive material that is deposited on a surface where it is unwanted. Subject to license control, a description of Contaminated Area scenarios and postings employed for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-012, Radiologically Controlled Area Posting and Access Control. When used, a minimum of one sign will be posted on each straight run of the RCA boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.14.6 High Contamination Area

A High Contamination Area is any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Regulatory Guide 1.86 (AEC 1974). When used, a minimum of one sign will

be posted on each straight run of the High Contamination Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.14.7 Radiation Area

A Radiation Area means any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates. A description of Radiation Area scenarios and postings employed for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-012, Radiologically Controlled Area Posting and Access Control. When used, a minimum of one sign will be posted on each straight run of the Radiation Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.14.8 High Radiation Area

A High Radiation Area means any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. A description of High Radiation Area scenarios and postings employed for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-012, Radiologically Controlled Area Posting and Access Control.

When used, a minimum of one sign will be posted on each straight run of the High Radiation Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.14.9 Airborne Radioactivity Area

An Airborne Radioactivity Area is a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations:

- In excess of the DACs specified in Appendix B to 10 CFR 20.1001–20.2401, or
- To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake or 12 DAC hours

As an example, for ^{226}Ra, the most likely airborne contaminant at Navy radiological remediation projects, the applicable DAC value is 3.0E-10 microcuries/milliliter. A description of Airborne Radioactivity Area scenarios and postings employed for control purposes can be located in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-012, Radiologically Controlled Area Posting and Access Control. When used, a minimum of one sign will be posted on each straight run of the Airborne Radioactivity Area boundary. Additional signs should be placed at approximately 30-meter intervals on long runs of any boundary.

3.15 CONTAMINATION CONTROL

Contamination control practices are established to preclude the spread of contaminants into uncontrolled areas. Recognized applications are detailed in corporate procedure NLP-05, Radioactive Contamination Control; SOP-001, Radiation and Contamination Surveys; SOP-003, Release of Materials and Equipment from Radiologically Controlled Areas; SOP-007, Decontamination of Equipment and Tools; and SOP-008, Control of Radioactive Material.

3.15.1 Physical Boundary

A physical boundary will be established using criteria referenced in Section 3.14.4 to fully enclose a location established as a Contaminated Area.

3.15.2 Entry

Entry into a Contaminated Area will be compliant with pre-established requirements as detailed on a job-specific RWP. In such instances, an RCT will be present to assist in radiological control and support. (See Section 3.17.1 for details related to RWP use.)

3.15.3 Exit

Exit from a Contaminated Area will be compliant with pre-established requirements as detailed on a job-specific RWP. In such instances, an RCT will be present to assist in radiological control and support. (See Section 3.17.1 for details related to RWP use.)

3.15.4 Limitations on Entry

Personnel with open wounds or sores are not generally granted access into a Contaminated Area. Entry may be authorized by the RSOR or designee, on a case-by-case basis, if appropriate protection of the wound or sore is verified, planned work activities are unlikely to compromise the protection, and there is no other medical reason to restrict entry.

Jewelry and personal items are not allowed in Contaminated Areas; only project furnished tools, materials, and equipment necessary to accomplish the planned task are acceptable. Container wrappings, packing, and similar materials must be segregated from essential items prior to entry.

3.15.5 Control of Items

Items such as equipment and tools to be removed from a Contaminated Area must meet unconditional release criteria as detailed in applicable portions of corporate procedure NLP-05, Radioactive Contamination Control, and SOP-003, Release of Materials and Equipment from Radiologically Controlled Areas.

3.16 INSTRUMENTATION

As detailed in SOP-002, Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use, field survey instruments will be calibrated annually at a minimum in accordance with the manufacturers' specifications. Instruments will be removed from service on or before calibration due dates and returned to the supplier for recalibration.

3.17 CONTROL OF RADIOLOGICAL WORK

All radiological work activities will be planned in consultation with the RSOR, the PjM, and other project personnel tasked with oversight responsibilities. Work performed in areas of radiological concern require establishment of an RWP, which details radiologically based requirements and protective measures.

3.17.1 Radiation Work Permits

RWPs detail the protective measures and controls needed to perform tasks in areas of radiological concern. Information considered during RWP development is detailed in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-010, Issue and Use of Radiation Work Permits.

3.17.2 Task-specific Work Instructions

Task-specific WIs are used to supplement RWP requirements and address in greater detail corresponding activities planned while personnel are inside areas of radiological concern. These instructions are required for tasks scheduled to occur in locations as determined by the PjM, RSO, RSOR, or the Construction Manager. The RSO or designee will finalize, control, and issue radiologically based WIs.

3.18 CREDENTIALING OF STAFF

Qualification and training requirements for RCTs are provided in RML No. 29-31396-01, No. 7909-01, and as detailed in applicable portions of corporate procedure RPG 2-5, Radiation Safety Training. The RSO verifies qualifications and conducts required license-specific training with any RSOR designated on the license as an authorized user.

To supplement and validate the correct use and implementation of this RPP and RML No. 29-31396-01 and No. 7909-01, a Health Physicist certified by the American Board of Health Physicists provides support to active field projects.

3.19 PROCUREMENT, RECEIPT, AND INVENTORY OF SEALED RADIOACTIVE SOURCES

It is not anticipated that field projects will receive radioactive material shipments other than exempt-quantity radioactive check sources. As detailed in corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control, check sources are controlled, stored, posted, and managed as radioactive material.

3.19.1 Leak Testing

Radioactive sealed sources with quantities exceeding the licensable threshold will be leak-tested as detailed in applicable portions of corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control.

3.19.2 Transport of Sources

Check sources will be used on field projects only for the period of time necessary to execute planned work, will not be introduced onto a project location prior to project initiation, and will be returned to the provider immediately following the completion of planned field activities.

Check sources will be maintained as detailed in applicable portions of corporate procedures NLP-02, Radioactive Material Accountability, NLP-03, Sealed Radioactive Source Control, and SOP-008, Control of Radioactive Material.

3.19.3 Reporting Lost, Damaged, or Stolen Sources

As detailed in applicable portions of corporate procedures NLP-02, Radioactive Material Accountability, and NLP-03, Sealed Radioactive Source Control, if a check source is lost, damaged, or stolen, the event will be reported immediately to the RSOR or designee. The RSOR will immediately notify the RSO, the PjM, and the client (i.e., the Navy) and initiate appropriate recovery actions. In consultation with the client, a report will be filed by the RSO or designee with the appropriate law enforcement agency if it is determined that radioactive material was stolen. The RSO will make any necessary notifications to the NRC and/or CDPH.

3.20 SHIPPING AND TRANSPORTATION OF RADIOACTIVE MATERIALS

Off-site shipment of radioactive materials other than exempt-quantity radioactive check sources by TtEC is not anticipated. Information pertinent to an authorized shipper for a field project is provided in Section 6.0.

3.21 CONTROL OF RADIOACTIVE WASTE

Radioactive waste will be minimized by compliance with contamination control practices (Section 3.15) combined with segregation and survey practices. A waste shipment provider contracted to the client (e.g., the Navy through the Army Joint Munitions Command) will provide brokerage services including waste characterization sampling, waste containers, and transportation of radioactive materials/waste generated from a field project. Soil and used PPE will typically be processed for final disposition in disposal bins, or other appropriate container. When filled, containers will be transferred to the custody and control of the authorized shipper. As detailed in corporate procedure NLP-02, Radioactive Material Accountability, commodities are stored in a locked radioactive materials storage area, controlled by the RSOR or designee, and will periodically be packaged and transferred to the authorized shipper for disposal. Radioactive material will be packaged, stored, shipped, and disposed of as required by U.S. Department of Transportation (DOT) regulations.

3.22 RADIATION PROTECTION RECORDS

As detailed in the applicable portions of corporate procedure NLP-07, Radiological Protection Records, and SOP-004, Radiological Records, the RSO or designee is responsible for ensuring that airborne monitoring, contamination surveys, and exposure/dose rate surveys are reviewed for

accuracy and completeness as an on-going process. Individual exposure records including dosimetry and bioassay reports for personnel are reviewed for results as generated.

3.23 REPORTS AND NOTIFICATIONS

Workers who have previous occupational work history with radiological environments will supply the RSO or designee with prior estimated or reported dose histories on an NRC Form 4 or equivalent as defined in 10 CFR 20.2104.

Records of radiation exposures to workers who have been issued external dosimetry monitoring devices will be maintained. Dosimetry monitoring results for workers will be reported to the RSO annually at a minimum. Annual occupational exposure greater than or equal to 100 millirem for the previous calendar year, or otherwise when requested, requires a summary of individual exposure to be reported to the employee monitored.

3.24 LICENSES

Entities subject to the use of this RPP will conduct radiological-based tasks with use of TtEC RML No. 29-31396-01 and No. 7909-01. TtEC will ensure that the Radiological Control Program and work practices are implemented and performed in accordance with the RML requirements and the RPP. (Any client-designated waste shipment provider may implement their RML to conduct waste characterization sampling of waste material in support of low-level radioactive waste shipment and disposal. An MOU between TtEC and a waste shipment provider will be developed, identifying interfaces and commitments for the transfer of radioactive materials. Active MOUs will be maintained by the RSO or designee.)

3.25 REVIEW AND APPROVALS OF RADIATION PROTECTION PLANS

The RSO or designee will prepare the RPP, which will then be reviewed for approval with subject matter experts (e.g., the PjM, RSOR). In addition, the client (i.e., the Navy) will have an opportunity to review the draft content, provide input, and indicate acceptance of the plan. Changes to the RPP will be reviewed and accepted following the same process.

3.26 PLANNED SPECIAL EXPOSURES

No anticipated event within work scopes subject to this RPP will require use of a planned special exposure. In the event it is necessary to initiate such a need, an activity-specific WI including a formal ALARA review and an RWP will be prepared and submitted for acceptance following the same process as the RPP submittal in Section 3.24.

4.0 PERSONAL PROTECTIVE EQUIPMENT

Minimum PPE requirements based on chemical contaminants are established by the Health and Safety Manager (in a project-/task-specific APP/SSHP). This primary level of PPE, Modified Level D, is historically sufficient for radiological work activities and is supplemented by activity-specific RWPs based on the radiological conditions and field tasks required to perform planned activities. Information considered for PPE during RWP development is detailed in applicable portions of corporate procedure NLP-04, Radiological Entry Control Program, and SOP-012, Radiologically Controlled Areas Posting and Access Control.

4.1 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT

Personnel must wear PPE commensurate with contamination hazards associated with both the work area and the planned activity as detailed in SOP-005, Radiological Protective Clothing Selection, Monitoring, and Decontamination. Activities that require heavy physical effort or that have an increased potential for damage to PPE may require additional layers or different PPE materials, even in areas of low contamination. Site- or task-specific PPE requirements beyond the minimum traditionally used will be detailed in a corresponding RWP.

4.2 DONNING AND DOFFING PPE

To prevent contamination of personnel or the spread of contamination, PPE must be donned and doffed in a specific manner. Directions for donning and doffing standard PPE ensembles are provided in the applicable sections of corporate procedure NLP-05, Radioactive Contamination Control, and SOP-005, Radiological Protective Clothing Selection, Monitoring, and Decontamination. Additional instructions for non-standard site- or task-specific PPE requirements will be provided in the applicable RWP.

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5.0 DECONTAMINATION PROCEDURES

Following details identified in applicable portions of corporate procedure NLP-05, Radioactive Contamination Control; SOP-005, Radiological Protective Clothing Selection, Monitoring and Decontamination; and SOP-007, Decontamination of Equipment and Tools, decontamination will be performed at a dedicated location (e.g., decontamination pad, room).

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6.0 SHIPPING AND TRANSPORTATION OF RADIOACTIVE MATERIALS

Field projects subject to the use of this RPP will conduct radiological-based activities with use of RML No. 29-31396-01 and No. 7909-01. The client-designated waste shipment provider associated with a field project may implement their RML to conduct waste characterization sampling of waste material in support of low-level radioactive waste shipment and disposal. An MOU between TtEC and a waste shipment provider will be used, identifying interfaces and commitments for the transfer of radioactive materials. In such instances, a current MOU will be maintained by the project RSOR for projects subject to the requirements of the RPP.

Environmental samples shipped for off-site analysis and exempt-quantity radioactive check sources are packaged and shipped in accordance with DOT regulations via commercial carriers.

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7.0 REFERENCES

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——————. Title 29, Part 1910, Occupational Safety and Health Standards, U.S. Government Printing Office, Washington, DC, July 1, 2003, <http://www.gpoaccess.gov/cfr/index.html>, May 2007.

NRC (U.S. Nuclear Regulatory Commission). 1996. Regulatory Guide 8.29, Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1, Washington, DC. February.

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APPENDIX A

RADIATION PROTECTION PLAN ACKNOWLEDGMENT FORM

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Radiation Protection Plan Acknowledgment Form

I have reviewed, understand, and agree to follow the Radiation Protection Plan for the Hunters Point Naval Shipyard project. Additionally, I understand that there are additional nonradiological health and safety requirements, which are presented in the Site Safety and Health Plan. I agree to abide by the requirements of the Radiation Protection Plan for the work that I will perform.

Printed Name	Signature	Representing	Date

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ATTACHMENT 2

BASEWIDE RADIOLOGICAL MANAGEMENT PLAN

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Base Realignment and Closure
Program Management Office West
33000 Nixie Way, Bldg. 50
San Diego, California 92147

CONTRACT NO. N62473-13-D-4808
CTO NO. 0003

ATTACHMENT 2

FINAL

BASEWIDE RADIOLOGICAL MANAGEMENT PLAN
August 2015

BASEWIDE RADIOLOGICAL SUPPORT
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

DCN: ECSD-4808-0003-0003

Prepared by

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Steven Adams, CHP
Corporate Radiation Safety Manager

August 6, 2015
Date

Shanti Montgomery
TtEC Project Manager

August 6, 2015
Date

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ABBREVIATIONS AND ACRONYMS

μR/hr	microroentgens per hour
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
APP	Accident Prevention Plan
BRAC	Base Realignment and Closure
cm^2	square centimeter
cpm	counts per minute
CTO	Contract Task Order
DAC	derived air concentration
DoD	Department of Defense
DON	Department of the Navy
dpm	disintegrations per minute
DQO	data quality objective
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
G-RAM	general radioactive material
HPNS	Hunters Point Naval Shipyard
HRA	Historical Radiological Assessment
ISO	International Organization for Standardization
LLRW	low-level radioactive waste
m	meter
m^2	square meter
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
$MDCR_{SURVEYOR}$	MDCR calculated assuming a surveyor efficiency
MDER	minimum detectable exposure rate
MeV	megaelectron volt
min	minute

ABBREVIATIONS AND ACRONYMS
(Continued)

NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NRDL	Naval Radiological Defense Laboratory
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/mL	picocuries per milliliter
PMO	Program Management Office
PPE	personal protective equipment
QC	quality control
^{226}Ra	radium-226
RCA	Radiological Control Area
RASO	Radiological Affairs Support Office
RCT	Radiological Control Technician
RML	Radioactive Materials License
RPM	Remedial Project Manager
RPP	Radiation Protection Plan
RSO	Radiation Safety Officer
RSOR	Radiation Safety Office Representative
RTS	Radiological Task Supervisor
RWP	Radiation Work Permit
SFRA	San Francisco Redevelopment Agency
SOP	Standard Operating Procedure
^{90}Sr	strontium-90
SSHP	Site Safety and Health Plan
TtEC	Tetra Tech EC, Inc.
UC	Utility Corridor
WI	Work Instruction

1.0 INTRODUCTION

This Basewide Radiological Management Plan (Management Plan) describes survey procedures and methodologies that will be implemented as part of the radiological basewide support activities at the former Hunters Point Naval Shipyard (HPNS), San Francisco, California. Tetra Tech EC, Inc. (TtEC) was contracted by the Department of the Navy (DON) to prepare this Management Plan for the Base Realignment and Closure (BRAC) Program Management Office (PMO) West under Naval Facilities Engineering Command Southwest. This Management Plan is an attachment to, and will be used in conjunction with, the Work Plan for Basewide Radiological Support, Hunters Point Naval Shipyard, San Francisco, California (Basewide Work Plan).

A basic concept in radiation protection is that exposures to ionizing radiation and releases of radioactive material should be managed to reduce doses to workers and the public, and ensure that exposure is as low as reasonably achievable (ALARA). The ALARA principle will be applied during the course of the radiological work carried out under the Management Plan for survey activities at HPNS.

The objective of this Management Plan is to provide the radiological procedures and methodologies for:

- Evaluating impacted material, equipment, and other items that may contain residual radioactivity above the release criteria as a result work activities within impacted areas of HPNS.
- Providing radiation protection to contractors conducting work within impacted areas of HPNS. Radiation protection activities may include radiation safety training, personnel surveys, and radiological monitoring of work activities.
- Releasing material and equipment from TtEC-controlled radiological control areas (RCAs).
- Removing identified radioactive contamination.
- Confirming that the release criteria have been met.

The radiological activities that support the objective of the Management Plan include:

- Reference (background) surveys
- Personnel surveys
- Equipment and material surveys
- Surveys of truckloads of dispersible material for unconditional release
- Decontamination and dismantling

Work activities will be performed in accordance with this Management Plan and the Standard Operating Procedures (SOPs) and applicable WIs presented in the project-specific Work Plan. Table 1-1 lists each of the TtEC field SOPs developed for performing radiological work at HPNS. Copies of the SOPs as well as WIs are available in the TtEC offices at HPNS and can be provided to the DON and/or regulatory agencies for review upon request.

This Management Plan is organized as follows:

- **Section 1.0 Introduction** – Section 1.0 provides an overview of the project scope, work objectives, and organization of the Management Plan.
- **Section 2.0 Background** – Section 2.0 describes HPNS, provides a historical summary of the shipyard, and includes an overview of the radiological history of HPNS, including impacted sites.
- **Section 3.0 Key Radiological Personnel and Work Control Procedures** – Section 3.0 discusses the project organization, roles and responsibilities of key project personnel, personnel qualifications, and work control activities.
- **Section 4.0 Radiological Survey Types** – Section 4.0 identifies the types of surveys that will be conducted.
- **Section 5.0 Release Criteria and Investigation Levels** – Section 5.0 identifies the criteria for radiological release for unrestricted use.
- **Section 6.0 Instrumentation** – Section 6.0 identifies field instrumentation that will be used to perform surveys.
- **Section 870 Survey Implementation** – Section 7.0 presents the approach to implementing surveys that will be conducted as well as associated sampling activities.
- **Section 8.0 Decontamination, Dismantling, and Disposition** – Section 8.0 discusses the surveys and follow-up activities that will be implemented in response to surveys of materials and equipment contaminated by radiation above release limits.
- **Section 9.0 Radioactive Materials Management** – Section 9.0 describes how radioactive materials will be managed, including control of samples, work areas, and wastes.
- **Section 10.0 Documentation and Records Management** – Section 10.0 presents procedures that will be used to manage records/documentation, as well as to assess, interpret, and report data.
- Secti**on 11.0 References** – Section 11.0 presents references cited in this Management Plan.

2.0 BACKGROUND

The following sections provide the location and description, a general site history, and a brief radiological history of HPNS.

2.1 HUNTERS POINT NAVAL SHIPYARD LOCATION AND DESCRIPTION

HPNS is located in the southeastern part of San Francisco on a long promontory that extends east into San Francisco Bay. Presently, HPNS encompasses approximately 866 acres, including approximately 420 acres on land. The land portion of HPNS was purchased by the DON in 1939 and leased to Bethlehem Steel Corporation. At the start of World War II in 1941, the DON took possession of the property and operated it as a shipbuilding, repair, and maintenance facility until 1974 when the DON deactivated HPNS. From 1976 to 1986, the DON leased HPNS to Triple A Machine Shop, Inc. (Triple A), a private ship repair company. In 1986, Triple A ceased operations and the DON resumed occupancy through 1989. In 1991, HPNS was placed on the DON's BRAC list, and its mission as a DON shipyard ended in April 1994.

A 1998 BRAC decision requires full closure and cleanup of HPNS. Essentially, this may entail removal of buildings and structures, including subsurface systems, as well as removal of contaminated materials. HPNS was divided into 13 parcels, A, B-1, B-2, C, D-1, D-2, E, E-2, F, G, UC1, UC2, and UC3. Parcel A, consisting of the most inland 75 acres, was transferred to the San Francisco Redevelopment Agency (SFRA) in 2004. The remainder of HPNS will be conveyed to the SFRA once the environmental cleanup is complete.

2.2 GENERAL SITE HISTORY

Commercial shipyard activity has taken place on the Hunters Point peninsula since 1868 when the first dry dock on the Pacific Coast was constructed there. By 1939, two dry docks and associated support facilities were located on Hunters Point. The DON purchased the dry docks and surrounding land from Bethlehem Steel in 1939 and occupied the site in late 1941, creating HPNS. After a significant expansion and buildup during World War II (including the construction of four additional dry docks), the shipyard diversified as a major fleet support center performing ship repair throughout the Korean Conflict. The shipyard operated as a general repair facility specializing in submarines, aircraft carrier overhaul, and ship repair operations through the early 1970s. The workload consisted primarily of the repair and conversion of conventionally powered ships, repair of diesel submarines, and non-radiological work on nuclear-powered ships.

The DON deactivated HPNS in 1974 and most of the site was then leased to a commercial ship repair company, Triple A, from 1976 to 1986. Triple A dedicated more than 80 percent of the shipyard to the repair of commercial and naval vessels and subleased unused facilities to private warehousing, industrial, and commercial firms. In 1986, the DON again assumed control of the shipyard and used it for the docking and repair of several DON surface ships.

In 1991, HPNS was selected for closure pursuant to the terms of the Defense Base Closure and Realignment Act of 1990. The property will be transferred to the City and County of San Francisco for non-defense use. Closure activities at HPNS involve environmental remediation activities to make the property suitable for transfer. Currently, BRAC PMO manages the HPNS property. Routine access to the property is controlled by the SFRA under an agreement with the DON.

Hazardous materials are present at HPNS because of previous shipyard operations. Investigation and cleanup of contamination at HPNS by the DON has been underway since the 1980s. In 1989, the U.S. Environmental Protection Agency (EPA) placed HPNS on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986.

2.3 RADIOLOGICAL HISTORY

As part of the environmental investigations being performed to facilitate transfer of HPNS, the Naval Sea Systems Command prepared a Historical Radiological Assessment (HRA) that documents the history of radiological materials at HPNS. The HRA is presented in two volumes. Volume I (NAVSEA 2000) addressed radioactivity associated with the Naval Nuclear Propulsion Program and concluded that berthing of nuclear-powered ships at HPNS or work done on these ships resulted in no adverse effects on the human population or the environment. Volume II (NAVSEA 2004) presented the history of general radioactive material (G-RAM) at HPNS in three primary operational areas:

- Use of G-RAM at HPNS by the naval shipyard and Triple A
- Decontamination activities associated with ships that participated in atomic weapons testing including OPERATION CROSSROADS
- Radiological activities associated with the Radiation Safety Section/Radiation Laboratory/Navy Radiological Defense Laboratory (NRDL)

Volume II (NAVSEA 2004) concluded that areas of known or potential radiological contamination are present at HPNS and identified additional investigation and/or cleanup activities to support transfer and reuse. This Management Plan was prepared to address the recommendations presented in Volume II of the HRA.

According to the HRA (NAVSEA 2004), devices incorporating radioluminescent radium paint came into wide use in the Navy beginning in the late 1930s. These devices constituted the first G-RAM introduced to HPNS. Other G-RAM used at HPNS as part of routine shipyard activities included:

- Other radioluminescent devices
- Gamma sources for gamma radiography
- Sources for calibrating radiation-detection instruments
- Materials found in items such as smoke detectors, welding rods, and night vision equipment

The use and/or handling of these materials may have resulted in radiological contamination at HPNS.

Some of the ships that participated in atomic weapons testing, including OPERATION CROSSROADS, were brought to HPNS for decontamination. OPERATION CROSSROADS involved detonating two atomic bombs at Bikini Atoll in July 1946. During these tests, a number of ships at the atoll became contaminated with radioactive materials. The DON concluded that a shipyard environment would be needed to decontaminate many of these ships, and HPNS was selected as the principal location for this activity. Consequently, contaminated ships were involved in experimental decontamination efforts at HPNS. Decontamination of these ships and ships involved in other atomic weapons testing was conducted by mechanical methods, such as scraping or sandblasting, and/or chemical methods, such as acid washing. Decontamination activities and/or the associated waste disposal may have resulted in radiological contamination at HPNS.

In 1946, the DON created an organization tasked with applying radiological safety throughout the Navy. Initially known as the Radiological Safety Section, this unit was briefly renamed the Radiation Laboratory and ultimately became the NRDL in 1948. The unit was established at HPNS with the original mission of supporting the decontamination efforts on OPERATION CROSSROADS ships. By the time the unit became the NRDL, the mission had expanded to include the study of nuclear weapons effects and development of methods for the protection of DON personnel and ships. From the 1950s until 1969 when it was closed, NRDL was recognized as a leading radiological research facility. The research performed by NRDL included the use of a large number of radionuclides. The use of these materials and the disposal of wastes generated during research activities may have resulted in radiological contamination at HPNS.

An “impacted site” is defined as one that has a potential for radioactive contamination based on historical information or is known to have radioactive contamination. An impacted site does not mean the radionuclide concentrations at the site exceeds the release criteria. Based on the review of historical radiological operations at HPNS, the HRA concluded that 91 sites were impacted.

The HRA (NAVSEA 2004) recommended 56 sites at HPNS for further investigation and remediation by the DON. However, since publication of the HRA, the DON has also identified several additional sites that require investigation. These include buildings, dry docks, former building sites, outdoor areas, Installation Restoration Program sites, ships’ berths, the Gun Mole Pier, and the storm drain and sanitary sewer systems. Specific recommendations for surveys and/or cleanup at each of the 56 areas were presented in the HRA. Additional sites will be characterized in accordance with the Management Plan. As appropriate, individual, location-specific, or stand-alone work plans may be prepared for these sites and will supersede this Management Plan.

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3.0 KEY RADIOLOGICAL PERSONNEL AND WORK CONTROL PROCEDURES

This section describes the responsibilities of key personnel necessary for management of radiological activities at HPNS. In addition, this section identifies the minimum training requirements for workers at HPNS and work control procedures including Work Instructions (WIs), Radiation Work Permits (RWPs), and radiological notifications.

3.1 KEY RADIOLOGICAL PERSONNEL

Specific personnel are essential in performing radiological activities at HPNS. Qualified and experienced personnel will fulfill the necessary functions to ensure the consistent and successful implementation of radiological work activities at HPNS. All key radiological personnel are expected to have the requisite skills necessary to perform these functions. The key radiological personnel include the following.

3.1.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for implementing and directing all radiological project-related activities. The RSO has the responsibility and authority to perform the following:

- Provide oversight of implementation and ensuring compliance with the NRC Radioactive Materials License (RML) Number 29-31396-01, and/or CA RML Number 7909-01.
- Serve as contact for announced NRC site inspections.
- Assist DON representatives during announced site audits.
- Maintain, revise, review, and approve changes to SOPs.
- Provide technical assistance in the development and implementation of project surveys.
- Define the dosimetry program for all site workers entering radiologically controlled areas.
- Define radiological controls.
- Identify radiological analysis needs.
- Provide health physics guidance on an as-needed basis.
- Provide radiological control protection services, if required.
- Assist the Radiation Safety Officer Representative (RSOR) to determine if an external dose is to be assigned to an individual who reported lost or damaged dosimetry devices.
- Review all changes to the Waste Characterization Sample Collection Procedures (Appendix A, Basewide Work Plan) to ensure radiological requirements are met.
- Ensure that the required radiological safety training is provided.

- Review and approve SOPs and authorized Work Control Documents associated with the handling of radioactive materials or access to radiological areas.
- Ensure timely and thorough review of records, in accordance with corporate SOP NLP-07, Radiological Records, and SOP 004 prior to approval.
- Approve records with verifiable signature and date once records meet the quality standards as described in corporate SOP NLP-07, Radiological Records and SOP 004.
- Conduct radiation incident investigations.
- Conduct radiological inspections.
- Conduct data assessments and evaluations.
- Conduct annual radiological audits in accordance with the NRC RML Number 29-31396-01.

3.1.2 Radiation Safety Officer Representative

The RSOR will report to the RSO and will perform on-site duties as designated by the RSO. In accordance with DON requirements, the RSOR is the RSO's on-site designee during radiological work activities conducted under this Management Plan. The RSOR has the responsibility and authority to perform the following:

- Implement, direct, and supervise on-site radiological activities
- Create, modify, and terminate Radiation Work Permits (RWPs)
- Ensure the radiological conditions stated in the RWP are correct; the PPE requirements, if any, are sufficiently protective of workers; and the controls and monitoring of radioactive materials described in the RWP will ensure the worker exposure and dose will be ALARA
- Perform the post-job radiological conditions and closeout review of RWPs
- Control exposure conditions for site workers
- Implement the approved dosimetry program for all site workers entering radiologically controlled areas
- Enforce radiological controls
- Coordinate radiological activities with other NRC or Agreement State-licensed contractors in areas controlled by TtEC
- Keep the RSO advised of radiological activities with other NRC or Agreement State licensees at TtEC-controlled areas
- Ensure all radiological work activities comply with the requirements of all authorized Work Control Documents, WIs, SOPs, RWPs, and the RML
- Direct and assist radiological personnel in proper completion of radiological records
- Coordinate with unlicensed Navy contractors to provide radiation safety coverage

- Assist the RSO in identifying radiological analysis needs
- Provide health physics guidance
- Assist the RSO in establishment of radiological controls
- Oversee preparation and approval of site-specific radiological work documents and field procedures
- Ensure implementation of approved personnel monitoring requirements
- Assist the RSO in identifying training needs and establishing on-site training programs
- Implement and monitor on-site radiological training programs
- Conduct assessments of field practices and procedures
- Review and approve data from radiological investigations and surveys
- Ensure adequate radiological controls are in place at all work sites
- Ensure that specified radiological safety procedures are followed and that the radiological safety tests and inspections identified in authorized Work Control documents are complete and acceptable
- Conduct daily oversight and field safety inspections and tests required by authorized Work Control documents, e.g., WIs, SOPs, RWPs, and RML
- Attend required meetings, including the pre-construction conference, weekly quality control (QC) meetings, pre- and post-construction site inspections, and other scheduled and unscheduled meetings
- Administer the on-site dosimetry program
- Verify compliance with on-site RWPs and SOPs
- Assist the RSO in reviewing changes to the Waste Characterization Sample Collection Procedures (Appendix A, Basewide Work Plan) to ensure radiological requirements are met
- Approve issuance of any site-specific work document pertaining to radiological safety issues
- Provide surveillance of radiologically related activities
- Assist the RSO in directing the production of radiological work documents and reports
- Confer with radiological personnel to provide technical advice and to resolve problems
- Prepare daily project status reports
- Notify the RSO regarding radioactive anomalies

- Manage the storage of radioactive waste in accordance with the authorized Work Control Document, e.g., WIs, SOPs, RWPs, and RML

3.1.3 Radiological Task Supervisor

An RTS, when needed, will direct field survey personnel and health physics operations as assigned by the RSO, RSOR, or designee. The RTS has the responsibility and authority to perform the following:

- Assist the RSOR in overseeing task-specific radiological field activities to ensure compliance with the authorized Work Control Documents, e.g., WIs, SOPs, RWPs, and RML
- Coordinate task-specific activities with the RSOR
- Assist the RSOR in preparing RWPs
- Assist the RSOR in ensuring all field staff are properly trained
- Supervise field staff during performance of survey and decontamination activities, use of survey equipment and instrumentation, and support of other radiological activities
- Assist the RSOR in ensuring compliance with the applicable Work Control Documents, e.g., WIs, SOPs RWPs, and RML.
- Interpret and verify task-specific data accumulated during surveys and monitoring activities

3.1.4 Radiological Control Technicians

Radiological Control Technicians (RCTs) will support projects in the field, and have the responsibility and authority to perform the following:

- Conduct radiological field activities under the direction of the RTS or RSOR, in accordance with authorized Work Control documents, e.g., WIs, SOPs, RWPs, and RML
- Maintain “eyes on” contact with other Navy contractors and subcontractors performing work in RCAs
- Document field survey activities in accordance with the authorized Work Control documents, e.g., Management Plan, WIs, and SOPs, RWPs, and RML
- Release personnel, material, and equipment from RCAs in compliance with authorized Work Control documents, e.g., WIs and SOPs
- Release truckloads of dispersible non-low-level radioactive waste (LLRW) in accordance with authorized Work Control documents, e.g., WIs and SOPs.
- Interpret and verify field data gathered during survey and monitoring activities
- Support dose assessments, and ensure compliance with emergency plans and procedures
- Perform effluent monitoring and radioactive material inventories
- Perform survey equipment response checks, and daily checks of the survey instruments

- Conduct evaluations of health physics survey instruments and field equipment
- Implement RWPs, including being present at active work areas to ensure compliance with authorized Work Control documents, e.g., WIs, SOPs, RWPs, and RML

3.2 MINIMUM TRAINING REQUIREMENTS

The minimum training requirements for personnel working in the field at HPNS include the following:

- Occupational Safety and Health Administration 40-Hour Training and Annual 8-Hour Refresher Training
- Radiation awareness and RWP training
- WI training for the specific site or task
- Activity Hazard Analysis training for the specific site or task
- Training as required in the implemented Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP), and as identified in the project-specific Work Plan

3.3 WORK CONTROL PROCEDURES

Prerequisites for the initiation of survey activities include review of the associated WI, radiological evaluation of the designated work areas, and identification of any potential safety concerns. Work control procedures include the preparation and review of WIs, RWPs, and WIs, and appropriate notifications of anomalies or significant radiological events.

3.3.1 Radiological Health and Safety

SOPs will be used to address controls necessary for radiologically safe operations and referenced as necessary in appropriate WIs. Table 1-1 lists each of the TtEC field SOPs developed for performing radiological work at HPNS. Copies of the SOPs as well as WIs are available in the TtEC offices at HPNS and are available for review by the DON and/or regulatory agencies upon request.

Dose rate, contamination, and air monitoring, including initial baseline sampling to determine radiological background conditions, will be performed as necessary and in accordance with the APP/SSHP included with the approved project-specific Work Plan. Field activities will be performed in accordance with the approved RWP and APP/SSHP as required by the Work Plan. RWPs will be prepared in accordance with the applicable Radiation Protection Plan (RPP) and SOP-010, *Issue and Use of Radiation Work Permits*. Personal protective equipment (PPE) levels dictated by radiological considerations and physical and chemical safety issues identified at each work location will be assigned or modified, according to the approved RWP and APP/SSHP included in the approved project-specific Work Plan and SOP-005, *Radiological Protective Clothing Selection, Monitoring, and Decontamination*. Radiological personnel monitoring records will be prepared, approved, and recorded in accordance with SOP-004, *Radiological Records*.

3.3.2 Task-specific Work Instructions

When unlicensed Navy contractors are required to work within impacted areas of HPNS, radiological WIs may be prepared to facilitate each specific activity. These radiological WIs, when used, will be provided to the BRAC PMO and the RASO for review and approval. Copies of the WIs are available in the TtEC offices at HPNS and can be provided to the DON and/or regulatory agencies for review upon request.

3.3.3 Notifications

During survey activities, radioactive anomalies may be identified and significant radiological events could occur. For the purposes of the Management Plan, an anomaly is described as a radiological survey instrument response that appears to be an outlier in the professional judgment of the RSOR. When an anomaly is identified, the RSOR will notify the RSO and Supervising Project Manager who will notify the BRAC PMO Remediation Project Manager (RPM) and the RASO. If neither the RSO nor the Supervising Project Manager is available, the RSOR will leave a voice mail and confirmatory e-mail describing the anomaly and follow up with a call to the appointed designee, if any.

Significant events include regulatory visits (such as by the NRC or other regulatory agencies), radiological issues, injuries, and breaches in security. All significant events will be disclosed to the RPM and RASO as described above. Any radiological issues will also be reported to the RSO.

4.0 RADIOLOGICAL SURVEY TYPES

Several types of radiological surveys will be conducted at HPNS. Surveys will be used to support the release of materials, equipment, vehicles, and personnel from a radiological work area. This section describes the types of surveys that may be performed at HPNS.

4.1 REFERENCE (BACKGROUND) AREA SURVEY

The reference area is a geographical area or structure from which representative radioactivity measurements are performed for comparison with measurements performed in an impacted area. The reference area selected should have physical, chemical, radiological, and biological characteristics similar to the impacted area(s) being investigated. The reference area must not be identified as impacted by the HRA (NAVSEA 2004). All on-site and off-site locations selected as reference areas will be approved by the RSO or RSOR. The same survey methods and equipment that will be used for conducting a survey in an impacted area will be used for the background area survey. Reference area data will normally be provided to the RSO prior to the start of a survey.

4.2 PERSONNEL SURVEYS

Surveys will be performed on all personnel leaving a radiological area to ensure that individuals are free of radiological contamination as identified in the applicable RPP presented in the project-specific Work Plan. Unlicensed contractors covered by Tetra Tech are specifically trained to work with RCTs in order to never leave a radiological area without a personnel survey.

4.3 EQUIPMENT AND MATERIALS SURVEYS

Before being put into service or leaving a radiological work area, equipment and/or materials will be surveyed in an area of low background radiation levels to ensure that the equipment and materials release criteria are not exceeded, using appropriate SOPs as identified in the project-specific Work Plan.

- Equipment and/or materials being put into service in a radiological work area at HPNS that exceed the release criteria will be returned to the supplier for replacement or decontamination.
- Outgoing equipment and/or materials that do not meet the release criteria will be decontaminated before leaving the radiological work area or stored for disposal.

Figure 4-1 is a decision tree diagram that displays a summary of the process for releasing material and equipment from RCAs.

4.4 VEHICLE SURVEYS

Unconditional release surveys will be performed on all vehicles that enter radiation control areas to ensure that the vehicles are free of radiological contamination as identified in the applicable RPP presented in the project-specific Work Plan. Vehicles will be decontaminated and resurveyed as needed to comply with the unconditional release criteria.

Surveys will be performed on vehicles leaving and arriving at HPNS that are loaded with non-contaminated material as a measure to protect against the inadvertent shipment or receipt of materials exhibiting elevated radiation levels. Surveys of vehicles loaded with dispersible material, e.g., soil, debris, asphalt, and concrete that has been cleared for disposal as non-LLRW by RASO will be conducted per SOP-011, *Gamma Screening of Truckloads Using the Stationary Portal Monitor and Using Portable Survey Instrumentation.* Clearance of the non-LLRW dispersible material requires the following actions.

- Prior to removing any material, the RSOR will confirm documentation has been signed by RASO stating that the material has been cleared for disposal as clean waste.
- The RSOR will accompany the contractor loading the material to ensure the proper stockpiled material is being removed.
- The detector alarm set point will be set as directed by the site RSOR with the concurrence of RASO.
- Trucks should adhere to the required pauses and speed defined in SOP-011 when passing through the detectors. Failure to carefully follow these requirements will result in invalid or incomplete screenings, and will require the screening to be repeated.

5.0 RELEASE CRITERIA

The release criteria for equipment and materials are the same surface concentrations as those listed in Table 1 of Atomic Energy Commission (AEC) Regulatory Guide 1.86 (AEC 1974). Release criteria for soils are taken from the EPA's (risk-based) Preliminary Remediation Goals for two future-use scenarios, or from negotiated agreements with regulators, as specified in the final Basewide Removal Action, Action Memorandum – Revision 2006 (Action Memorandum) (DON 2006). The release criteria for various radionuclides of concern at HPNS are provided in Table 5-1. Limits for atypical materials will be provided in the WIs, which are congruent with the criteria defined in the Action Memorandum.

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6.0 INSTRUMENTATION

Radiation survey instruments will be selected that are suitable for the physical and environmental conditions at the site. The instruments and measurement methods selected will be able to detect the radionuclide of concern or radiation types of interest, and are, in relation to the survey or analytical technique, capable of measuring levels sufficient to support the requirements in the authorized Work Control documents, e.g., WIs and SOPs. Table 6-1 identifies the instrumentation resources available to support the survey objectives.

6.1 FIELD SURVEY INSTRUMENTS

Portable survey instruments will be used to perform measurements in the field. Table 6-1 lists the types of portable survey equipment expected to be used during survey activities at HPNS.

6.1.1 Calibration

Portable survey instrument calibration will be completed on an annual frequency. Instrument calibration will also be performed after repairs or modifications have been performed on the instrument. The instrument will be calibrated in accordance with the manufacturer's recommended method. When the manufacturer does not provide a recommended method, the calibration facility methodology should comply with ANSI N323B-2003 (IEEE 2003) and ANSI N42.17A-2010 (IEEE 2010) *American National Standard for Performance Specifications for Health Physics Instrumentation – Portable Instrumentation for Use in Normal Environmental Conditions* (IEEE 2010).

6.1.2 Daily Performance

Prior to use of the portable survey instruments, calibration verification, physical inspection, battery check, and source-response check will be performed per SOP-002, *Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use*. All portable survey instruments will have a current calibration label that will be verified daily prior to use of the instrument.

Physical inspection of the portable survey instrument will include:

- General physical condition of the instrument and detector prior to each use
- Knobs, buttons, cables, connectors
- Meter movements/displays
- Instrument cases
- Probe/probe window(s)
- Other physical properties that may affect the proper operation of the instrument or detector

Any portable survey instrument or detector having a questionable physical condition will not be used until the problems have been corrected. A battery check will be performed to ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual. The instrument will be exposed to the appropriate (alpha, beta, gamma) check source to verify that the instrument response is within the plus or minus percent range determined during the initial response check. The calibration certificates and daily QA/QC records for each instrument used, as well as chi-square test records, will be provided in the project report.

In the event that any portable survey instrument or instrument and detector combination having a questionable physical condition that cannot be corrected fails any of the operation checks stated in SOP 002, or has exceeded its annual calibration date without RSOR approval, the instrument shall be put in an "out of service" condition by placing an "out of service" tag or equivalent on the instrument and securing the instrument or the instrument/detector combination a separate area such that the instrument and instrument/detector combination cannot be issued for use. The RSOR and any Radiological Control Technicians (RCTs) and their respective supervisors shall be notified immediately when any survey instrumentation has been placed "out of service." Instruments tagged as "out of service" will not be returned to service until all deficiencies have been corrected. The results of the daily operation checks, discussed above, will be documented.

6.1.3 Instruments for Surface Scan Surveys for Alpha Activity

Scan surveys for alpha radiation will be performed using a Ludlum Model 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 or a Ludlum Model 43-89 or 43-93 ZnS(Ag) plastic scintillation detector (or equivalent).

6.1.4 Instruments for Surface Scan Surveys for Beta Activity

Scan surveys for beta radiation will be performed using a Ludlum Model 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 or a Ludlum 43-89 or 43-93 ZnS(Ag) plastic scintillation detector (or equivalent).

6.1.5 Instruments for Direct Measurement Static Surveys for Alpha Activity

Static surveys for alpha radiation will be performed using a Ludlum Model 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 or a Ludlum Model 43-89 or 43-93 ZnS(Ag) plastic scintillation detector (or equivalent).

6.1.6 Instruments for Direct Measurement Static Surveys for Beta Activity

Static surveys for beta radiation will be performed using a Ludlum Model 2360 data logger (or equivalent) equipped with either a Ludlum Model 43-68 or a Ludlum Model 43-89 or 43-93 ZnS(Ag) plastic scintillation detector (or equivalent).

6.1.7 Instruments for Scan Surveys for Gamma Activity

Scan surveys for gamma radiation will be performed using a Ludlum Model 2350-1 data logger (or equivalent) equipped with a Ludlum Model 44-10 2-inch by 2-inch sodium iodide (NaI) scintillation detector (or equivalent).

6.1.8 Instruments for Direct Measurement Static Surveys for Gamma Activity

Direct measurement static surveys for gamma radiation will be performed using a Ludlum Model 2350-1 data logger (or equivalent) equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI scintillation detector (or equivalent).

6.1.9 Instruments for Direct Measurement Surveys for Beta Gamma Activity

Direct measurement surveys for beta and gamma radiation will be performed using Ludlum Model 3, Model 12, Model 177, or equivalent, with a Model 44-9 Geiger Mueller pancake probe (or equivalent). This instrument combination is normally used for routine surveys associated with monitoring personnel and equipment exiting a radiologically controlled area.

6.1.10 Instrument for Exposure Rate Surveys

Exposure rate surveys are conducted with use of a Ludlum Model 19 MicroR meter (or equivalent). Compatible with anticipated exposure rates, the instrument is equipped with an internally mounted 1-inch by 1-inch NaI scintillation detector that is integral to the meter housing.

6.1.11 Instrument for Portal Monitor Truckload Surveys

The Ludlum Model 3500-1000RWM Radiation Monitor System is designed to detect low levels of radiation in vehicle loads of dispersible material documented to be non-LLRW. Two scintillation detectors, each containing approximately 480 cubic inches of plastic detector media, provide coverage to both sides of the vehicle. The detector's large size (48 inches long by 5 inches wide by 2 inches thick) provides a large area for the detection of gamma radiation.

6.2 INSTRUMENTATION EQUATIONS

The following equations are used to calculate efficiencies, MDCs, and minimum detectable count rates (MDCRs).

6.2.1 Instrument Efficiency

The instrument efficiency (ε_i) is defined as the ratio between the net count rate, in cpm, of the instrument and the surface emission rate of the calibration source for a specified geometry. The surface emission rate is the 2π particle fluence that is affected by both the attenuation and backscatter of the radiation emitted from the calibration source.

Equation 6-1 will be used to calculate the instrument efficiency in counts per particle, although efficiency is typically reported as having no units or unitless:

Equation 6-1

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi}\left(\frac{W_A}{S_A}\right)}$$

Where:

R_{S+B}	=	the gross count rate of the calibration measurement (cpm)
R_B	=	the background count rate in cpm
$q_{2\pi}$	=	surface emission rate of the calibration source (National Institute of Standards and Technology [NIST] traceable) in particles per minute
W_A	=	active area of the detector window (square centimeters [cm^2])
S_A	=	area of the source (cm^2)

The instrument efficiency procured from the instrument calibration service is determined by obtaining static counts with the detector over a calibration source that has a NIST-traceable surface emission rate. The 2π particle fluence rate is corrected for decay, attenuation, and scatter. Then the surface emission rate of the source must be corrected for the area subtended by the probe. Factors that can also affect instrument efficiency are discussed below:

- Efficiency Check Sources. Efficiency check sources that emit alpha or beta radiation with energies similar to those expected from the contaminant in the field (similar to the expected radionuclide[s] of concern) will be selected.
- Source Geometry Factors. Instrument efficiency will usually be determined with an efficiency check source equal to or greater than the area of the probe. If a source smaller than the probe is used, a conversion factor is applied to the MDC to account for the active region of the probe.
- Source-to-Detector Distance. The detector efficiency will be calculated at a source-to-detector distance the same as the detector-to-surface distance used in the field.

6.2.2 Surface Activity Measurements

Scan and static surveys are used to quantify the total (fixed and removable) surface concentrations on material and equipment. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998) and Selection and Use of Portable Radiological Survey Instruments for Performing In Situ Radiological Assessments in Support of Decommissioning (American Society for Testing and Materials 1998) are used as technical guidance to ensure accuracy in the measurement of surface activity.

Equation 6-1a is used to calculate the surface activity in units of disintegrations per minute (dpm) per 100 cm^2:

Equation 6-1a

$$A_S = \frac{R_{S+B} - R_B}{\varepsilon_i \varepsilon_s \frac{W_A}{100\,cm^2}}$$

Where:

A_S	=	total surface activity (dpm/100 cm^2)
R_{S+B}	=	the gross count rate of the measurement in cpm
R_B	=	the background count rate in cpm
ε_i	=	the instrument efficiency
ε_s	=	the contaminated surface efficiency
W_A	=	the area of the detector window (cm^2)

Background, R_B, is a function of the material being surveyed. For example, the ambient alpha background for a Ludlum Model 43-68 in a low background area may be 1 cpm but the count rate for non-impacted concrete or dry wall is typically 2 – 7 cpm, non-impacted brick is 6 cpm, and ceramic floor tiles 15 cpm (NRC 1998). The background count rate for beta emissions is relatively uniform for most materials (NRC 1998). Surface material background count rates should be collected to reduce the probability of false positive for potential alpha emitters.

The instrument efficiency, ε_i, is defined as the ratio between the net count rate of the instrument and the surface emission rate of a source for a specified geometry and particle energy. The surface emission rate, $q_{2\pi}$, is defined as the "number of particles of a given type above a given energy emerging from the front face of the source per unit time" (IOS 1988). NUREG-1507 shows instrument alpha efficiencies calculated using a distributed source, equal in area to the detector window, reduced from 0.473 to a ε_i of 0.273 for a point source (NRC 1998). Adjustments are made for the area of potential alpha contamination when the surface contamination approaches the release criterion. Instrument efficiencies for beta particles are highly dependent on the beta energy (NRC 1998). The ε_i for strontium-90, a common beta emitter used in calibration, for a gas proportional detector is typically 0.36. The εi for the beta emitters in the uranium-238 decay chain or for low energy beta emitting fission and activation products is 33 percent lower, 0.24 (NRC 1998). To the extent practical the energy of the beta calibration source should match the beta energies of the potential beta contaminants.

The surface efficiency is a function of the surface material, the energy of the particle, the distance from the surface to the detector, and condition of the surface. The effect of these parameters are addressed in detail in Chapters 4 and 5 of NUREG-1507 (NRC 1998). ISO-7503-1 recommends a surface efficiency of 0.25 for beta emitters with maximum energies between 0.15 and 0.4 MeV, and 0.5 for beta emitters with maximum energies exceeding 0.4 MeV.

In the absence of experimentally determined surface efficiencies NUREG-1507 provide conservative recommendations for the total efficiency, ε_s x ε_i, of 0.20 for alpha emitters and 0.25 for beta emitters for 100 cm^2 gas proportional detectors (NRC 1998).

6.2.3 MDC for Static Alpha and Beta Counts

The static MDC is *a priori* estimate of the true surface concentration of a radionuclide required to give a specified high probability (typically 95 percent) that the *measured* response will be greater than the critical detection and quantification capabilities value for a specific portable survey instrument using a specific measuring technique. Equation 6-2 is used to calculate the 95 percent confidence level instrument MDC in dpm per 100 cm^2 when the background and sample are counted for the same time intervals:

Equation 6-2

$$MDC = \frac{3 + 4.65\sqrt{R_B T_B}}{\varepsilon_s \varepsilon_i \frac{W_A}{100} T_B}$$

Where:

R_B = background count rate (cpm)
T_B = background counting time (minute [min])
ε_i = instrument efficiency (counts per particle)
ε_s = contaminated surface efficiency (particles per disintegration)
W_A = active area of the detector window (cm^2)

In Equation 6-2, W_A is the size of the "active" area of the detector window. If the area of the detector window (cm^2) does not equal 100 cm^2, it is necessary to convert the detector response to units of dpm per 100 cm^2.

If the background and sample are counted for different time intervals, Equation 6-3 is used to calculate the 95 percent confidence level MDC in dpm per 100 cm^2:

Equation 6-3

$$MDC = \frac{3 + 3.29\sqrt{R_B T_{S+B}\left(1 + \frac{T_{S+B}}{T_B}\right)}}{\varepsilon_i \varepsilon_s \frac{W_A}{100\ cm^2} T_{S+B}}$$

Where:

R_B = background count rate (cpm)
T_B = background counting time (min)
T_{S+B} = sample counting time (min)
ε_i = instrument efficiency (counts per particle)
ε_s = contaminated surface efficiency (particles per disintegration)
W_A = active area of the detector window (cm^2)

6.2.4 Surface Efficiency (ε_s) for Surface Activity Measurements

The surface efficiency term in the preceding equations is used to determine the 4π total efficiency for a particular surface and condition. Suitable values are based on the radiation and radiation energy, and are primarily impacted by the backscatter and self-absorption characteristics of the surface on which the contamination exists in the field. Backscatter is most affected by the energy of the radiation and the density of the surface material. Self-absorption characteristics or attenuation are also a function of the radiation's energy and surface condition. Surfaces typically encountered in the field include concrete, asphalt, wood, drywall, plaster, carpet, and metal. Surface conditions include both physical effects, such as scabbled concrete, and the effect of surface coatings: dust, paint, rust, water, and oil.

In the absence of experimentally determined surface efficiencies, ISO-7503-1 (ISO 1988) and NUREG-1507 (NRC 1998) provide conservative recommendations for surface efficiencies. ISO-7503-1 recommends a surface efficiency of 0.5 for maximum beta energies exceeding 0.5 megaelectron volt (MeV) and to use a surface efficiency of 0.25 for beta energies between 0.15 and 0.4 MeV and for alpha emitters (ISO 1988; NRC 1998). NUREG-1507 provides surface efficiencies based on studies performed for the NRC. In general, NUREG-1507 indicates that the ISO rule of thumb for surface efficiencies is conservative, particularly for beta-emitting radionuclides with end-point energies between 0.25 MeV and 0.4 MeV. A surface efficiency of 0.25 will be used for all alpha emitters and beta emitters with maximum beta energies less than 0.5 MeV. A surface efficiency of 0.5 will be used for all beta emitters with maximum beta energies greater than 0.5 MeV.

6.3 LABORATORY INSTRUMENTS

Laboratory equipment will be used to analyze samples collected in support of the basewide contract at HPNS.

6.3.1 Quality Assurance Checks

Quality assurance checks shall be performed on laboratory instrumentation to ensure proper operation and to maintain calibration. The quality checks shall be documented, reviewed, and maintained. Data trends outside the tolerance limits shall be investigated to determine the cause and potential effect on measurement results.

6.3.2 Gross Alpha/Beta Loose Surface Contamination Surveys

Swipe samples will be analyzed using a Ludlum Model 2929, Ludlum Model 3030, or a Protean Model WPC-1050 (or equivalent). The Ludlum Model 2929 combines a dual channel scaler with a 43-10-1 scintillator/ZnS(Ag) phoswitch detector. The dual-channel scaler incorporates a pulse height analyzer that provides independent alpha and beta counts. The data output can be supplied to a laptop or PC for download to a spreadsheet or data base. The TtEC 43-10-1 counter is surrounded on three sides by two-inches of lead shielding resulting in very low background count rates.

The Ludlum Model 3030 incorporates an internally housed ZnS(Ag) plastic scintillator detector, a scaler, and a shielded sample tray. The system includes background subtraction, crosstalk correction, separate alpha/beta counts and alarms, either cpm or dpm operating modes, and user defined QC functions. The output is controllable by a laptop or PC and can be downloaded to a spreadsheet or data base.

The Protean WPC-1050 is an automated ultralow-background gas proportional counter that can count up to 100 samples automatically and can be programmed by the user to count 12 different types of samples, e.g., smears for 3-minutes, air samples for 10-minutes.

All three alpha beta counting systems provides a full range of simultaneous alpha and beta analysis at MDAs required for release of material and equipment and air monitoring necessary to support the basewide requirements. Data are reported in units of dpm per 100 cm2.

6.3.3 Gamma Spectroscopy

Gamma spectroscopy will be performed in accordance with the project-specific Work Plan by a Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) accredited laboratory. All results are reported in pCi/g, picocuries per milliliter (pCi/mL), or picocuries per liter (pCi/L), depending on the media analyzed.

6.3.4 Liquid Scintillation Analysis

Liquid scintillation counting will be performed in accordance with the project-specific Work Plan by a DoD ELAP accredited laboratory. The results are identified in dpm or pCi/g and grouped by energy.

6.3.5 Total Strontium Analysis

Total strontium analysis will be performed by a DoD ELAP accredited laboratory in accordance with the project-specific Work Plan. The results of total strontium analysis typically are reported in pCi/g, pCi/mL, or pCi/L, depending on the media analyzed.

Total strontium is the analysis of choice because the only radioactive strontium isotope present at this time is the longest half-life isotope, strontium-90 with a half-life of 29.1 years. The radioactive strontium isotope with the next longest half-life is strontium-85 (^{85}Sr) with a half-life of 64.84 days. Since any ^{85}Sr has undergone 118 half-lives there is no other radioactive strontium present but strontium-90.

6.3.6 Alpha Spectroscopy Analysis

Analysis of alpha-emitting radioisotopes will be performed in accordance with the project-specific Work Plan by a DoD ELAP accredited laboratory. The results of alpha spectroscopy analysis are reported in pCi/g, pCi/mL, or pCi/L, depending on the media analyzed.

7.0 SURVEY IMPLEMENTATION

This section discusses the types of surveys and their implementation in the field with a focus on the methods for conducting each type of survey. The survey procedures described in this section will be performed in accordance with approved SOPs or WIs as identified in the project-specific Work Plan. Additional survey implementation details will be identified in each WI and/or project-specific Work Plan. Detailed information regarding the types of equipment appropriate for conducting radiological surveys at HPNS is provided in Table 7-1.

7.1 REFERENCE (BACKGROUND) AREAS

An average background level will be determined by performing measurements at systematic or random locations within the designated background area. The detector probe will be held approximately 10 centimeters (4 inches) from the surface area for gamma radiation and 0.25 inch from the surface area for alpha/beta radiation. Instrumentation will be allowed to stabilize before background readings are taken. The range in count rates for scan and static surveys, swipes, and exposure rates will be collected for reference data. The same survey methodology and instruments used to collect the background data will be used to perform measurements within survey units. In some cases, solid samples will need to be collected in the background area for comparative analyses of samples collected during basewide activities. The background solid samples will be analyzed by a DoD ELAP accredited laboratory using the same methodology as the sample(s) collected during the basewide activities and in accordance with project-specific Work Plan.

7.2 SCAN SURVEYS

Scan surveys are an integral part of survey programs conducted to determine contamination levels. The surveys are an evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation. It will be used to identify areas with elevated count rates or dose rates that may require additional survey measurements.

7.2.1 Scan Surveys for Alpha/Beta Radiation

Surface scan surveys for alpha and beta radiation will be performed by moving the detector over the surface being surveyed at a rate of approximately 4-inches per second. The detector will be held within 0.635 centimeter (0.25 inch) over the surface being surveyed. A project-specific Work Plan may require faster or slower scan speeds.

7.2.2 Scan Surveys for Gamma Radiation

Scan measurements are obtained by traversing a path at a maximum speed (scan rate) of approximately 0.5 meter per second and slowly moving the detector assembly in a serpentine (S-shaped) pattern, while maintaining the detector approximately 10 centimeters (4 inches) above

the area being surveyed. A project-specific Work Plan may require faster or slower scan speeds and that the survey path follow a rectangular grid system.

7.3 STATIC SURVEYS

Static contamination surveys are used to determine contamination levels on surface areas for scoping, characterization, and/or material and equipment release surveys. The surveys are an evaluation technique performed by holding a detection device over a surface for a specified time at a set distance to detect radiation.

7.3.1 Static Surveys for Alpha and Beta Surface Activity

Direct measurements will be conducted with the detector within 0.635 centimeter (0.25 inch) above the surface. Count time for conducting the measurement will be dependent upon the radionuclide of concern.

7.3.2 Static Surveys for Gamma Radiation

Static gamma measurements require positioning the detector assembly approximately 10 centimeters (4 inches) above the surface and completing a stationary 60-second survey.

7.4 EXPOSURE RATE MEASUREMENTS

Exposure rate surveys are performed to measure ambient gamma radiation levels. These measurements are obtained by holding the detection device at the required distance from the surface being surveyed defined in the WI or project-specific Work Plan. Instrumentation will be allowed to stabilize before taking the measurement.

7.5 SWIPE SAMPLE MEASUREMENTS

Swipe sampling will be performed to assess the presence of radioactive contamination that is readily removed from a surface. Swipe samples will be taken to evaluate the presence of alpha and beta surface activity. The procedures for collecting swipe samples are discussed in SOP-001, *Radiation and Contamination Surveys*.

7.6 SURVEY AND SAMPLE LOCATIONS

Static survey locations on equipment and materials are given in the WI and/or the project-specific Work Plan; SOP-001, *Radiation and Contamination Surveys*; SOP-003, *Release of Materials and Equipment from Radiologically Controlled Areas*; and other WIs. Table 1-1 lists each of the TtEC SOPs for performing radiological work at HPNS. Copies of the SOPs are provided in Attachment 3. SOPs and project-specific Work instructions are available on-site at HPNS and can be provided to the DON and/or regulatory agencies for review upon request.

7.7 EQUIPMENT AND MATERIAL SURVEYS

Equipment and materials surveys will be performed in accordance with SOPs as identified in the project-specific Work Plan. Table 5-1 lists acceptable levels of contamination based on the AEC Regulatory Guide 1.86 limits. In the event that survey results indicate levels of contamination exceeding the limits listed in Table 5-1 (for surfaces), appropriate decontamination methods will be performed using methods described in SOP-007, *Decontamination of Equipment and Tools*.

7.8 PERSONNEL SURVEYS

Properly trained staff will perform personnel surveys in a predesignated low-background area before leaving a radiologically controlled area, as specified in the RWP or when deemed necessary by the RCT. Personnel who are not qualified to administer a self-survey will be monitored by a qualified technician. Personnel surveys will be performed using the appropriate survey methods described above and in accordance with SOP-001, *Radiation and Contamination Surveys*.

7.9 MEDIA SAMPLING

Various samples may be collected for radiological analysis, including soil and water. The project-specific Work Plan describes the methods for collecting samples, sample packaging, sample shipment, and completion of the associated chain-of-custody and other required documentation.

7.10 AIR SAMPLING

As specified in the RWP, airborne activity monitoring (continuous or grab samples) and engineering controls will be necessary during the course of work. To control occupational exposures, establish PPE, and determine respiratory protection requirements, monitoring and trending for airborne radioactive material will be performed as necessary. Engineered controls will be implemented if required to maintain airborne concentrations below 10 percent of the applicable derived air concentration (DAC) value for the radionuclides of concern (Table 7-2).

If, during the course of work, airborne concentration exceeds 10 percent of the DAC, ongoing activities will cease and the affected location will be posted until the source of the airborne concentration is eliminated and levels are confirmed to be below 10 percent of the DAC. Air monitoring will be performed using the methods described in SOP-009, *Air Sampling and Sample Analysis*.

7.11 TRUCK SURVEYS

During the course of work at HPNS, uncontaminated non-LLRW dispersible material, e.g., soils and debris, will be transported via truck to recycling centers, landfills, and other licensed disposal sites. The dispersible material will require documentation that they are uncontaminated including concurrence from RASO prior to being loaded for transport. As an added measure against inadvertently sending radioactive materials to a landfill or disposal site, trucks carrying uncontaminated non-LLRW dispersible material will be surveyed for gamma radiation. Truck

surveys will be performed using a portal monitor in accordance with SOP-011, *Gamma Screening of Trucks Using the Stationary Portal Monitor and Using Portable Survey Instrumentation*. The RSO, RSOR, and Project Manager will be immediately notified of any truck rejected at the HPNS portal monitor.

7.12 GLOBAL POSITIONING SYSTEM MEASUREMENTS

As specified in WIs, Global Positioning System (GPS) units may be used while performing outdoor area field surveys. For example, during an outdoor gamma scan survey, a GPS unit may be carried adjacent to the gamma detector. The GPS output will be logged along with the gamma count rates, so that each gamma reading will have an associated location point. After the survey, gamma data may be color coded and plotted on a survey map.

In addition, outdoor survey units may be mapped by walking the perimeter with a GPS unit. Once the outline is digitized, static reading locations for that survey unit can be generated in latitude and longitude, using Visual Sample Plan software (Gilbert et al. 2007). These points can be located using the GPS unit followed by the collection of static readings and samples, as appropriate.

Although GPS cannot be used for indoor surveys, building locations will be recorded by taking GPS readings at the exterior building corners, or taken from geospatially referenced aerial photographs, or found through other investigations or accepted land-surveying practices.

8.0 DECONTAMINATION, DISMANTLING, AND DISPOSITION

Decontamination, dismantling, and disposition activities will be performed, as identified in a WI and/or project-specific Work Plan, as part of radiological basewide support activities performed at HPNS. Decontamination is the removal, by chemical or physical means, of radioactive material from various types of internal and external surfaces including equipment, materials, components, systems, and structures. Dismantling is the removal, as applicable, of furniture, equipment, and walls or similar structural outworks and components for the purpose of permanently breaking down, removing, and eliminating such materials. This would also include conducting work in open land areas to support the removal of contaminated material or devices. To assess the extent and type of contaminants identified during the course of ongoing basewide support activities, various support surveys will be necessary.

8.1 DECONTAMINATION

To support ongoing work at HPNS, decontamination of materials, equipment, and structures may be necessary. There are numerous decontamination methods available for use. If practical, manual decontamination methods should be used. Abrasive methods may be necessary if areas of fixed contamination are identified. Chemical decontamination can also be advantageous by using detergents for nonporous surfaces with contamination present. Chemicals should be selected for decontamination that will minimize the creation of mixed waste. Decontamination activities will be conducted using SOP-007, *Decontamination of Equipment and Tools*.

8.2 DISMANTLING AND REMEDIATION

To support the release of equipment and materials, remedial support activities may be required. These activities include, but are not limited to, dismantling, disassembling, and/or removal of various systems, and components. Specific control methods and more detailed information regarding dismantling and remediation procedures will be provided in the WI and/or project-specific Work Plan.

8.3 DISPOSITION

Disposition is the methodology of identifying the radiological status of equipment, materials, and structures for its end use. Disposition will be conducted after the decontamination and/or dismantling activities have been completed. This will include the following key elements:

- Control of equipment and materials
- Free release
- Decontaminate for free release
- Off-site disposal

Controlling equipment and materials is essential to ensure that contaminated items are not used in uncontrolled areas to prevent the inadvertent spread of contamination. If decontamination methods are unsuccessful, some materials and equipment may be stored for future use in radiologically controlled areas. If it is not feasible or cost-effective to control contaminated equipment and materials, they will be disposed of off-site in accordance with the project-specific Work Plan.

9.0 RADIOACTIVE MATERIALS MANAGEMENT

Planned basewide support activities are expected to involve the presence of radioactive materials. These activities will be conducted by trained and qualified personnel who are designated to apply management and control measures as regulated by the appropriate regulatory agencies. The management of radioactive materials including handling and control will be performed in accordance with TtEC's NRC radioactive materials license number 29-31396-01 and the RPP presented in the project-specific Work Plan.

The control of RAM shall be performed in accordance with the provisions of SOP 003, *Release of Materials and Equipment from Radiologically Controlled Areas*, SOP 007, *Decontamination of Equipment and Tools*, SOP 008 *Control of Radioactive Material*, and SOP 012, *Radiologically Controlled Areas – Posting and Access Control*.

Radioactive material will be consolidated in common RMAs to the greatest extent practical to simplify the implementation of adequate materials control. RMAs posted because of potentially radiologically impacted surface or subsurface soil, buildings, and associated equipment and materials that has not been remediated need not have locked entrances Control of RMAs with containerized RAM will include security measures (i.e., locks, fencing, packaging, etc.) to preclude unauthorized access to or removal of RAM. Access shall also be controlled to prevent non-radiation workers from gaining entry to RMAs. RMAs with containerized RAM will be inspected at least once a week by an RCT. RCTs shall note the physical status of RMAs noting:

- Locked/secure status
- Labeling/posting
- Condition of containers

A radioactive waste inventory (RWI) program will be used to track RAM waste generated during basewide activities and RAM waste generated during previous characterization and remediation activities at HPNS. The program includes the provision for regular inventory checks. The specific requirements for inventory management are given in the following paragraphs.

If radioactive material is not immediately transferred to a LLRW broker or contractor, a running inventory of radioactive materials in a container will be kept on the container. Documentation of stockpile inventories, e.g., identification number and figures showing site location will be maintained on site. Inventories of material in a container or stockpile will be kept on the Stockpile/Container Inventory Log Sheet, or equivalent in accordance with SOP 008 Attachment 1. The log sheet will be updated as material is added to containers or stockpiles or when stockpiled material is removed for disposal. Moving of stockpiled material within an RMA may not require updating of the inventory log sheet but may require updates of site figures and or drawings of the RCA.

TtEC will maintain reports including the following information for RAM waste:

- Point of origin
- Storage location
- Removal Date
- Waste description
- Isotope and activity (If known)
- Other hazardous constituents (If known)
- Estimated quantity or volume
- Waste packaging dates
- Any additional comments

TtEC will maintain a master RAM inventory at each project site. The RSOR will ensure the inventory is updated at least quarterly. Work Control documents or client contractual obligations may require more frequent updating. Note that electronic records or alternate forms may be used as replacements for Attachments 1 and 2 of SOP-008, provided the record/form contains the same minimum information.

Disposition of RAM collected during basewide support activities or generated through HPNS site activities will either be through disposal or reduction in volume by decontamination. In some instances, it may be possible to reduce the volume of RAM by decontaminating items contaminated with RAM to levels at which the item no longer needs to be classified as RAM. The guidance for determining if decontamination is appropriate and for actually performing decontamination is given in SOP 007, *Decontamination of Equipment and Tools*.

Any former RAM that has been decontaminated to levels below those requiring classification as RAM shall have any RAM labels removed or otherwise defaced such that the wording and radiation symbol are no longer legible. Additionally, the status of any inventoried RAM that has been decontaminated shall be updated on the associated data sheets and in the RWI log to indicate that it is no longer an actively tracked RWI item.

RAM should be disposed of as LLRW. Preparation of material for disposal and actual disposal shall be conducted under the approved procedures of a licensed waste broker or client approved contractor. The status of RAM waste that has been disposed of and removed from the site shall be updated on inventory data sheets and in the RWI log to indicate that the item is no longer in storage on site. Waste inventory reports and transfer documentation to the LLRW waste broker or contractor will be retained as records.

10.0 DOCUMENTATION AND RECORDS MANAGEMENT

The purpose of this section is to define standards for the maintenance and retention of radiological records. Radiological records provide historical data, document radiological conditions, and record personnel exposure.

Sample collection, field measurements, and laboratory data will be recorded both electronically and on paper, to the extent practicable. Electronically recorded data and information will be backed up to the HPNS server and TtEC's mainframe on a nightly basis. Data and information recorded on paper will be recorded using indelible ink. Both electronic and paper records of field-generated data will be reviewed by the RSOR or a designee knowledgeable in the measurement method for completeness, consistency, and accuracy. Data manually transposed to paper from electronic data collection devices will be compared to the original data sets to ensure consistency and to resolve noted discrepancies. Electronic copies of original electronic data sets will be preserved on a nonmagnetic retrievable data storage device. No data reduction, filtering, or manipulation will be performed on the original electronic versions of data sets.

Changes or corrections to project documentation will be made by crossing out the erroneous item with a single line, initialing (by the person performing the correction), and dating the correction. The original item, although erroneous, must remain legible beneath the cross-out line. The new information will be written above the crossed-out item. Corrections must be written clearly and legibly with indelible black or blue ink.

10.1 REQUIREMENTS

Records resulting from implementation of this Management Plan shall meet the quality standards as outlined herein. All records must be retrievable and maintained for their prescribed retention time defined in the Project Contractor Quality Control Plan included with each project-specific Work Plan. Working copies of records used for reference will be stored separately from the original. Completed records awaiting transfer to long-term storage shall be stored in an appropriate manner to minimize loss and damage that could result from exposure to weather, fire, or other conditions.

Principal personnel who create, review, and approve radiological records must sign and date the record and follow quality standards specified in the Project Contractor Quality Control Plan presented in the project-specific Work Plan.

10.2 DOCUMENT QUALITY STANDARDS

Records shall be legible and completed with an indelible ink that provides reproducible and legible copies. Records shall be dated and contain a verifiable signature of the originator. Errors shall be corrected by marking a single line through the error and by initialing and dating the correction.

Radiological records shall not be corrected using an opaque substance. Shorthand or non-standardized terms may not be used.

To ensure traceability, each record shall clearly indicate:

- Name of the facility
- Specific location
- Function and process
- Date
- Document number (if applicable)

The quantities used in records shall be clearly indicated in standard units (curie, rad, rem, dpm, becquerel), including multiples and subdivisions of these units.

10.3 DOCUMENTATION

The four types of documentation that will be maintained and assessed are field operation records, laboratory records, data handling records, and work support documents. The majority of the data produced will be entered into the electronic data management system to produce quality data for inclusion in reports, documents, and presentations.

10.3.1 Data Management System

Supportable and definitive data must be produced and managed to achieve the removal action objectives. The TtEC team developed a unique "cradle-to-grave" data management system that seamlessly integrates all phases of the radiological and work process from initial survey and sampling to final disposition. Acquiring, evaluating, and managing data are the principal tasks involved in every aspect of the basewide support activities. The resulting survey data are easily uploaded to the Navy electronic data deliverable (NEDD) Naval Installation Restoration Information Solution (NIRIS) database.

10.3.2 Field Operation Records

The information contained in field operation records will document overall field operations and may consist of the following:

- Field measurement records – At a minimum, this documentation will identify the names of the persons conducting the activity, measurement identification, measurement locations, measurement results, maps and diagrams, equipment, and unusual observations. Data record forms, bound field notebooks, and electronic data loggers will be used to record raw data and make references to prescribed procedures and changes in planned activities.
- Sample tracking records – These records will be documented as presented in the project-specific Work Plan.

- QC records – QC records will be prepared as indicated in the Project Contractor Quality Control Plan presented in the project-specific Work Plan.
- Personnel files – Personnel files record the names and training certificates of the staff collecting data and will be maintained in accordance with the project-specific Work Plan.
- Deficiency and problem identification reports – These reports will be prepared as indicated in the Project Contractor Quality Control Plan presented in the project-specific Work Plan.
- Corrective action reports – Corrective action reports will be prepared as identified in the Project Contractor Quality Control Plan presented in the project-specific Work Plan.

10.3.3 Laboratory Records

Survey and laboratory data assessment and records will be prepared as indicated in the approved project-specific Work Plan.

10.3.4 Data Assessment

Assessment of survey data consists of four separate and identifiable phases: data reduction, data verification, data validation, and data quality assessment (DQA). Verification and validation pertain to evaluation of survey and analytical data and are considered as two separate processes. DQA considers all sampling, analytical, and data handling details, external QA assessments, and other historical project data to determine the usability of data for decision-making.

Data reduction involves data transformation processes such as converting raw data into reportable quantities and units, using significant figures, and calculating measurement uncertainties.

Data verification compares the survey data against the requirements of the project-specific Work Plan and SOPs. For example the survey locations, scan speed, number and location of systematic static survey measurements, and the number and location of swipe samples. A verification report may be prepared depending on the size and complexity of the survey. The verification report identifies those requirements that were not met (called exceptions). Verification may be accomplished using a plan or checklist, which doesn't necessarily need to be project-specific. Data verification also involves reviewing reports of data entered into the electronic data management systems by the appropriate supervisory personnel knowledgeable of and with access to the original data to verify data transcription accuracy in accordance with SOPs identified in the project-specific Work Plan.

Validation is a systematic check on a set of survey data being used to meet the project requirements and is performed to addresses the reliability of the survey data. The validation process begins with a review of the survey data package to identify its areas of strength and weakness. The validation process should determine the impact of not meeting the requirements of the project-specific Work Plan and SOPs. Validation then evaluates the data to determine the absence of a required survey measurement and the uncertainty of the survey process.

During validation, the technical reliability and the degree of confidence in the reported survey data are considered. The validator will note survey data that do not meet the performance criteria established in the project-specific Work Plan and SOPs. The products of the validation process are validated data and a statement on which data are acceptable and which data are sufficiently inconsistent that it should not be used in the decisions for which the survey data was collected. The appropriate survey data acceptance criteria will be established during the project planning phase and documented in the project-specific Work Plan. Documenting that such a check cannot be done is an appropriate and essential validation activity. (For example, applying numerical tests to data already determined to be unreliable is of no value.)

Data Quality Assessment is the last phase of the data collection process, and consists of a scientific and statistical evaluation of project-wide knowledge to assess the usability of survey data sets. To assess and document overall data quality and usability, the data quality assessor integrates the data validation report, field information, assessment reports, and historical project data, and compares the findings to the data quality objectives defined in the project-specific Work Plan. The DQA process uses the combined findings of these multi-disciplinary assessments to determine data usability for the intended decisions, and to generate a survey report documenting that usability and the causes of any deficiencies.

The validation and DQA process varies depending on the survey objectives, and the level and depth of the verification. The level and depth of the process are determined during the planning stage, and should include the following:

- Appropriate selection of the survey instruments and survey method for the radionuclide(s) of concern
- Evaluation of data completeness
- Verification of instrument/detector calibration
- Daily response checks of the instrument/detector
- Assessment of survey method specifications, e.g., scan speed, distance from the detector to surveyed surface, survey path, time that counts are collected, length of time for static measurements
- Adherence to operator response requirements, e.g., static counts acquired at locations with count rates exceeding investigation level
- Appropriateness of assumptions used in calculating MDC and probability of detection
- Appropriate background count rate settings used when calculating net counts
- Checks on instrument system settings, e.g., voltages, gas flow rates, window thickness, cable connection
- Swipes collected as required by project-specific Work Plan

- Figures/forms accurately documented survey/swipe locations per project requirements
- Labeling of swipes
- Analysis of swipes compliant with SOPs and project-specific Work Plan

The level of data verification, validation, and DQA performed on radiological samples is defined in the project-specific Work Plan. Copies of surveys, sampling, and analytical data (and their supporting data) will be protected and maintained in project record files as indicated in the project-specific Work Plan. Table 1-1 lists each of the current TtEC field SOPs developed for use at HPNS. Copies of these SOPs, as well as WIs, are available in the TtEC offices at HPNS and can be provided to the DON and/or regulatory agencies upon request.

10.3.5 Work Support Documents

Work support documents may include RWPs, WIs, and reports that will be prepared, reviewed, and approved in accordance with the project-specific Work Plan.

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11.0 REFERENCES

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TABLES

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TABLE 1-1

HUNTERS POINT NAVAL SHIPYARD STANDARD OPERATING PROCEDURES[a]

Standard Operating Procedures	
SOP Number	**SOP Title**
SOP-001	Radiation and Contamination Surveys
SOP-002	Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use
SOP-003	Release of Materials and Equipment from Radiologically Controlled Areas
SOP-004	Radiological Records
SOP-005	Radiological Protective Clothing Selection, Monitoring, and Decontamination
SOP-006	Sampling Procedures for Radiological Surveys
SOP-007	Decontamination of Equipment and Tools
SOP-008	Control of Radioactive Material
SOP-009	Air Sampling and Sample Analysis
SOP-010	Issue and Use of Radiation Work Permits
SOP-011	Gamma Screening of Truckloads Using the Stationary Portal Monitor and Using Portable Survey Instrumentation
SOP-012	Radiologically Controlled Areas Posting and Access Control
SOP-014	Transfer of Low-level Radioactive Waste to Another Contractor for Waste Disposal

Notes:

[a] The most current version of each controlled SOP and WI is available on-site at Hunters Point Naval Shipyard and can be provided to the DON and/or regulatory agencies upon request.

Abbreviations and Acronyms:

ARMI – Area Radiation Monitoring Instrument
DON – Department of the Navy
SOP – Standard Operating Procedure
WI – Work Instruction

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TABLE 5-1

RELEASE CRITERIA

Radionuclide	Surfaces			Soil[a] (pCi/g)				Water[f] (pCi/L)
	Equipment, Waste (dpm/100 cm^2)[b]	Structures (dpm/100 cm^2)[c]	Residual Dose (mrem/y)[d]	Outdoor Worker (pCi/g)[e]	Residual Dose (mrem/y)[d]	Residential (pCi/g)[e]	Residual Dose (mrem/y)[d]	
Americium-241	100	100	18.7	5.67	0.8661	1.36	24.84	15
Cesium-137	5,000	5,000	1.72	0.113	0.2142	0.113	0.2561	119
Cobalt-60	5,000	5,000	6.01	0.0602	0.5164	0.0361	0.3918	100
Europium-152	5,000	5,000	3.21	0.13[g]	0.5018	0.13[g]	0.502	60
Europium-154	5,000	5,000	3.49	0.23[g]	0.9593	0.23[g]	0.9599	200
Plutonium-239	100	100	18.1	14.0	1.743	2.59	1.138	15
Radium-226	100	100	0.612	1.0[h]	6.342	1.0[h]	14.59	5[i]
Strontium-90	1,000	1,000	0.685	10.8	0.1931	0.331	1.648	8
Thorium-232	1,000	36.5	24.9	2.7	24.91	1.69	25	15
Tritium	5,000	5,000	0.00053	4.23	0.00179	2.28	0.05263	20,000
Uranium-235+D	5,000	488	25	0.398	0.178	0.195	0.8453	30

Notes:

Criteria for other nuclides will be listed in WIs, if needed.

[a] EPA PRGs for two future-use scenarios.

[b] These limits are based on AEC Regulatory Guide 1.86 (1974). Limits for removable surface activity are 20 percent of these values.

[c] These limits are based on 25 mrem/y using RESRAD-Build Version 3.3 or Regulatory Guide 1.86, whichever is lower.

[d] The resulting dose is based on modeling using RESRAD-Build Version 3.3 or RESRAD Version 6.3, with radon pathways turned off.

TABLE 5-1

RELEASE CRITERIA

[e] The on-site and off-site laboratory will ensure that the MDA meets the listed release criteria by increasing sample size or counting time as necessary. The MDA is defined as the lowest net response level, in counts, that can be seen with a fixed level of certainty, customarily 95 percent. The MDA is calculated per sample by considering background counts, amount of sample used, and counting time.

[f] Release criteria for water have been derived from Radionuclides Notice of Data Availability Technical Document (EPA 2000) by comparing the limits from two criteria and using the most conservative limit.

[g] Based on EPA-decay corrected PRGs for commercial reuse and a previous Action Memorandum (TtEMI 2000, 2001).

[h] Limit is 1 pCi/g above background, per agreement with EPA.

[i] Limit is for total radium concentration.

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm^2 – square centimeter
dpm – disintegrations per minute
EPA – U.S. Environmental Protection Agency
MDA – minimum detectable activity
mrem/y – millirem per year
pCi/g – picocuries per gram
pCi/L – picocuries per liter
PRG – Preliminary Remediation Goal
WI – Work Instruction

TABLE 7-1

PORTABLE SURVEY INSTRUMENTS

Measurement/ Technique	Primary Use	Type of Instrumentation		Typical Background	Typical Total Efficiency (%)	Detection Sensitivity	Typical Minimum Detectable Concentration
		Detector Type and Model Number(s)	Meter Description and Model Number(s)				
Surface alpha/beta scans	Equipment, materials, debris, vehicles	Large-area gas - proportional 43-68 (126 cm^2)	Ratemeter/Scaler/Data Logger Ludlum Model 2360	150–250 cpm β 0–2 cpm α	~6 β total efficiency ~6 α total efficiency	900 dpm/100 cm^2 β 100 dpm/100 cm^2 α	553 dpm/100 cm^2 β 53 dpm/100 cm^2 α
Direct measurement static alpha/beta		Scintillation, Ludlum Model 43-89 or 43-93 or equivalent (100 cm^2)		100–200 cpm β 0–5 cpm α	~6 β total efficiency ~6 α total efficiency	900 dpm/100 cm^2 β 100 dpm/100 cm^2 α	553 dpm/100 cm^2 β 53 dpm/100 cm^2 α
				150–300 cpm β 0–3 cpm α	~10 β total efficiency ~10 α total efficiency	700 dpm/100 cm^2 β 100 dpm/100 cm^2 α	350 dpm/100 cm^2 β 50 dpm/100 cm^2 α
Surface gamma scans	Equipment, materials, debris	NaI 2-inch × 2-inch scintillation Ludlum Model 44-10	Ratemeter/Scaler/ Data Logger Ludlum Model 2350-1	4,000 to 7,000 cpm γ	N/A	1,500 cpm γ 1.6 pCi/g ^{137}Cs 0.58 pCi/g ^{226}Ra	353 cpm γ
Direct measurement static gamma							
Low energy gamma scans and statics	Soil, debris	Fiddler Model G-5	Ratemeter/Scaler/ Data Logger Ludlum Model 2350-1	50–100 cpm γ	Dependent on threshold settings	Dependent on threshold settings	Dependent on threshold settings
Towed array surface gamma scans	Surfaces	(2) TSA 12 inches × 39 inches × 1.5 inches (30.5 cm × 99 cm × 3.8 cm) DA372 organic plastic scintillators	TSA SC-770	750 cps γ	N/A	0.2 pCi/g ^{226}Ra	N/A

TABLE 7-1

PORTABLE SURVEY INSTRUMENTS

Measurement/ Technique	Primary Use	Type of Instrumentation		Typical Background	Typical Total Efficiency (%)	Detection Sensitivity	Typical Minimum Detectable Concentration
		Detector Type and Model Number(s)	Meter Description and Model Number(s)				
Surface beta/gamma scans	Equipment, materials, debris, personnel	Geiger-Mueller Ludlum Model 44-9 or equivalent	Ratemeter 3	50–100 cpm β γ	~ 10 β γ total efficiency	~ 1,000 dpm per probe area β γ	358 dpm/100 cm^2 β γ
Direct measurement static beta/gamma			Ratemeter 12	50–100 cpm β γ	~ 10 β γ total efficiency	~ 1,000 dpm per probe area β γ	358 dpm/100 cm^2 β γ
			Ratemeter 177	50–100 cpm β γ	~ 10 β γ total efficiency	~ 1,000 dpm per probe area β γ	358 dpm/100 cm^2 β γ
Exposure rates	All inclusive	MicroR Meter with integral 1-inch × 1-inch NaI scintillation	Ratemeter 19	7–8 µR/hr	N/A	2 µR/hr	N/A
Beta, gamma, X-ray surveys	Devices, gauges, dials	220 cm^2 Ion chamber/RO20	Analog movement with 5 linear ranges	Less than 1 µR/hr	N/A	N/A	N/A

Abbreviations and Acronyms:

α – alpha
β – beta
γ – gamma
µR/hr – microroentgens per hour
cm^2 – square centimeter
cpm – counts per minute
cps – counts per second
^{137}Cs – cesium-137
dpm – disintegrations per minute
N/A – not applicable
NaI – sodium iodide
^{226}Ra – radium-226

TABLE 7-2

DERIVED AIR CONCENTRATIONS

Radionuclide	Radiation	DAC (μCi/mL)	10% DAC (μCi/mL)
Radium-226	Alpha (α)	3.0×10^{-10}	3.0×10^{-11}
Plutonium-239		3.0×10^{-12}	3.0×10^{-13}
Thorium-232		5.0×10^{-13}	5.0×10^{-14}
Uranium-235		6.0×10^{-10}	6.0×10^{-11}
Strontium-90	Beta (β^-)	8.0×10^{-9}	8.0×10^{-10}
Tritium-3		2.0×10^{-5}	2.0×10^{-6}
Cobalt-60	Beta/gamma (β^-, γ)	7.0×10^{-8}	7.0×10^{-9}
Cesium-137		6.0×10^{-8}	6.0×10^{-9}
Americium-241	Alpha/gamma (α, γ)	3.0×10^{-12}	3.0×10^{-13}

Abbreviations and Acronyms:
μCi/mL – microcuries per milliliter
CFR – *Code of Federal Regulations*
DAC – derived air concentration (10 CFR 20 Appendix B)

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FIGURES

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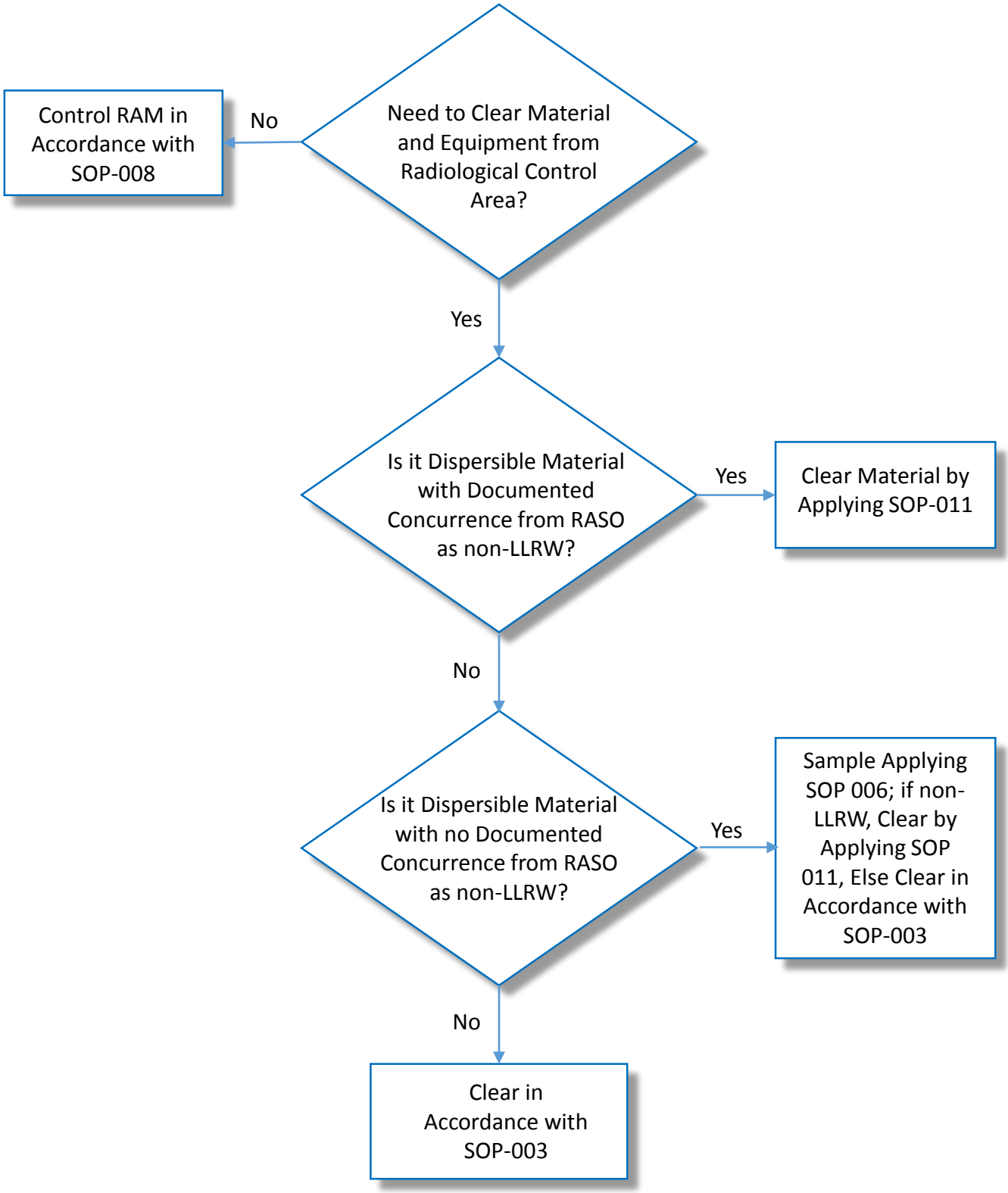
Figure 4-1. Flow Diagram Illustrating the Process for Releasing Material and Equipment from RCAs



ATTACHMENT 3

ABBREVIATED SAMPLING AND ANALYSIS PLAN

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SAP Worksheet #1 – Title and Approval Page

ATTACHMENT 3

FINAL

ABBREVIATED SAMPLING AND ANALYSIS PLAN

August 2015

BASEWIDE RADIOLOGICAL SUPPORT
HUNTERS POINT NAVAL SHIPYARD
SAN FRANCISCO, CALIFORNIA

Prepared for:

Base Realignment and Closure
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Prepared under:
Contract No. N62473-13-D-4808
DCN: ECSD-4808-0003-0003
CTO No. 0003

Review Signature: Gregory D Joyce — August 6, 2015
Greg Joyce — Date
TtEC Quality Control Program Manager

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EXECUTIVE SUMMARY

The Department of the Navy (DON) has contracted with Tetra Tech EC, Inc. (TtEC) to provide basewide radiological support at Hunters Point Naval Shipyard (HPNS), San Francisco, California. The work will be executed under Contract No. N62473-13-D-4808, Contract Task Order (CTO) No. 0003.

This Abbreviated Sampling and Analysis Plan (SAP), which is Attachment 3 of the Work Plan, has been prepared by TtEC to provide guidance for sampling, analysis, and quality control (QC) in support of sampling activities under this CTO, which only include waste characterization sampling and equipment surveys. The quality assurance/QC elements in this SAP were prepared in accordance with the U.S. Environmental Protection Agency (EPA) Uniform Federal Policy for Quality Assurance Project Plans (EPA 2005) and Requirements for Quality Assurance Project Plans, EPA QA/R-5, QAMS (EPA 2006) to ensure that all data collected are precise, accurate, representative, complete, and comparable to meet their intended use; however, only worksheets that are applicable to waste characterization sampling and equipment surveys have been included herein.

BACKGROUND

The radiological support will be provided under TtEC's United States Nuclear Regulatory Commission (NRC) Service Provider and California Agreement State License Radioactive Material licenses. Radiological support includes maintaining radiological control and postings, and supporting other contractors performing both chemical and radiological removal and remediation work at radiologically impacted sites at HPNS. A Memorandum of Understanding (MOU) among the contractors working at radiologically impacted sites throughout HPNS is kept current to detail TtEC's roles and responsibilities for basewide radiological support under this task order. Revisions to the MOU will be made in the event of changes to radiological boundaries and/or changes to the responsibilities of individual contractors.

SCOPE OF WORK

In support of the basewide contract, TtEC will perform sampling and analysis for waste characterization purposes. All waste characterization sample results will be provided to the DON to assess final disposition of wastes. Samples will be collected at a frequency determined in the field, and will be analyzed for the radionuclides of concern identified in the Historical Radiological Assessment (NAVSEA 2004). In addition, equipment surveys will be performed using field screening instruments.

REGULATORY OVERSIGHT

Environmental investigation and remediation activities are being conducted at HPNS under the Department of Defense Installation Restoration Program in accordance with the Comprehensive

Environmental Response, Compensation, and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan. Under Executive Order 12580, the DON is the lead agency responsible for implementation of the IR Program and the characterization, survey, and removal actions at HPNS. The EPA is the lead regulatory agency, while the California Department of Toxic Substances Control and Regional Water Quality Control Board San Francisco Bay Region will provide state regulatory oversight.

SAP Worksheets

Page

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#34 – Verification (Step I) Process Table 51
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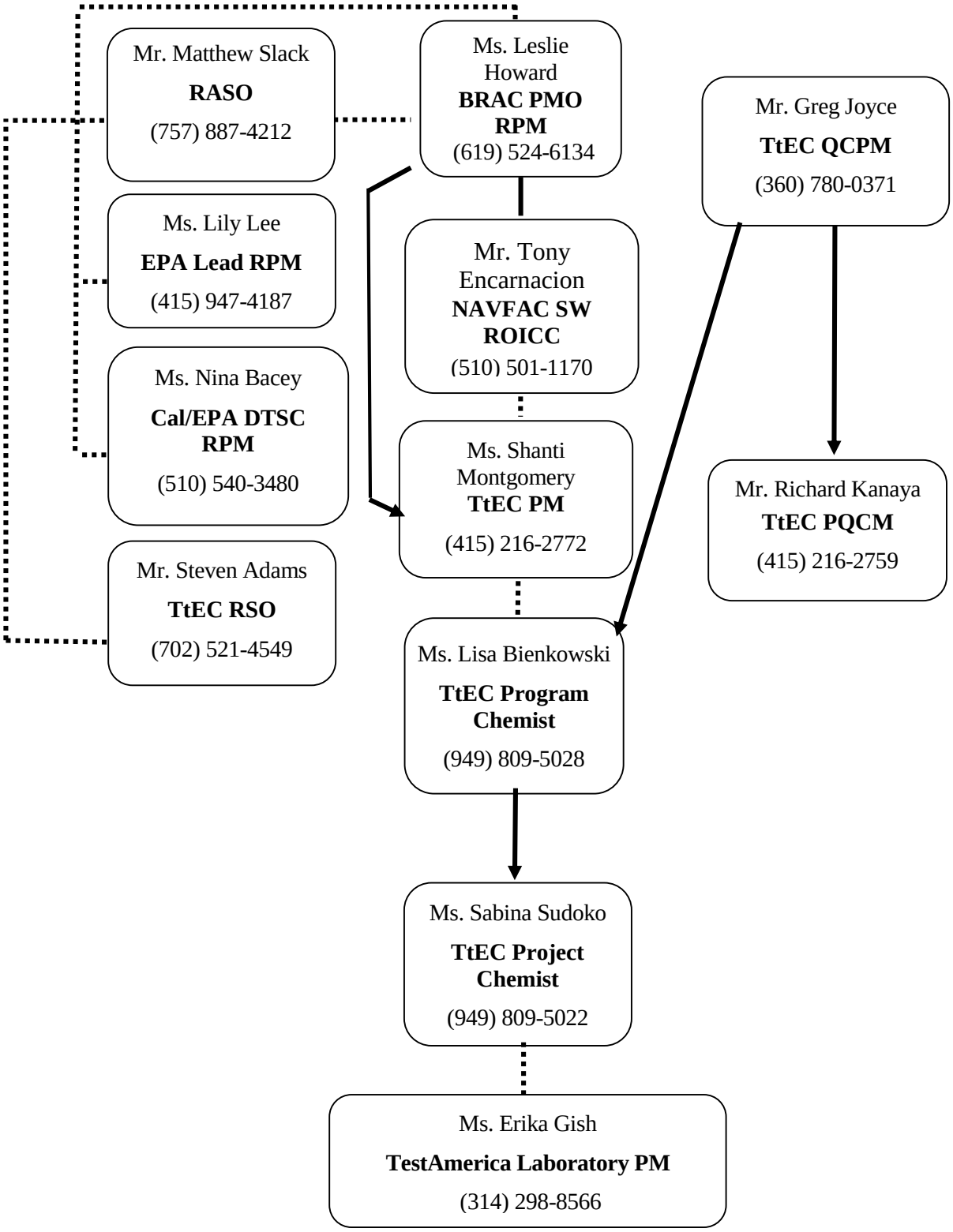
ABBREVIATIONS AND ACRONYMS

Bi-214	bismuth-214
BRAC	Base Realignment and Closure
Cal/EPA	California Environmental Protection Agency
CAS	Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm^2	square centimeters
Co-60	cobalt-60
COC	chain of custody
cpm	counts per minute
Cs-137	cesium-137
CTO	Contract Task Order
DCN	Document Control Number
DoD	Department of Defense
DOE	Department of Energy
DON	Department of the Navy
dpm	disintegrations per minute
DTSC	Department of Toxic Substances Control
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
g	grams
HNO_3	nitric acid
HPNS	Hunters Point Naval Shipyard
HRA	Historical Radiological Assessment
IR	Installation Restoration (Program)
keV	kiloelectron volts
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LLRW	low-level radioactive waste
LNO_2	nitrolinoleic acid
MDC	minimum detectable concentration
MeV	megaelecton volts
N_2	nitrogen gas
N/A	not applicable
NaI	sodium iodide

NAVFAC SW	Naval Facilities Engineering Command Southwest
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIRIS	Naval Installation Restoration Information Solution
NIST	National Institute of Standards and Technology
PARCC	precision, accuracy, representativeness, completeness, and comparability
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PDF	portable document format
PM	Project Manager
PMO	Program Management Office
PQCM	Project Quality Control Manager
Pu-239	plutonium-239
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCPM	Quality Control Program Manager
QSM	Quality Systems Manual
Ra-226	radium-226
RASO	Radiological Affairs Support Office
RER	relative error ratio
ROC	radionuclides of concern
ROICC	Resident Officer in Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
RSO	Radiation Safety Officer
RSOR	Radiation Safety Officer Representative
SAP	Sampling and Analysis Plan
SDG	sample delivery group
SOP	Standard Operating Procedure
Sr-90	strontium-90
TBD	to be determined
Th-232	thorium-232
TtEC	Tetra Tech EC, Inc.
UFP	Uniform Federal Policy
Y	yttrium

SAP Worksheet #5 – Project Organizational Chart

Lines of Authority ——— Lines of Communication



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SAP Worksheet #14 – Summary of Project Tasks

Radiological activities performed by Tetra Tech EC, Inc. (TtEC) for this project may include the following:

1. Preparation of project-specific plans including the Work Plan and this Sampling and Analysis Plan (SAP)
2. Preparation of Work Instructions
3. Preparatory activities and meetings
4. Radiological sampling of soil or water for waste characterization
5. Transfer of non-low-level radioactive waste (LLRW) to the Department of the Navy's (DON's) non-LLRW contractor or contractor who generated the waste stream
6. Transfer of LLRW to the DON's LLRW contractor for disposal
7. Surveying of personnel, material, and equipment
8. Decontamination of equipment

Activities associated with sampling are described below.

SAMPLE COLLECTION PROCEDURES

The following sections provide the sampling procedures for collection of samples associated with survey and remedial activities for this project.

Reference Background Area Sampling

Reference background area samples for radiological analyses of equipment and material will be collected in accordance with Standard Operating Procedures (SOPs) discussed in SAP Worksheet #21 and as included in Attachment 4. For analysis by TestAmerica St. Louis, the background activity for Ra-226, based on the mean of the greater of the reported activity or method detection limit, was determined to be 0.625 picocuries per gram (pCi/g), placing the release criterion at 1.625 pCi/g of Ra-226 for final definitive data (TtEC 2011).

Radiological Surveys

Surveys will be conducted in accordance with SOPs discussed in SAP Worksheet #21 (Attachment 4). Swipe samples will be screened using a Ludlum 2929 or 3030 scaler with a Ludlum 43-10-1 detector (or equivalent). Data are reported in units of disintegrations per minute (dpm) per 100 square centimeters (cm^2).

Soil and Water Sampling

Soil or water samples will be collected in accordance with the SOP listed in SAP Worksheet #21 (Attachment 4). Soil waste samples will be placed into a 1-gallon plastic bag about ¾ full, or in containers provided by the laboratory to equal about 1,000 grams. Wastewater samples will be transferred into containers provided by the laboratory depending upon the analyses required (see

SAP Worksheet #19). Sample labels will be affixed to the plastic bag or containers; the labels will include, at a minimum, the sample number, date, and time collected.

SAMPLE CUSTODY PROCEDURES

An overriding consideration for data resulting from laboratory analyses is the ability to demonstrate that the data are legally defensible, i.e., that the samples were obtained from the locations stated and that they reached the laboratory without alteration. To accomplish this, evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal will be documented through the chain-of-custody (COC) record. A sample is considered to be in custody if the following conditions have been observed:

- In actual possession or in view of the person who collected the sample
- Locked in a secure area
- Placed in an area restricted to authorized personnel

The COC record lists each sample and the individuals performing the sample collection, shipment, and receipt. The COC record will be the controlling document to ensure that the sample custody is maintained. Each time the sample custody is transferred, the former custodian will sign the COC on the _Relinquished By_ line, and the new custodian will sign the COC on the _Received By_ line. The date, time, and project or company affiliation will accompany each signature. When a commercial carrier is used to ship samples to the laboratory, the carrier name (i.e., FedEx or UPS) will be recorded on the COC. The shipping container will be secured with two custody seals, thereby allowing for custody to be maintained by the shipping personnel until receipt by the laboratory.

Sample custody will be the responsibility of sampling personnel from the time of sample collection until the samples are accepted by the laboratory. Thereafter, the laboratory performing the analysis will maintain custody. The sample custodian will sign the COC, inventory each shipment, and note any discrepancies on the sample login form. The laboratory will immediately notify the TtEC Project Chemist of any discrepancies. The laboratory will have a system for tracking samples. TtEC may request that samples submitted to the laboratory be returned to the project site for archiving and disposition.

In addition to providing a custody exchange record for the samples, the COC record serves as a formal request for sample analyses. The COC records will be completed, signed, and distributed as follows:

- A copy sent to the laboratory along with the samples
- A copy retained on-site for inclusion in the project files
- A copy e-mailed to the Project Chemist on a daily basis to allow tracking of samples sent to the laboratory to confirm laboratory receipt of samples

SAMPLE PACKAGING PROCEDURES

Samples will be delivered for analysis to the laboratory in a box, cooler, or similar container along with the COC record. Samples designated for transport off-site will be packaged in accordance with applicable Department of Transportation and International Air Transport Association procedures. At a minimum, samples placed in a box, cooler, or similar container for shipment will be packaged with bubble wrap or other materials, as necessary, to prevent breakage. Samples will be surveyed prior to shipment using an appropriate exposure rate meter. The COC record will be placed in a plastic bag and then placed inside the shipping container, which will then be taped shut with strapping tape. Two custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. Clear tape will be applied to the custody seals to prevent accidental breakage during shipment. The pouch for the air bill will be placed on the shipping container. If multiple containers are being shipped, air bills will be placed on the shipping containers as instructed by the commercial carrier. The air bill (or tracking information from the air bill) will be sent to the Project Chemist for tracking of samples.

FIELD LOGBOOK PROCEDURES

A permanently bound field logbook with consecutively numbered pages, used for sampling activities only, will be assigned to this project. The logbooks will be numbered sequentially on the cover by the Project Quality Control Manager (PQCM) and that number will be entered into a logsheet maintained by the PQCM. All entries will be recorded in indelible black or blue ink. At the end of each work day, the logbook pages will be signed by the responsible sampler, and any unused portions of the logbook pages will be crossed out, signed, and dated. If it is necessary to transfer the logbook to another person, the person relinquishing the logbook will sign and date the last page used, and the person receiving the logbook will sign and date the next page to be used. At a minimum, the logbook will contain the following information:

- Project name and site location
- Date and time
- Personnel in attendance
- General weather information
- Work performed
- Field observations
- Sampling performed, including specifics such as location, type of sample, type of analyses, and sample identification
- Field analyses performed, including results, instrument checks, problems, and calibration records for field instruments
- Descriptions of deviations from this SAP

- Problems encountered and corrective action taken
- Identification of field quality control (QC) samples
- QC activities
- Verbal or written instructions
- Any other events that may affect the samples

LABORATORY DOCUMENTATION PROCEDURES

Samples will be assigned by the laboratory into a sample delivery group (SDG) number for every batch of 20 samples or less, as received on a daily basis by the laboratory. Initial analytical results that are submitted electronically to the TtEC Project Chemist for review will be submitted by the laboratory at the turnaround time and contain the following:

- COC
- Case narrative
- Sample results
- Method blank results
- Laboratory control sample (LCS) results
- Laboratory duplicate results

For each detector, an energy control check standard daily form is completed by the laboratory and is available for review.

Within 10 business days after the turnaround time, the laboratory will then produce a final U.S. Environmental Protection Agency (EPA) Level IV-equivalent data package in PDF format that will be sent electronically to the TtEC Project Chemist. (Hardcopies of the data packages will be provided by the laboratory at the request of the TtEC Project Chemist.) The data package will be page numbered, and contain the following information:

- Cover page (with laboratory name, address, phone number, contact person, and sample delivery group number, as well as the project name and project number)
- Table of contents
- Case narrative including resolution of all corrective actions and nonconformance
- Sample management records, including a copy of the COC record, shipping documents, as applicable, and laboratory sample receipt forms

- Analytical results and QC information by test as follows:
  - Radiological raw data sequence
    a. Sample results forms, including method blanks
    b. Sample raw data
    c. QC summaries
    d. Initial calibration
    e. Calibration checks, including all related continuing calibration verifications
    f. Instrument run log
    g. Sample preparation log

All relevant laboratory raw data and documentation, including, but not limited to, logbook, data sheets, electronic files, and reports, will be maintained by the laboratory for at least 5 years.

An electronic data deliverable (EDD) may also be submitted electronically by the laboratory at the request of the TtEC Project Chemist. Both the EDDs and the PDF data package will present results to at least three significant figures. Results for QC analyses (method blanks, LCS, and duplicates) will also be reported to at least three significant figures.

When revisions to data packages are required, the revised pages will be stamped with the notation "amended or revised report" and have the same page numbering system as the original pages. If the revisions affect the EDDs, then a revised EDD will be sent along with the revised PDF data package to the TtEC Project Chemist.

DATA MANAGEMENT PROCEDURES

Field surveying data, logbooks, and COC records will be maintained in the TtEC project file. The field crews will e-mail a copy of the COC records and commercial carrier air bill information to the TtEC Project Chemist the day any samples are collected and shipped to the laboratory.

The TtEC Project Chemist will provide the initial analytical results due at the turnaround time (and an EDD if requested) to the project team members for their review. Prior to transfer of the radiological data to the DON's LLRW waste contractor, the DON's non-LLRW contractor, or the contractor who generated the waste stream, the initial analytical results and EDD will be checked for required values and project-specific requirements against this SAP. Any discrepancies will be corrected by the laboratory.

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SAP Worksheet #15 – Reference Limits and Evaluation Table

Matrix: Soil
Analytical Group: Gamma Isotopes

Analyte	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference	Project MDC (pCi/g)	Laboratory-specific MDC [b] (pCi/g)
Americium-241	86954-36-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Bismuth-212	14913-49-6	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Bismuth-214	14733-03-0	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Cesium-137	10045-97-3	0.113	Release criteria	0.07	0.07 (See note 2 below)
Cobalt-60	10198-40-0	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Europium-152	14683-23-9	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Europium-154	15585-10-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Lead-212	15092-94-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Lead-214	15067-28-4	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Potassium-40	13966-00-2	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Protactinium-234	15100-28-4	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Radium-226	13982-63-3	1.0 above background (See note 1 below)	Release criteria	0.2	0.2 (See note 2 below)
Thallium-208	14913-50-9	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Thorium-232	7440-29-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Thorium-234	15065-10-8	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Uranium-235	15117-96-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]

Note 1: Radium-226 background for definitive data is 0.625 pCi/g for this project.

Note 2: An MDC at or less than the value listed must be achieved for cesium-137 and radium-226 for all samples for this project. MDCs for other radionuclides analyzed by gamma spectroscopy are not required to be achieved unless specifically requested on the applicable COC.

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Soil
Analytical Group: Sr-90

Analyte	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference	Project MDC (pCi/g)	Laboratory-specific MDC [b] (pCi/g)
Total Strontium	7440-24-6	0.331	Release criteria	0.16	0.16
Strontium-90	10098-97-2	0.331	Release criteria	0.16	0.16

Total strontium analysis will be performed first by the laboratory since all strontium isotopes (except strontium-90) have decayed away since activities involving radioactive material ceased at HPNS in April 1994. If the total strontium result is less than the release criterion, a strontium-90-specific analysis is not required. However, if the total strontium result is above the release criterion, then a strontium-90-specific analysis will be performed.

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Soil
Analytical Group: Alpha Isotopes

Analyte	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference	Project MDC (pCi/g)	Laboratory-specific MDC [b] (pCi/g)
Plutonium-239/240	10-12-8	2.59	Release criteria	0.10	0.10

Plutonium-239 is listed in the above table as plutonium-239/240 because the alpha energy peaks for the isotope of plutonium cannot be separated in alpha spectroscopy. Therefore, the laboratory will report as listed above in the table.

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Soil
Analytical Group: Tritium

Analyte	CAS Number	Project Action Limit (pCi/g)	Project Action Limit Reference	Project MDC (pCi/g)	Laboratory-specific MDC [b] (pCi/g)
Tritium	10028-17-8	2.28	Release criteria	1	1

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Water
Analytical Group: Gamma Isotopes

Analyte	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference	Project MDC (pCi/L)	Laboratory-specific MDC [b] (pCi/L)
Americium-241	86954-36-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Bismuth-212	14913-49-6	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Bismuth-214	14733-03-0	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Cesium-137	10045-97-3	119	Release criteria	55	55 (See note 1 below)
Cobalt-60	10198-40-0	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Europium-152	14683-23-9	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Europium-154	15585-10-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Lead-212	15092-94-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Lead-214	15067-28-4	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Potassium-40	13966-00-2	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Protactinium-234	15100-28-4	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Radium-226	13982-63-3	5	Release criteria	2.5	2.5 (See note 1 below)
Thallium-208	14913-50-9	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Thorium-232	7440-29-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Thorium-234	15065-10-8	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]
Uranium-235	15117-96-1	Not applicable [a]	Not applicable [a]	Not applicable [a]	Not applicable [a]

Note 1: An MDC at or less than the value listed must be achieved for cesium-137 and radium-226 for all samples for this project. MDCs for other radionuclides analyzed using gamma spectroscopy are not required to be achieved unless specifically requested on the applicable COC.

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Water
Analytical Group: Sr-90

Analyte	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference	Project MDC (pCi/L)	Laboratory-specific MDC [b] (pCi/L)
Total Strontium	7440-24-6	8	Release criteria	4	4
Strontium-90	10098-97-2	8	Release criteria	4	4

Total strontium analysis will be performed first by the laboratory since all strontium isotopes (except strontium-90) have decayed away since activities with radioactive material ceased at HPNS in April 1994. If the total strontium result is less than the release criterion, a strontium-90-specific analysis is not required. However, if the total strontium result is above the release criterion, then a strontium-90-specific analysis will be performed.

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Water
Analytical Group: Alpha Isotopes

Analyte	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference	Project MDC (pCi/L)	Laboratory-specific MDC [b] (pCi/L)
Plutonium-239/240	10-12-8	15	Release criteria	7.5	7.5

Plutonium-239 is listed in the above table as plutonium-239/240 because the alpha energy peaks for the isotope of plutonium cannot be separated in alpha spectroscopy. Therefore, the laboratory will report as listed above in the table.

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Soil

Analytical Group: Tritium

Analyte	CAS Number	Project Action Limit (pCi/L)	Project Action Limit Reference	Project MDC (pCi/L)	Laboratory-specific MDC [b] (pCi/L)
Tritium	10028-17-8	20,000	Release criteria	1	1

SAP Worksheet #15 – Reference Limits and Evaluation Table (Continued)

Matrix: Swipe

Analytical Group: Gross Alpha/Gross Beta (performed by instrumentation described in SAP Worksheet #21)

Analyte	CAS Number	Removable Surface Contamination Limit (dpm/100 cm^2)	Removable Surface Contamination Limit Reference	Removable Surface Contamination MDC (dpm/100 cm^2)	Laboratory-specific MDC [b] (dpm/100 cm^2)
Gross Alpha	12587-46-1	20	Regulatory Guide 1.86	14	Not applicable since analyzed on site.
Gross Beta	12587-47-2	200	Regulatory Guide 1.86	84	Not applicable since analyzed on site.

Notes:

[a] Gamma isotopes associated with Ra-226 or other naturally occurring radioactive material (potassium-40 and uranium-235) are reported at the request of the RASO even though the release criteria have not been established.

[b] MDCs are being used in place of limits of quantitation, limits of detection, and detection limits for radiochemistry analyses. MDCs are calculated on a per-sample, per-analysis basis and take into account instrument background, sample size, and count time. Therefore, any MDC value listed in this worksheet for the radiological analyses is the minimum MDC value that the laboratory will achieve. However, laboratory reports will list the actual MDC value calculated for each isotope.

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SAP Worksheet #17 – Sampling Design and Rationale

RADIOLOGICAL PERSONNEL, MATERIAL, AND EQUIPMENT SURVEYS

The Basewide Radiological Management Plan (Attachment 2) describes survey and decontamination procedures that will be implemented in support of the radiological release of personnel, equipment, and materials from impacted areas at Hunters Point Naval Shipyard (HPNS).

WASTE CHARACTERIZATION SAMPLING

Soil or water samples to be analyzed for waste characterization will be collected at a frequency based on professional judgment or in consultation with the Radiological Affairs Support Office (RASO). The analyses will include, at a minimum, the isotopes of concern for the site from which the waste was generated. Table 1 below lists the established radiological release criteria for radionuclides at HPNS, and Table 2 lists the isotopes of concern for buildings, sites, or areas at HPNS that have not achieved unrestricted free release as of February 10, 2015. When collecting soil or water samples from waste that was generated from a building, site, or area listed in Table 2, the isotopes of concern listed will be included in the analyses. The information in Table 1 then will be used to evaluate the results.

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

TABLE 1
RELEASE CRITERIA

Radionuclide	Total Surface Contamination		Soil [d] (pCi/g)		Water [e] (pCi/L)
	Equipment or Waste (dpm/100 cm^2) [a]	Structures (dpm/100 cm^2) [b]	Outdoor Worker (pCi/g) [c]	Residential (pCi/g) [c]	
Americium-241	100	100	5.67	1.36	15
Cesium-137	5,000	5,000	0.113	0.113	119
Cobalt-60	5,000	5,000	0.0602	0.0361	100
Europium-152	5,000	5,000	0.13 [f]	0.13 [f]	60
Europium-154	5,000	5,000	0.23 [f]	0.23 [f]	200
Plutonium-239	100	100	14.0	2.59	15
Radium-226	100	100	1.0 [g]	1.0 [g]	5 [h]
Strontium-90	1,000	1,000	10.8	0.331	8
Thorium-232	1,000	36.5	2.7	1.69	15
Tritium	5,000	5,000	4.23	2.28	20,000
Uranium-235+D	5,000	488	0.398	0.195	30

Reference: Final Base-wide Radiological Removal Action, Action Memorandum - Revision 2006, Hunters Point Shipyard, San Francisco, CA (DON 2006)

Notes:

[a] These limits are based on AEC "Regulatory Guide 1.86" (AEC 1974). Limits for removable surface activity are 20 percent of these values.

[b] These limits are based on 25 mrem/yr, using RESRAD-Building Version 3.3 or "Regulatory Guide 1.86" (AEC 1974), whichever is lower.

[c] The laboratory will ensure that the MDC meets the listed release criteria by increasing sample size or counting time as necessary. The MDC is defined as the lowest net response level, in counts, that can be seen with a fixed level of certainty, customarily 95 percent. The MDC is calculated per sample by considering background counts, amount of sample used, and counting time.

[d] EPA PRGs for two future-use scenarios.

[e] Release criteria for water have been derived from "Radionuclides Notice of Data Availability Technical Document" (EPA 2000) by comparing the limits from two criteria and using the most conservative limit.

[f] Based on EPA-decay-corrected PRGs for commercial reuse and a previous action memorandum (TtEMI 2000 and 2001).

[g] Limit is 1 pCi/g above background, per agreement with EPA.

[h] Limit is for total radium concentration.

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm^2 – square centimeters
DON – Department of the Navy
dpm – disintegrations per minute
EPA – U.S. Environmental Protection Agency
MDC – minimum detectable concentration
mrem/yr – millirem per year
pCi/g – picocuries per gram
pCi/L – picocuries per liter
PRG – preliminary remediation goal
TtEMI – Tetra Tech EM, Inc.

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

TABLE 2

BUILDING/AREA ASSESSMENT AND CLASSIFICATION AND ASSOCIATED ISOTOPES OF CONCERN

Building No. or Area	Contamination Potential					Contaminated Media							Potential Migration Pathways							Recommended Actions	Isotopes of Concern
	Known-Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Surface Water	Groundwater	Air	Structures	Drainage System		
PARCEL B																					
IR-07*				✓		**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Scoping Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
IR-18*				✓		**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Scoping Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
Drydock 5				✓		**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Scoping Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
Drydock 6				✓		**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Review Final Status Survey Report	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
Drydock 7				✓		**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Scoping Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
PARCEL C																					
205 and Discharge Channel				✓		**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Scoping Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
211		✓				**N**	**N**	**N**	**N**	**N**	**M**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Remediation and Final Status Survey	^{137}Cs, ^{226}Ra, and ^{232}Th

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

Building No. or Area	Contamination Potential					Contaminated Media							Potential Migration Pathways							Recommended Actions	Isotopes of Concern
	Known-Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Surface Water	Groundwater	Air	Structures	Drainage System		
224			✓			**N**	**N**	**N**	**N**	**N**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**L**	**N**	Review Final Status Survey Report	^{137}Cs, ^{239}Pu, and ^{90}Sr
253		✓				**N**	**N**	**N**	**N**	**N**	**H**	**H**	**N**	**N**	**N**	**N**	**N**	**M**	**M**	Remediation and Final Status Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, ^{90}Sr, and ^{232}Th
Drydock 2			✓			**N**	**N**	**N**	**N**	**N**	**M**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Review Final Status Survey Report	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
Drydock 3			✓			**N**	**N**	**N**	**N**	**N**	**M**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Review Final Status Survey Report	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
Drydock 4			✓			**N**	**N**	**N**	**N**	**N**	**M**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	Review Final Status Survey Report	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
PARCEL D																					
383				✓		**N**	**N**	**N**	**N**	**N**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**L**	**N**	Review Final Status Survey Report	^{3}H, ^{226}Ra, and ^{90}Sr
Gun Mole (Regunning) Pier			✓			**L**	**L**	**N**	**N**	**N**	**L**	**N**	**L**	**L**	**N**	**N**	**N**	**L**	**N**	Review Characterization Report	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

Building No. or Area	Contamination Potential					Contaminated Media							Potential Migration Pathways							Recommended Actions	Isotopes of Concern
	Known-Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Surface Water	Groundwater	Air	Structures	Drainage System		
Mahan Street-NRDL			✓			**M**	**M**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Review Final Status Survey Report	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
PARCEL E																					
500 Building Series			✓			**M**	**H**	**N**	**N**	**N**	**N**	**H**	**L**	**M**	**N**	**N**	**N**	**N**	**H**	Scoping Survey	^{241}Am, ^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
510 Site			✓			**L**	**L**	**N**	**N**	**N**	**N**	**M**	**L**	**L**	**N**	**N**	**N**	**N**	**L**	Characterization Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
510A Site			✓			**L**	**L**	**N**	**N**	**N**	**N**	**M**	**L**	**L**	**N**	**N**	**N**	**N**	**L**	Scoping Survey	^{137}Cs and ^{90}Sr
517 Site			✓			**L**	**L**	**N**	**N**	**N**	**N**	**M**	**L**	**L**	**N**	**N**	**N**	**N**	**L**	Characterization Survey	^{60}Co, ^{137}Cs, and ^{90}Sr
520 Site		✓				**M**	**M**	**N**	**N**	**N**	**N**	**M**	**M**	**M**	**N**	**N**	**N**	**N**	**L**	Characterization Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
707/Kennels		✓				**L**	**L**	**N**	**N**	**N**	**L**	**M**	**L**	**L**	**N**	**N**	**N**	**L**	**M**	Characterization Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
707 B Site				✓		**L**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**L**	**N**	**N**	**N**	**N**	**L**	Characterization Survey (as part of 707 Triangle Area Survey)	^{137}Cs, ^{226}Ra, and ^{90}Sr
707 C Site				✓		**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Characterization Survey (as part of 707 Triangle Area Survey)	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

Building No. or Area	Contamination Potential					Contaminated Media							Potential Migration Pathways							Recommended Actions	Isotopes of Concern
	Known-Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Surface Water	Groundwater	Air	Structures	Drainage System		
707 Triangle Area		✓				**L**	**H**	**N**	**N**	**N**	**N**	**H**	**L**	**M**	**N**	**N**	**N**	**N**	**M**	Characterization Survey	^{137}Cs, ^{239}Pu, ^{226}Ra, ^{90}Sr, and ^{235}U
708				✓		**L**	**N**	**N**	**N**	**N**	**L**	**N**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	Review Final Status Survey Report	^{137}Cs and ^{90}Sr
719 Site				✓		**L**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	Scoping Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
Shack 79 Site			✓			**M**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Final Status Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
Shack 80 Site		✓				**H**	**M**	**N**	**N**	**N**	**N**	**N**	**M**	**L**	**N**	**N**	**N**	**N**	**N**	Remediation and Final Status Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
Experimental Shielding Range			✓			**M**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Review Final Status Survey Report	^{60}Co, ^{137}Cs, and ^{226}Ra
IR-01/21, Industrial Landfill		✓				**H**	**H**	**N**	**N**	**N**	**N**	**N**	**M**	**M**	**N**	**N**	**N**	**N**	**N**	Review Characterization Survey Report, Remediation, and Final Status Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
IR-02, Bay Fill		✓				**H**	**H**	**N**	**L**	**N**	**N**	**N**	**M**	**M**	**N**	**L**	**N**	**N**	**N**	Characterization Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
IR-03			✓			**M**	**M**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Scoping Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
Former Salvage Yard			✓			**M**	**M**	**N**	**N**	**N**	**N**	**N**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	Scoping Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

Building No. or Area	Contamination Potential					Contaminated Media							Potential Migration Pathways							Recommended Actions	Isotopes of Concern
	Known-Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Surface Water	Groundwater	Air	Structures	Drainage System		
Shoreline		✓				**H**	**M**	**L**	**N**	**N**	**N**	**N**	**M**	**M**	**L**	**N**	**N**	**N**	**N**	Characterization Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr
BASEWIDE																					
Storm Drain Lines		✓				**N**	**L**	**N**	**N**	**N**	**L**	**H**	**N**	**L**	**N**	**N**	**N**	**L**	**M**	Scoping/Characterization Surveys of systems associated with NRDL sites or sites associated with radium use	^{137}Cs, ^{226}Ra, and ^{90}Sr
Sanitary Sewers		✓				**N**	**L**	**N**	**N**	**N**	**L**	**H**	**N**	**L**	**N**	**N**	**N**	**L**	**M**	Scoping/Characterization Survey of systems associated with NRDL sites or sites associated with radium use	^{137}Cs, ^{226}Ra, and ^{90}Sr
Septic Systems			✓			**N**	**M**	**N**	**N**	**N**	**N**	**H**	**N**	**L**	**N**	**N**	**N**	**N**	**M**	Scoping/Characterization Surveys of systems associated with NRDL buildings	^{137}Cs, ^{226}Ra, and ^{90}Sr
PARCEL F																					
Underwater Areas			✓			**N**	**L**	**N**	**N**	**N**	**N**	**N**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	Scoping Surveys in areas of Operation CROSSROADS decontamination activities and site outfall discharge	^{137}Cs, ^{239}Pu, ^{226}Ra, ^{90}Sr, and ^{235}U

SAP Worksheet #17 – Sampling Design and Rationale (Continued)

Building No. or Area	Contamination Potential					Contaminated Media							Potential Migration Pathways							Recommended Actions	Isotopes of Concern
	Known-Restricted Access	Known-Continued Access	Likely	Unlikely	Unknown	Surface Soil	Subsurface Soils	Surface Water	Groundwater	Air	Structures	Drainage System	Surface Soil	Subsurface Soil	Surface Water	Groundwater	Air	Structures	Drainage System		
All Ships' Berths				✓		**L**	**L**	**N**	**N**	**N**	**L**	**N**	**N**	**L**	**N**	**N**	**N**	**L**	**N**	Review Final Status Survey Report for completed berths; Scoping Survey on remainder	^{137}Cs, ^{239}Pu, ^{226}Ra, and ^{90}Sr
OFF-SITE FACILITY																					
ICW 418				✓		**N**	**N**	**N**	**N**	**N**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**L**	**N**	Scoping Survey	^{137}Cs, ^{226}Ra, and ^{90}Sr

Source: HRA (NAVSEA 2004)

Notes:

* Received restricted release from the State of California

H High = Evidence of contamination in the media or migration pathway has been identified.

L Low = The potential for contamination in the type of media or migration pathway is remote.

M Moderate = The potential for contamination in the media or migration pathway exists, although the extent has not been fully assessed.

N None = Evidence of contamination in the specific media or migration pathway has not been found, or known contamination has been removed, and surveys indicate that the media or migration pathway meets today's release criteria.

SAP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table

Sampling Location	Matrix	Analytical Group	Number of Samples	Sampling SOP Reference
Waste characterization samples	Soil/Water	Gamma Isotopes, Sr-90, Alpha Isotopes, and/or Tritium as required	See SAP Worksheet #17	SOP-006
Equipment surveys	Swipe	Screened on-site via field instrumentation	See SAP Worksheet #17	SOP-001 and SOP-003

Notes: Field QC samples are not applicable to waste characterization samples and are not listed above.

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SAP Worksheet #19 – Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical Method Laboratory SOP Reference	Containers	Sample Volume	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/analysis)
Soil	Gamma Isotopes	EPA 901.1 / DOE HASL 300 Ga-01-R ST-RD-0102	Gallon size resealable plastic bag or the equivalent in containers	~ 1,000 g	None	Not applicable
Soil	Sr-90	EPA 905.0 / DOE HASL 300 Sr-02 ST-RD-0403				
Soil	Alpha Isotopes	DOE HASL A-01-R ST-RD-0210				
Soil	Tritium	EPA 906.0 ST-RD-0210				
Water	Gamma Isotopes (Ra-226 only)	EPA 903.0 / EPA 9315 ST-RD-0403	1 liter plastic container	1 liter	pH ≤ 2 w/HNO_3	Not applicable
Water	Gamma Isotopes (remainder of list besides Ra-226)	EPA 901.1 / DOE HASL 300 Ga-01-R ST-RD-0102	1 liter plastic container	1 liter	pH ≤ 2 w/HNO_3	Not applicable
Water	Sr-90	EPA 905.0 / DOE HASL 300 Sr-02 ST-RD-0403	1 liter plastic container	1 liter	pH ≤ 2 w/HNO_3	Not applicable
Water	Alpha Isotopes	DOE HASL A-01-R ST-RD-0210	1 liter plastic container	1 liter	pH ≤ 2 w/HNO_3	Not applicable
Water	Tritium	EPA 906.0 ST-RD-0302	1 liter plastic container	1 liter	pH ≤ 2 w/HNO_3	Not applicable

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SAP Worksheet #21 – Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-001	Radiation and Contamination Surveys, Revision 2, 7/17/2015	TtEC	See SOP in Attachment 4 of the Work Plan	N	None
SOP-003	Release of Material and Equipment from Radiological Control Areas, Revision 3, 7/17/2015	TtEC	See SOP in Attachment 4 of the Work Plan	N	None
SOP-006	Sampling Procedures for Radiological Surveys, Revision 2, 7/17/2015	TtEC	See SOP in Attachment 4 of the Work Plan	N	None

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SAP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
Ludlum Mod 3 or 12 Meter w/ 44-9 detector (or equivalent); Ludlum Model 19 (or equivalent); Ludlum 2350-1 w/ 44-10 detector (or equivalent); Ludlum 2360 w/ 43-68 detector (or equivalent); Ludlum 2360 w/ 43-89 detector (or equivalent); Eberline Model RO-20 (or equivalent); Ludlum 2360 w/ 43-93 (or equivalent); Ludlum 2929 w/ 43-10-1 (or equivalent).	1. Calibrate at laboratory featuring NIST traceable standards 2. Operational checks and verifications	1. Annually 2. Daily	1. Pass/fail 2. +/- 20% of baseline response criteria	1. If recalibration fails, then instrument combo is retained/exchanged by instrument vendor. 2. If checks and verifications fail, then instrument combo is placed OOS/returned to instrument vendor for repair/exchange. Subsequently, data collected with instrument since previous QC check will be reviewed.	Site Instrument Mechanic or Radiological Control Technician under direction of Project Supervisor (with oversight from project/ license RSO)	SOP-002 (as provided in Attachment 4 of the Work Plan)	None

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SAP Worksheet #23 – Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
ST-RD-0102	Gammavision Analysis, Revision 12, 04/16/14	Definitive	Soil/Water Gamma Isotopes	Germanium Spectroscopy System	TestAmerica	N
ST-RD-0403	Low Background Gas Flow Proportional Counting System Analysis Revision 14, 09/12/13	Definitive	Soil/Water Sr-90 and Ra-226 (water)	Gas Flow Proportional Counter	TestAmerica	N
ST-RD-0210	Alpha Spectroscopy Analysis Revision 11, 08/21/13	Definitive	Soil/Water Alpha Isotopes	Alpha Spectrometer	TestAmerica	N
ST-RD-0302	Liquid Scintillation Counter Analysis Revision 14, 05/08/13	Definitive	Soil/Water Tritium	Lquid Scintillation Counter	TestAmerica	N

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SAP Worksheet #28 – Laboratory QC Samples Table

Matrix: Soil/Water
Analytical Group: Gamma Isotopes
Analytical Method/SOP Reference: EPA 901.1 or DOE HASL 300 Method GA-01-R / ST-RD-0102

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Background Sample	Daily	Absolute value < MDC	[a]	TestAmerica Analyst	Accuracy	Absolute value < MDC
LCS	Weekly Weekly and may be performed 1 per preparatory batch (defined as ≤ 20 samples) for FSS samples	Gamma source check ± 20% of known activity Cs-137: 87 – 120% Co-60: 87 – 115%	[b]	TestAmerica Analyst	Accuracy	Gamma source check ± 20% of known activity Cs-137: 87 – 120% Co-60: 87 – 115%
Sample Duplicate	1 per preparatory batch (defined as ≤ 20 samples)	RPD ≤40% or RER ≤1	[c]	TestAmerica Analyst	Precision	RPD ≤40% or RER ≤1

SAP Worksheet #28 – Laboratory QC Samples Table (Continued)

Matrix: Soil/Water
Analytical Group: Sr-90 and Ra-226 (water)
Analytical Method/SOP Reference: EPA 905.0 or 905 / ST-RD-0403

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1 per preparatory batch (defined as ≤ 20 samples)	Analytes < MDC	[a]	TestAmerica Analyst	Accuracy	Analytes < MDC
LCS and/or LCSD	1 per preparatory batch (defined as ≤ 20 samples)	88–136% RPD ≤40% and/or RER ≤1	[b]	TestAmerica Analyst	Accuracy	88–136% RPD ≤40% and/or RER ≤1
Sample Duplicate	1 per preparatory batch (defined as ≤ 20 samples)	RPD ≤40% and/or RER ≤1	[c]	TestAmerica Analyst	Accuracy	RPD ≤40% and/or RER ≤1
Tracers	Per sample, blank, LCS, LCSD, duplicate	Sr and/or Y tracers: 40–110%	[d]	TestAmerica Analyst	Accuracy	Sr and/or Y tracers: 40–110%

SAP Worksheet #28 – Laboratory QC Samples Table (Continued)

Matrix: Soil/Water
Analytical Group: Alpha Isotopes
Analytical Method/SOP Reference: DOE HASL A-01-R / ST-RD-0210

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1 per preparatory batch (defined as ≤ 20 samples)	Analytes < MDC	[a]	TestAmerica Analyst	Accuracy	Analytes < MDC
LCS and/or LCSD	1 per preparatory batch (defined as ≤ 20 samples)	70–130% RPD ≤40% and/or RER ≤1	[b]	TestAmerica Analyst	Accuracy	70–130% RPD ≤40% and/or RER ≤1
Sample Duplicate	1 per preparatory batch (defined as ≤ 20 samples)	RPD ≤40% and/or RER ≤1	[c]	TestAmerica Analyst	Accuracy	RPD ≤40% and/or RER ≤1
Tracer	Per sample, blank, LCS, LCSD, duplicate	30–110%	[d]	TestAmerica Analyst	Accuracy	30–110%

SAP Worksheet #28 – Laboratory QC Samples Table (Continued)

Matrix: Soil/Water
Analytical Group: Tritium
Analytical Method/SOP Reference: EPA 906.0 / ST-RD-0302

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method Blank	1 per preparatory batch (defined as ≤ 20 samples)	Analytes < MDC	[a]	TestAmerica Analyst	Accuracy	Analytes < MDC
LCS and/or LCSD	1 per preparatory batch (defined as ≤ 20 samples)	78–122% RPD ≤40% and/or RER ≤1	[b]	TestAmerica Analyst	Accuracy	78–122% RPD ≤40% and/or RER ≤1
Sample Duplicate	1 per preparatory batch (defined as ≤ 20 samples)	RPD ≤40% and/or RER ≤1	[c]	TestAmerica Analyst	Accuracy	RPD ≤40% and/or RER ≤1

Notes:

[a] Any sample associated with a background sample or method blank that fails the criteria checks will be reprocessed in a subsequent preparation batch, except when the sample analysis resulted in a non-detect. If no sample volume remains for reprocessing, the results will be reported with appropriate data qualifying codes.

[b] Reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.

[c] Reprep and reanalyze the sample and duplicate in the associated preparatory batch for failed analytes if sufficient sample material is available and the sample is homogeneous. If RPD/RER still out of range, report as matrix interference confirmed and write a nonconformance. If reanalysis is in range, re-extract samples in batch.

[d] The data will be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.

SAP Worksheet #30 – Analytical Services Table

Matrix	Analytical Group	Sampling Locations/ ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/ Organization (contact information)	Backup Laboratory/ Organization (contact information)
All	All	All	All	Initial analytical results due at turnaround time are due to TtEC from anywhere to 10 to 21 business days depending upon analysis. Then, ten business days after receipt of that data, the laboratory will submit a Level IV-type data package as described in SAP Worksheet #14.	TestAmerica 13715 Rider Trail North Earth City, MO 63045 (314) 298-8566	TestAmerica 2800 George Washington Way Richland, WA 99354 (509) 375-3131

TestAmerica in Earth City, MO has been selected to analyze samples for this project, and they have successfully completed the Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) certification for the matrices and methods listed in SAP Worksheet #19 and will maintain current status throughout the duration of this project. The laboratory is capable of providing the project QC and data deliverables required by this SAP and the Quality Systems Manual (QSM) for Environmental Laboratories Version 4.2 (DoD 2010). TestAmerica in Earth City, MO may be updating their DoD ELAP certification to the new version of the QSM (Version 5.0 published in July 2013) by January 2016; therefore, TestAmerica in Earth City may use QSM Version 5.0 requirements once their certification is updated for this project.

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SAP Worksheet #34 – Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification (Title and Organizational Affiliation)
Field logbook	Field logbooks will be reviewed weekly and verified for information accuracy and completeness. The inspection will be documented in daily QC reports.	I	PQCM, TtEC
COC records	COC records will be reviewed daily upon their completion and verified for completeness.	I	PQCM, TtEC Project Chemist, TtEC
Sample receipt	The Project Chemist will verify receipt of samples by the laboratory.	I	Project Chemist, TtEC
Sample logins	Sample login information will be reviewed and verified for accuracy and completeness in accordance with the requirements in this SAP.	E	Laboratory PM, TestAmerica
Laboratory analytical results prior to release	Laboratory analytical results will be reviewed to verify that the requirements in this SAP have been met. Prior to release, results will be verified as follows:	E	Laboratory PM, TestAmerica
	All analytical results (100 percent) comply with the method- and project-specific requirements and any deviations or failure to meet criteria is documented for the project file.	E	Analyst, TestAmerica
	All manual entries (100 percent) are free of transcription errors and manual calculations are accurate; computer calculations are spot-checked to verify program validity; results reported are compliant with method- and project-specific QC requirements; raw data and supporting materials are complete; spectral assignments are confirmed; descriptions of deviations from method or project requirements are documented; significant figures and rounding have been appropriately used; reported values include dilution factors; and results are reasonable.	E	Peer Analyst, TestAmerica
	Analytical results reported are compliant with method- and project-specific QC requirements; the reported information is complete; the information in the report narrative is complete and accurate; and results are reasonable.	E	Supervisor, TestAmerica
	Analytical results reported are compliant with method- and project-specific QC; analytical methods are performed in compliance with approved SOPs. This review may be conducted after release of results since reviews are done only on 10 percent of the results.	E	Laboratory QA Manager, TestAmerica

SAP Worksheet #34 – Verification (Step I) Process Table (Continued)

Verification Input	Description	Internal/ External	Responsible for Verification (Title and Organizational Affiliation)
Laboratory analytical results due at turnaround time listed on COC	Laboratory analytical results will be verified for having been obtained following the protocols in this SAP.	I	Project Chemist, TtEC
Laboratory data packages	EPA Level IV-equivalent laboratory data packages will be verified by the laboratory performing the work for completeness and technical accuracy prior to submittal in accordance with requirements described in SAP Worksheet #14.	E I	Laboratory PM, TestAmerica Project Chemist, TtEC
Field and electronic data	One hundred percent of manual entries will be reviewed against the hardcopy information and 10 percent of electronic uploads will be checked against the hardcopy.	I	Project Chemist, TtEC

REFERENCES

DoD (Department of Defense). 2010. Quality Systems Manual for Environmental Laboratories. Version 4.2. October.

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EPA (U.S. Environmental Protection Agency). 2000. Radionuclides Notice of Data Availability Technical Support Document. Targeting and Analysis Branch, Standards and Risk Management Division, Office of Groundwater and Drinking Water, EPA. March.

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NAVSEA (Naval Sea Systems Command). 2004. Final Historical Radiological Assessment, Volume II. August 31.

TtEC (Tetra Tech EC, Inc.). 2011. Survey Unit Project Reports Abstract for Sanitary Sewer and Storm Drain Removal Conducted After January 1, 2011, Hunters Point Naval Shipyard, San Francisco, California. July.

TtEMI (Tetra Tech EMI, Inc.). 2000. Draft Phase IV Radiation Investigation Report, HPS, San Francisco, California. May 15.

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ATTACHMENT 4

STANDARD OPERATING PROCEDURES

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Standard Operating Procedure

RADIATION AND CONTAMINATION SURVEYS

SOP-001

Revision 2

Approved By:

Steven Adams, CHP, Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/9/12	0	E. Abkemeier	Original	All
8/15/14	1	E. Abkemeier	Provided clarification regarding alpha scanning, efficiencies, and static counts	8-10
7/17/15	2	S. Adams	Revised definitions, inserted section on roles and responsibilities, revised alpha and beta scan instrument and surface efficiencies, added references and attachment on example of quality control checks, added section on leak testing	4-22

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1.0 PURPOSE

The purpose of this procedure is to specify methods and requirements for radiological surveys, and to provide documentation of acquired survey data. Adherence to this procedure will provide reasonable assurance that the surveys performed are accurate and representative of the radiological conditions. The guidance for control of radiation exposures provided in this procedure is in accordance with the "as low as reasonably achievable" philosophy.

2.0 SCOPE

This procedure shall be implemented by Tetra Tech EC, Inc. (TtEC) staff and subcontractor personnel when conducting radiation or contamination surveys.

3.0 DEFINITIONS AND ABBREVIATIONS

Activity – The rate of disintegration (transformation) or decay of radioactive material. The units of activity for the purpose of this procedure are disintegrations per minute (dpm) for loose and fixed surface contamination, picocuries per gram for soil, or microcuries per milliliter for airborne contamination.

Client Agency – Organization given the authority to approve or reject a decision to allow free release of material or equipment, e.g., state or federal regulatory agency, Navy Radiological Affairs Support Office.

Client Representative – Client decision maker given the authority to approve or reject a decision to allow free release of material or equipment. The client representative is defined in the appropriate work control document, e.g., client Radiation Safety Officer (RSO), Project Manager (PM), or Program Manager. The client representative may be an individual in the client agency.

Contamination – Deposition of radioactive material in material/debris. Contamination may be due to the presence of alpha particles, beta particles, or gamma-ray-emitting radionuclides.

Exposure/Dose Rate – The amount of radiation (exposure or dose) delivered at a given point per unit time. Typical units for exposure are microroentgen per hour, while typical units for dose are micro rem per hour.

Fixed Contamination – Radioactive material that has been deposited onto a surface and cannot be readily removed by non-destructive means, such as casual contact, wiping, brushing, or laundering. Fixed contamination does not include radioactive material that is present in a matrix, such as soil or cement, or radioactive material that has been induced in a material through neutron activation processes.

Minimum Detectable Activity – The smallest activity that can be detected with specific confidence for a given portable survey instrument and specific survey technique. The minimum detectable concentration (MDC) is usually specified as the smallest activity concentration that can be detected with 95% confidence (i.e., 95% of the time, a given instrument and measurement procedure will detect activity at the MDC).

Minimum Detectable Concentration – The *a priori* estimate of the true concentration of a radionuclide required to give a specified high probability that the *measured* response will be greater than the critical detection and quantification capabilities value for a specific portable survey instrument using a specific measuring technique.

Removable Surface Contamination – Radioactive contamination that is readily removed from a surface by non-destructive means, such as casual contact, wiping, brushing, or washing.

Total Surface Contamination – The sum of the fixed and removable surface contamination.

Work Control Document – Authorized document that defines the criteria and data quality objectives (DQOs) for performing surveys, sampling, and radioanalysis used to define the surface and subsurface radioactive concentrations. The criteria and DQOs may be more stringent than the requirements in this standard operating procedure (SOP). The work control documents also define the client representative and client agency. Examples of work control documents include Task-Specific Plans, Sampling and Analysis Plans, Radiation Protection Plans, Characterization and Remediation Plans, and Final Status Survey Plans.

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this SOP are defined below.

4.1 Radiation Safety Officer

The RSO is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO makes an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

The RSO performs the following tasks:

- Provide technical assistance in the development and implementation of project surveys.

Review and approve technical decisions for not requiring a survey, down posting an area based on survey results, or revising survey methods that are not addressed or defined in the appropriate approved work plan documents.

- Review and approve technical decisions addressing instrument sensitivity to detect the nuclides present at a fraction of the control levels.
- Review and approve technical decisions addressing release criteria for potentially contaminated soil, asphalt, concrete, debris, and liquids.
- Periodically review project survey programs to ensure compliance with approved SOPs and authorized work control documents.

In the event the Radiation Safety Officer Representative (RSOR) is not available on site to perform the duties, the RSO is to designate a temporary RSOR.

4.2 Radiation Safety Officer Representative

The RSOR performs the following tasks:

- Ensures effective implementation of the radiological survey program and ensures that the program is in compliance with the radioactive material license and regulatory requirements.
- Communicates significant changes or any unexpected radiological condition(s) to the PM and the RSO.
- Provides supervision and guidance to Radiation Control Technicians (RCTs) regarding performing and conducting surveys.
- Ensures that appropriate instrumentation, protective devices, dosimetry, and other items needed to perform surveys, in addition to training activities, are in accordance with SOPs and approved project documents, and are available and used properly.

- Interfaces with the PM on radiological survey issues.
- Exercises independent lines of communication to the RSO as needed to ensure the survey requirements are fully implemented.
- Maintains survey reports as required in the authorized project documents.
- Acts as a primary project point of contact for radiation survey-related communications.

The RSOR, or his/her designee, is responsible for the following activities.

- Serves as an authorized user and is on site during the majority of project activities and all high-risk evolutions.
- Implements, directs, and supervises all radiological survey activities on the project.
- Provides radiological technical advice and guidance during execution of surveys.
- Provides radiological material-related safety briefings.
- Approves all survey documents.

4.3 Radiation Control Technicians

The RCT performs the following tasks:

- Ensures the instrument is set up, as required in accordance with SOP 002, prior to use.
- Performs survey tasks and documents results in accordance with approved SOPs and authorized work documents.
- Communicates significant changes in the work area configuration, controls, or unexpected high or low survey results that demonstrate unexpected radiological conditions to the RSOR.
- Communicates the survey results to the RSOR.
- Documents the survey results completely and accurately.
- Maintains the survey system parameters (e.g., scan speeds, static survey count time, survey acquisition times, instrument system settings), unless trained, qualified, and authorized in writing by the RSOR or his/her designee.

5.0 PROCEDURE DETAILS

The procedures to follow in conducting activities under this SOP are provided below.

5.1 General

Radiation surveys are performed to identify radiation and contamination areas; measure the contamination levels, exposure and/or dose rate; and assess the intensity and shape of those areas to determine control requirements at the worksite.

Contamination surveys are conducted to detect loose surface contamination and total contamination. Loose surface contamination is normally detected indirectly by a swipe sample performed on the item or surface of interest. Total surface contamination levels are measured directly.

Survey results, locations, and any unusual conditions shall be documented and described on survey forms, e.g., Attachments 1 and 2, *Radiation/Contamination Survey Form*, and

Radiation/Contamination Survey Supplement, respectively. Attachment 3, *Example of a Survey Check List,* or equivalent, should be used to ensure that the survey complies with the appropriate quality control requirements and recommendations defined in the work control document.

When performing surveys, express readings as the actual observed number. Do not report that the reading is less than the minimum detectable activity (<MDA) or less than background (<bkg.). When background corrections are made, results may be expressed as negative numbers, as applicable. Field backgrounds and instrument system efficiencies will be checked and MDC calculations verified each work day.

5.1.1 Discussion

Radiation and contamination surveys shall be performed on an as-needed basis. The need for a survey is identified by, but not limited to, the following conditions:

- A condition exists where radiological data are needed.
- An investigation is required due to abnormal conditions or indications.
- An ongoing job requires a survey to update radiological postings.
- A routine survey is required to meet TtEC's Nuclear Regulatory Commission Radioactive Materials License or Agreement State Radioactive Materials License.
- A survey is required to support Multi-Agency Radiation Survey and Site Investigation Manual-based (NRC et al. 2000) survey activities.
- A survey is required to comply with work control documents.
- A survey is required at the direction of appropriate client agency representatives.

5.1.2 Planning and Prerequisites

Instruments used to perform radiation and contamination surveys shall be operated in accordance with the specified operation procedures. Steps to be completed during the planning phase include the following:

- Obtain appropriate survey instruments and prepare the instruments for use.
- Obtain the necessary forms, swipes, and applicable protective clothing that will be used during the survey.

Prior to entering an area to perform a survey, each radiation detection instrument shall be:

- Checked to make sure the battery is charged.
- Checked for obvious physical damage.
- Checked to identify background count rates for alpha/beta/gamma detector systems.
- Quantitatively response-checked daily, prior to use.
- Checked to ensure that the instrument calibration is current.

If any of the above conditions are unsatisfactory, the instrument shall be tagged "out of service" and not used.

5.2 Procedure Process

The processes required for various types of surveys are described in the following sections.

5.2.1 Exposure/Dose Rate Surveys

Always survey a sufficient number of locations to determine the average and maximum general area and contact radiation levels. Comply with the authorized guidance contained in the work control document regarding the number of measurements needed to determine average, maximum, and contact radiation levels.

A Ludlum Model-19, Bicron MicroREM, or equivalent meter, should be used for performing radiation exposure or dose rate surveys. The instrument should be operated in accordance with the manufacturer-supplied operations manual and any applicable requirements from work control documents. Care should be taken to ensure that the instrument has been allowed to stabilize between individual measurements.

When performing general area exposure/dose rate surveys, the RCT should:

- Attempt to determine the source of radiation fields.
- Record the highest level as the general area exposure/dose rate.
- Perform contact exposure/dose rate measurements with the detector at the appropriate distance for the specific detector, typically 1–2 inches from the surface to be surveyed.
- Perform surveys at approximately 1 meter (waist level) from the ground or floor surface to establish posting requirements for the area.
- Include dose rate measurements of the general area, dose rates at a distance of 30 centimeters from a source or surface of interest to evaluate potential whole-body exposures, and dose rates on contact with potential sources of radiation where there is potential for hands-on work.
- Verify the exposure/dose rates of known elevated exposure/dose rate locations.

5.2.2 Removable Contamination Surveys

Procedures for conducting removable contamination surveys are described below.

5.2.2.1 Removable Contamination Swipe

The following guidance shall be used unless an approved site-specific survey/work instruction suggests to do otherwise.

5.2.2.2 Swipe Surveys

1. Label or number swipes, as necessary, to identify each swipe.
2. Wipe the swipes over approximately 100 square centimeters (cm^2) (16 square inches) of the surface to be sampled.
3. Apply moderate pressure.
4. Exercise care on rough surfaces so as not to tear the swipes.
5. Exercise care on wet surfaces so as not to degrade the swipes. Ensure that surfaces are not submerged in water, and that cloth swipes, or similar, are used on wet/damp surfaces.

When surveying an area:

1. Obtain swipes from sample points that are representative of the average and maximum contamination levels in the area, as identified during preliminary surveys. These areas could include:
    a. Areas of high traffic.
    b. On and under benches or tables.
    c. Beneath piping and components.
    d. On accessible wall surfaces.
    e. On piping and significant components.
    f. Near drains, sumps, and low spots.
2. Swipe floor and component surfaces that display evidence of (potentially) contaminated fluid leaks.
3. Ensure that contamination is not spread to clean areas when obtaining swipes.
4. Indicate on Attachment 2 when wipes of items smaller than 100 cm^2 are collected to avoid erroneous interpretation.

When surveying equipment:

1. Obtain swipes on exposed surfaces.
2. Obtain swipes in cracks or crevices where contamination may have settled.
3. Obtain swipes on openings to internal surfaces.
4. Handle swipes in a manner that will prevent cross-contamination.

5.2.2.3 Counting Swipes

A Ludlum Model-2929 scaler with a Model 43-10-1 ZnS(Ag) scintillation probe (or equivalent) or Protean Alpha/Beta Gas Flow Proportional Counter (or equivalent) may be used.

1. Count the swipes in accordance with the operating procedure for the instrument.
2. Record swipe results in dpm/100 cm^2.
3. Store/archive used swipes as radioactive material until disposal is approved by the client representative.

5.2.2.4 Removable Contamination Surveys Using Large-area Wipes

Large-area contamination surveys using large-area wipes (LAWs) are appropriate for monitoring the radiological status of non-contaminated areas or equipment, to track area decontamination progress, or to initially verify that surfaces are free of contamination. LAWs survey results can also be obtained to evaluate general conditions and trends.

No specific requirements exist concerning the amount of area to be wiped when performing LAWs. The area wiped should be determined based on survey data and the dust loading of the

LAW material. When documenting results of LAWs on Attachment 1 or 2, indicate that the wipes used are not 100 cm^2 in area.

5.2.2.5 Performing LAWs

Use masslin, oil-impregnated cloths, or equivalent media to perform LAWs. Select an appropriate collection material and method based upon the survey conditions, such as wet surfaces, rough surfaces, heavily soiled areas, and oily and greasy surfaces.

1. Label or number the cloths, as necessary, to assist in determining the location of the sample.
2. Determine the size of the area to be sampled based on the survey requirements.
3. Wipe the collection media over the surface using moderate pressure by hand, with a masslin mop, or other approved techniques.

5.2.2.6 Evaluating LAWs

1. Allow wet LAWs to dry prior to counting.
2. Scan the LAW with an appropriate field instrument (Ludlum Model-2360 meter with a 43-89 probe, or equivalent), in an area with a low background concentration.
3. Hold the detector within a quarter inch of the swipe and move the detector over the swipe at a maximum rate of 1 inch per second.
4. If any indication of an increased count rate is noted, pause to allow the meter reading to stabilize.
5. If the swipe reading is indistinguishable from background, consider the surveyed surface to be free of contamination. If the LAW reading is greater than background, conduct further surveys to isolate the boundaries of the contamination.

5.2.3 Surveys for Fixed Alpha/Beta Contamination

Fixed contamination surveys are used to obtain indications of fixed contamination levels on building surfaces, equipment, vehicles, furniture, or tools used for characterization and/or release surveys. Fixed contamination surveys are also performed to assess whether the residual contamination is greater than the release criteria for the radionuclide(s) of concern.

A Ludlum Model-2360 datalogger with a 43-68 gas flow proportional detector or 43-89 scintillation detector, or equivalent, should be used when performing fixed contamination surveys for alpha and beta contamination. For large-area surveys of alpha and beta contamination, a Ludlum Model-2360 datalogger with a 43-37 series detector, or equivalent, or the area radiation monitoring instrument may be used.

5.2.3.1 Scans

1. When surveying for fixed alpha/beta contamination, the probe should be held within a quarter inch or less of the surface being surveyed. The movement rate of the detector probe should be 4 centimeters per second or slower, unless specified otherwise in the work control document for a specific survey. Note that alpha surveys involve listening and monitoring for 1 or more counts over a specified time interval when using a 43-68 detector, or equivalent, or 2 or more counts over a specified time interval when using a 43-37 series detector, or equivalent, unless specified otherwise in the work control

document for a specific survey. **This time interval must be programmed into the Ludlum Model-2360 datalogger, per the operator's manual, prior to commencing surveying.** Follow-up investigations will consist of pausing over the area registering the counts. If the counts are duplicated or exceeded, a two minute static count with a Ludlum Model 43-68 detector, or equivalent, is necessary for verification of potential fixed contamination.

2. When performing direct scan surveys of objects, surfaces, materials, equipment, etc., static measurements should be performed frequently to ensure the detection of residual activity.
3. Whenever practical, 100 percent of accessible areas being surveyed should be direct-scan surveyed, unless the applicable W Control document indicates otherwise.
4. Scan ranges are documented as the range from the lowest measurement to the highest measurement observed, unless more detailed documentation is required in the work control document for a specific survey.

5.2.3.2 Static

1. Count time for conducting static measurements will be dependent upon the isotope of concern and the MDA for the instrument being used.
2. Static measurements should be performed as specified in the work control document, or frequently enough to ensure the detection of residual activity. A typical static count time for alpha-emitting radionuclides is 2 minutes to ensure an acceptable MDA is achieved. Note that the desired MDA to be achieved is typically 50% of the applicable release criterion to be achieved, but the MDA to be achieved shall not exceed 90% of the release criterion to be achieved unless specified otherwise in the work control document for a specific survey. For example, for an alpha release criterion of 100 dpm/100 cm^2, a target MDA is 50 dpm/100 cm^2, but 90 dpm/100 cm^2 is considered acceptable.
3. When taking a static measurement for fixed alpha/beta contamination, the probe should be held within a quarter inch or less of the surface being surveyed.
4. Results should be reported in units of net counts per minute (cpm) above background or dpm/100 cm^2.

The following formula should be used for converting direct probe readings in cpm to dpm/100 cm^2:

$$A_S = \frac{R_{S+B} - R_B}{\varepsilon_i \varepsilon_s \frac{W_A}{100\,\mathrm{cm}^2}}$$

where

A_S = total surface activity (dpm/100 cm^2)
R_{S+B} = gross count rate of the measurement in cpm
R_B = background count rate in cpm
ε_i = instrument efficiency (counts per particle)
ε_s = surface efficiency (particles per disintegration)
W_A = physical area of the detector window (cm^2)

Background, R_B, is a function of the material being surveyed. For example, the ambient alpha background for a Ludlum Model 43-68 in a low background area may be 1 cpm, but the count rate for non-impacted concrete or dry wall is typically 2–7 cpm, for brick is 6 cpm, and for ceramic floor tiles is 15 cpm (Abelquist et al. 1998). The background count rate for beta emissions is relatively uniform for most materials (Abelquist et al. 1998). Surface material background count rates should be collected to reduce the probability of false positive for potential alpha emitters.

The instrument efficiency, ε_i, is defined as the ratio between the net count rate of the instrument and the surface emission rate of a source for a specified geometry and particle energy. The surface emission rate, $q_{2\pi}$, is defined as the "number of particles of a given type above a given energy emerging from the front face of the source per unit time" (IOS 1988). NUREG-1507 shows instrument alpha efficiencies calculated using a distributed source, equal in area to the detector window, reduced from 0.473 to a ε_i of 0.273 for a point source (Abelquist et al. 1998). Adjustments should be made for the area of potential alpha contamination when the surface contamination approaches the release criterion. Instrument efficiencies for beta particles are highly dependent on the beta energy (Abelquist et al. 1998). The ε_i for strontium-90, a common beta emitter used in calibration, for a gas-proportional detector is typically 0.36. The εi for the beta emitters in the uranium-238 decay chain or for low-energy beta emitting fission and activation products is 33 percent lower at 0.24 (Abelquist et al. 1998). To the extent practical, the energy of the beta calibration source should match the beta energies of the potential beta contaminants.

The surface efficiency is a function of the surface material, the energy of the particle, the distance from the surface to the detector, and condition of the surface. The effects of these parameters are addressed in detail in Chapters 4 and 5 of NUREG-1507 (Abelquist et al. 1998). ISO-7503-1 recommends a surface efficiency of 0.25 for beta emitters with maximum energies between 0.15 and 0.4 million electron volts (MeV), and 0.5 for beta emitters with maximum energies exceeding 0.4 MeV.

In the absence of experimentally determined surface efficiencies, NUREG-1507 provides conservative recommendations for the total efficiency, $\varepsilon_s \times \varepsilon_i$, of 0.20 for alpha emitters and 0.25 for beta emitters for 100 cm^2 gas-proportional detectors (Abelquist et al. 1998).

5.2.4 **Gamma Surveys**

A Ludlum Model-2350-1 meter with a 44-10 probe, or equivalent, should be used for gamma radiation surveys. For large outdoor areas, a client representative-approved vehicle-towed array system may be used in accordance with *SOP 013, Vehicle-towed Array*. For indoor gamma surveys, a large area detector, such as a Ludlum Model 43-37 series, may be used in accordance with client representative approval.

5.2.4.1 Scans

1. Set the audio response switch to the “on” position.
2. If a single detector is used, traverse a path at a maximum speed of approximately 0.5 meter per second, and slowly move the detector assembly in a serpentine (S-shaped) pattern, while maintaining the detector approximately 10 centimeters (cm) (4 inches) from the area being surveyed unless specified otherwise in an authorized work control document.
3. If a detector array is used, push or pull the detector in a straight line, with the detector centers positioned approximately 30 cm apart.

4. Record the scan ranges from the lowest reading to the highest reading noted.
5. If data logging is being performed, collect the scan data at the time interval necessary to obtain the measurements required for the survey.
6. Mark the locations where the count rates exceeded 3 standard deviations above the mean background reference area for further investigation. Alternatively, with client representative approval, mark the locations where the count rates exceeded 3 standard deviations above the mean count rate of the survey unit for further investigation.
7. Record the measurement results in cpm.

5.2.4.2 Static

1. For static gamma measurements, position the detector assembly approximately 10 cm (4 inches) above the surface and complete a stationary 60-second survey.
2. Perform the static measurements as frequently as recommended in the applicable work control document, or frequently enough to ensure the detection of residual activity.
3. Record the results in cpm.

5.2.4.3 Leak Test

Except for sealed radioactive sources consisting solely of gaseous radioactive material or tritium, each accountable sealed radioactive source shall be leak tested upon receipt, when damage is suspected, and at intervals not to exceed six months. The time period to conduct leak test activities may be extended, with the approval of the RSOR, by a period not to exceed 30 days to accommodate scheduling needs. An accountable sealed radioactive source found to be leaking shall be controlled in a manner that minimizes the spread of contamination. Sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with the operations involving the sources.

5.2.4.4 Leak Test Criterion

Source leak tests shall be capable of detecting radioactive material leakage equal to or exceeding 0.005 microcurie (i.e., 11,100 dpm). Radioactive analysis shall be for the appropriate type of radiation emitted by the source (i.e., alpha emitter source shall be leak tested/analyzed for alpha radiation; beta emitter source shall be leak tested/analyzed for beta radiation; gamma emitter source shall be leak tested/analyzed for beta/gamma radiation). Radioactive source leak test results shall be recorded in a format equivalent to the information specified in Attachment 4. All leak test results shall be documented and provided to the RSOR.

5.2.4.5 Leak Testing of Exempt Sources

Good radiation protection practice requires that leak tests of exempt radioactive sources and/or other forms of radioactive materials (e.g., sealed, unsealed, or containers of liquids or gases) be periodically performed to verify the integrity of the source container, shield or device containing such a source. It is recommended that exempt radioactive sources be leak tested and inventoried at six-month intervals along with the accountable sealed radioactive sources.

5.2.4.6 Leak Test Criterion for Liquid or Gaseous Sources

Sealed or contained radioactive sources consisting solely of liquid or gaseous radioactive material (e.g., krypton or tritium) are not required to be periodically leak tested; however, good radiation protection practice requires that such leak tests be periodically performed to check for the integrity of the containment of the liquid or gaseous radioactive material.

5.2.4.7 Leak Test for Small and Electroplated Sources

For sources having surface areas less than 100 cm^2, the leak test (i.e., swipe) should be taken over as much of the accessible surface area of the source as possible. For electroplated sources (e.g., alpha and beta sources), the electroplated surface area containing the radioactive material should not be directly handled or directly swiped; but the reverse side of the electroplated surface or the container for protecting/storing the source shall be swiped to serve as the source leak test. The leak test of a radioactive source contained within a shield or device may be checked by swiping as much of the container's external surface area as possible (e.g., 100 cm^2, if possible) where contamination is most likely to occur from a failure of the source integrity.

5.2.4.8 Exceeded Prescribed Time Interval

If a leak test of a sealed radioactive source cannot be performed within the prescribed time interval, the source will be removed from service and tagged as "not-in-service."

5.2.4.9 Exceptions

Equipment or a device containing a radioactive source need not be disassembled just to perform routine leak tests of the source. An accountable sealed source shall not be subject to periodic inventory and source leak testing if that source is located in an area that is unsafe for human entry or is otherwise inaccessible. The inventory record shall so indicate the specific location of the source and that such a source is inaccessible or unsafe to access.

5.2.4.10 "Not-In-Service" Radioactive Sources

A radioactive source is not subject to periodic leak testing every six months if that source is removed from service. A "not-in-service" source should be identified and stored in a controlled location. The "not-in-service" source shall be physically inventoried on at least a 6-month schedule. The inventory record for radioactive sources should indicate each "not-in-service" source. Prior to being returned to service, a "not-in-service" radioactive source shall be leak tested.

To expedite the physical inventory of "not-in-service" radioactive sources, such sources may be contained within a protective container (e.g., a paint can, 30-gallon steel drum) that is appropriately labeled and sealed to visually indicate if the protective container has been opened. A listing of all radioactive sources within the protective container may be maintained, and, so long as the sealed protective container has not been opened, a physical inventory of each source contained within need not be completed. Good radiation protection practice requires that such protective containers of "not-in-service" radioactive sources should be periodically swiped (e.g., at least once per year) to detect whether external contamination of the container has occurred, thereby determining the integrity of the sources contained within. A protective container with "not-in-service" liquid or gaseous radioactive sources should be periodically swiped on its external surface (e.g., once per year) to verify the integrity of such liquid and gaseous "not-in-service" radioactive sources.

5.2.4.11 Leaking Radioactive Sources

Sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with the operations involving the sources. An accountable sealed radioactive source found to be leaking radioactive material at any level of measured contamination shall be removed from service and controlled in a manner that minimizes the spread of contamination. For a leaking radioactive source, the following actions should be considered:

- Removing the source from service, and so indicating on the inventory record.
- Containing the source by appropriate means (e.g., bagging in plastic, placing in glass/plastic container).
- Marking the "leaking source" container to warn personnel of its contamination status.
- Providing a proper storage location for the leaking source so that contamination is controlled.
- Notifying the RSOR immediately so that a timely decision may be made regarding whether to dispose of the leaking source, or to decontaminate or repackage the leaking source.
- Decontaminating the source and its container, as directed by the RSOR

Each item or container/device/shield of a radioactive source, whether accountable or exempt, shall bear a durable, clearly visible label (or tag) bearing the standard radiation warning trefoil and the words "Caution, Radioactive Material" or "Danger, Radioactive Material," as required by the licensing agency. The label/tag shall also provide sufficient information to permit individuals handling, using, or working in the vicinity of the items or containers to take precautions to avoid or control radiation exposures. Labels shall have a yellow background with a magenta or black standard radiation symbol. Lettering shall be magenta or black. The label associated with packaged radioactive material shall be visible through the package or affixed to the outside.

Radioactive material labels/tags applied to sealed radioactive sources may be excepted from the regulatory color specifications of 10 CFR 835.601 for radiological warning postings. The RSOR shall ensure that each radioactive source is properly labeled. Labels shall contain, to the extent practical, the following current information:

- Radionuclide(s)
- Activity
- Date of assay
- Serial number or identification number
- RSOR name and contact phone number
- Other pertinent information (e.g., radiation level, removable contamination level, date of last leak test), as applicable

6.0 RECORDS

The following records were referenced in this SOP:

- Radiation/Contamination Survey Form
- Radiation/Contamination Survey Supplement
- Example of a Survey Quality Control Checklist

7.0 REFERENCES

Reference	*Title*
IOS, 1988	Evaluation of Surface Contamination - Part 1: Beta Emitters and Alpha Emitters, 1st Ed., International Organization for Standardization, Geneva, SW (ISO-7503-1)
NRC, 2000	Multi-Agency Radiation Survey and Site Investigation Manual (NUREG-1575), Washington, D.C.
Abelquist, E.W., W.S. Brown, G.E. Powers, A.M. Hutfert, 1998	Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions (NUREG-1507), NRC, Washington, D.C.

8.0 ATTACHMENTS

Forms provided in this section illustrate the minimum requirements for the respective subject matter. Alternative documents or electronic data logging may be used, providing the information is presented in a clear and concise manner and the content meets or exceeds the information required to complete these documents.

Attachment 1, Radiation/Contamination Survey Form

Attachment 2, Radiation/Contamination Survey Supplement

Attachment 3, Example of a Survey Quality Control Checklist

Attachment 4, Leak Test Survey Form

ATTACHMENT 1 – RADIATION/CONTAMINATION SURVEY FORM

DATE: TIME:	INSTRUMENTATION USED					
SURVEY NUMBER:	**Model Inst/Det.**	**Serial Number**	**Calibration Due Date**	**% Efficiency**	**MDC/MDA (dpm/100cm^2)**	**Background (dpm/100cm^2)**
LOCATION:						
SURVEYOR:						
REVIEWED BY:						
RSOR:						

Isotopes of Concern:

Description or drawing:

Routine (Daily / Weekly / Monthly) ☐ Non-routine ☐

All radiation readings in µr/hr unless otherwise noted.
(#)….denotes swipe location or fixed α/β readings.
#…….denotes G/A radiation readings.
#/#…denotes contact / 1 meter radiation readings.
*……denotes highest radiation reading on contact.
Δ……...denotes static location.

ATTACHMENT 2 - RADIATION/CONTAMINATION SURVEY SUPPLEMENT

SURVEY NUMBER:								
SURVEYOR:				LOCATION:				
Location	**Exposure Rate (μR/hr)**		**Fixed + Removable**			**Removable**		**Comments**
	Contact	**1 Meter**	**Gamma (cpm)**	**Alpha dpm/probe**	**Beta/Gamma dpm/probe**	**Alpha dpm/100cm²**	**Beta/Gamma dpm/100cm²**	
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Reviewer	Date/Time:	RSOR	Date/Time:

ATTACHMENT 3: EXAMPLE OF A SURVEY QUALITY CONTROL CHECK LIST

Item No.	Requirement	Comment	SSAT	UNSAT
1.	Verify RCTs are qualified to perform survey			
2.	Verify the appropriate SOP/work plan/TSP is identified for performing the survey			
3.	Verify the approved survey control document(s) specifies detectors, meters, scan speeds, when static surveys are to performed, time of static survey,			
4.	Verify Survey Unit (SU) numbers and boundary.			
5.	Verify instrument calibration is current			
6.	Verify backgrounds have been taken for instrumentation			
7.	Verify daily instrument response check is performed			
8.	Verify detector is set at the correct distance from surface being scanned per SOP or authorized work document			
9.	Verify instrument scan speed complies with SOP or authorized work document			
10.	Verify static surveys are performed in accordance with SOP or specific work plan document.			

ATTACHMENT 4

REQUIRED INFORMATION FOR ACCOUNTABLE SEALED RADIOACTIVE SOURCE LEAK TESTING

(Page 1 of 1)

The following required information for radioactive source leak testing may be documented on either a form, logbook, or electronic database/spreadsheet; and may have reports/printout of the laboratory analysis of leak test swipes attached as appropriate; however, each page of such documentation shall have the required "header" information:

- Date of leak test (i.e., date that the leak test swipe was obtained)
- Serial number and/or other unique identification number
- Activity measured on the leak test swipe, expressed in units of dpm for alpha, and/or beta/gamma, as appropriate for that source
- Each page of the Leak Test Record must be signed and dated by the individual(s) actually performing the leak test swiping
- Each page of the Leak Test Record having an attachment of the analysis of the leak test swipes must have the signature of the individual(s) actually performing the analysis of the leak test swipes
- Each page of the Leak Test Record, and any attached reports/printouts of the laboratory analysis of the leak test swipes must be signed by the RSOR or their designee

Notes:

1) Leak Test Record, and attached analysis report/printout if applicable, shall be developed and documented on a recurring 6-month cycle.

2) Leak Test Record shall be developed and documented as required; e.g., whenever an "out-of-service" source is returned to use, a source is damaged, a source is to be shipped off site.

3) The information contained in a Leak Test Record may be included on the Radioactive Source Inventory form.

4) "Non-record"/informational copies of all Leak Test Records, and attached analysis report/printout if applicable, should be maintained by the RSOR for the purpose of audits and assessments.

5) Leak Test Record, and attached analysis report/printout, if applicable, shall be transmitted by the RSOR to the project files in a timely manner.

Standard Operating Procedure

PREPARATION OF PORTABLE RADIATION AND CONTAMINATION SURVEY METERS AND INSTRUMENTS FOR FIELD USE

SOP-002

Revision 2

Approved By:

Steven Adams, CHP Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/9/12	0	E. Abkemeier	Original	All
2/5/14	1	E. Abkemeier	Clarifications	4, 5, 6, 9
7/17/15	2	S. Adams	Added roles and responsibilities, corrected calibration and chi-square section, clarified text, added references and quality control check list	All

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1.0 PURPOSE

This procedure is used to specify the general requirements for preparing portable radiation and contamination survey meters and instruments for use at field locations. The procedures presented below will be supplemented by the specific instrument operation manuals, Tetra Tech EC, Inc. (TtEC)-approved subcontractor procedures, and specific work documents (i.e., Task-Specific Plans, work instructions, and other authorized work control documents.

2.0 SCOPE

This procedure will be used by TtEC personnel and its subcontractors for preparation of portable radiation and contamination survey meters and instruments used on site. This procedure is intended to provide general instructions for preparing radiation and contamination survey meters and instruments for field operations. Development of specific procedures for the implementation of the requirements of this procedure is the responsibility of the end users.

In certain instances, the requirements of this procedure may need to be added to or modified to support specific field operations. Additional requirements and guidance for these cases will be provided in work-specific documents (e.g., Time Critical Removal Action Work Plan), will be subject to the same review process as this document, and will take precedence over the guidelines in this document, as appropriate.

3.0 DEFINITIONS AND ABBREVIATIONS

Acceptance Range – A range of values that describes an acceptable instrument check result. An acceptance range is typically determined by adding $\pm$ 20 percent or $\pm$ 2σ to the expected value.

Calibration Sticker – A label affixed to a properly calibrated instrument. The calibration sticker may be applied by the calibration facility or the end user. The calibration sticker should indicate the date through which the calibration is valid.

Chi-Square Test – A statistical test used to determine if the variance of the distribution of an instrument response to a check source is larger than predicted by the Poisson distribution at a desired level of significance. This test is used to evaluate the operation of an instrument, generally upon return from calibration.

Check Log – A form, or series of forms, used to document that an instrument was checked prior to usage in the field. Check logs can consist of multiple pages and must contain at least one page identifying the instrument. At least one page must also specify the parameters (source, geometry, etc.) used for the daily check. Space shall be provided to document the daily tests in the log. The log should be designed so as to clearly associate the required verifications with the signature or initials of the individual performing the check and date of each check.

Instrument Efficiency – A measure of the response (counts) obtained with a particular instrument when exposed to a known fluence of radioactive particles. Instrument efficiency is measured in counts per disintegration, though the readings are typically recorded as unitless values.

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this standard operating procedure (SOP) are defined below.

4.1 Corporate Radiation Safety Officer

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of their decision. Review and approve technical basis decisions addressing survey instrument setup.

4.2 Radiation Safety Officer Representative

The responsibilities of the Radiation Safety Officer Representative (RSOR) are described below.

- Ensuring effective implementation of the radiation survey and counting instruments program, and ensuring that the program is in compliance with the Radioactive Materials Licence and regulatory requirements.
- Periodically reviewing the site procedure(s) for applicability and efficacy at least annually or when changing radiological conditions, instruments, project objectives, quality assurance/quality control requirements, and licenses, or as regulatory changes warrant.
- Establishing project and/or site-specific requirements for radiological surveys and fixed instrumentation, including the selection of parameters to be measured and specific instruments to be used.
- Ensuring that instrument surveys performed for the demonstration of compliance conform to the requirements of this SOP, work plans, and all other authorized work documents, licenses, or regulations, as applicable.
- Maintaining an adequate inventory of functional, calibrated instruments, including support equipment e.g., planchets, tools, and check sources.
- Controlling the use, storage and operation of all portable and fixed instruments.
- Ensuring that the calibration and operational checks of portable and fixed instruments are properly documented and conform to the requirements of this procedure.
- Ensuring that only personnel with appropriate, documented training shall issue radiation protection instruments. Training and documentation shall comply with 10 CFR 20.19 for Nuclear Regulatory Commission licensees. Activities conducted under agreement state regulation shall require that the associated training be compliant with those regulations. Comprehensive Environmental Response, Compensation, and Liability Act sites shall have training programs equivalent to those required by the appropriate regulatory group.

4.3 Radiation Control Technicians

The Radiation Control Technician (RCT) shall ensure that the setup, use, and maintenance of portable radiation survey instruments are performed in accordance with this procedure.

5.0 PROCEDURE DETAILS

The procedures associated with this SOP are described below.

5.1 Calibration

Instrument calibrations shall be performed using measuring and test equipment and National Institute of Standards and Technology (NIST) traceable sources. Calibrations will be performed at an accredited calibration laboratory. Calibration will be performed in accordance with the equipment manufacturers' manuals or a subcontractor's TtEC-approved procedure. Properly calibrated instruments shall be marked with a calibration sticker and include an accompanying calibration certificate.

Instruments used to clear personnel, materials, and equipment from radiation control areas, or to perform background or final status surveys should be calibrated in accordance with American National Standards Institute (ANSI) N323b-2003, *American National Standard for Radiation Protection Instrumentation Test and Calibration, Portabel Survey Instruments for Near Background Operatoin* (IEEE 2003) and ANSI N42. 17A-2010 *American National Standard for Performance Specifications for Health Physics Instrumentation – Portable Instrumentation for Use in Normal Environmental Conditions* (IEEE 2010).

Calibration shall be performed annually (± 15 days) or on a schedule consistent with the manufacturer's recommendation, if more restrictive. The routine frequency may be extended by up to one additional month with written approval of the RSOR, or designee. However, the frequency of calibration may not be extended when instruments are being used for surveys of record (e.g., Final Status Surveys, Characterization Surveys, release of materials, equipment, and people from radiological control areas). In addition to the routine frequency of performance, calibration shall be performed under the following conditions:

- Prior to placing a new instrument into service.
- After any major repair or alteration to the instrument or detector.

5.2 General Considerations

Upon receipt of survey equipment from an off-site vendor, and prior to shipment to an off-site vendor, the survey equipment shall be surveyed for alpha/beta fixed and loose contamination in accordance with SOP 003*, Release of Materials and Equipment from Radiologically Controlled Areas*. If any contamination limits are exceeded, the RSOR should be notified immediately.

Determination of instrument background, chi-square testing, and instrument efficiency should be conducted in a controlled environment. This typically will consist of a secured office or laboratory area located in a non-impacted area that is known to be free of contamination. Testing jigs or apparatus may be employed, as necessary, to ensure that consistent, reproducible geometries are used, particularly during repeated measurements.

In the event that any instrument and detector combination fails a chi-square test or daily operation check, or has exceeded its annual calibration date without RSOR approval, the instrument shall be put in an "out of service" condition by placing an "out of service" tag or equivalent on the instrument and detector combination, and securing it in a separate area such that the instrument and detector combination cannot be issued for use. The RSOR and any RCTs, and their

respective supervisors, shall be notified immediately when any survey instrument has been placed “out of service”.

Any instrument and detector combinations that have not undergone a daily operation check because daily plans do not include their use shall be secured in an area to prevent their use until operation checks have been performed. Table 4-1 provides suggested geometries to use for the most commonly used instrument types. Alternate geometries can be used provided that they are more appropriate for the intended usage of the instrument.

5.3 Determination of Instrument Background

The determination of an instrument-specific background should be employed at the discretion of the RSOR. Instruments used for documenting scoping, characterization, and final status surveys should have the background determined annually, at a minimum. Instrument background determination is typically performed in a controlled environment, and usually consists of a series of repeated background measurements that are statistically analyzed to obtain an expected range of valid background values. The established instrument background range can be used as a means of performing daily operation checks.

Instrument background determinations, when necessary, are considered valid for as long as the instrument has been properly maintained per the requirements of this procedure. If instrument backgrounds are required, a new background determination should be performed following each calibration.

TABLE 4-1

SUGGESTED GEOMETRIES FOR BACKGROUND MEASUREMENTS AND SOURCE CHECKS

Measurement	Instrument/Detector Combinations	Probe Location
Exposure/Dose Rate	Ludlum Model 19, RO-20, Bicron MicroREM, or equivalent meter with integral tissue equivalent plastic or sodium iodide (NaI) 1”x1” detector	contact[a]
Gamma	Ludlum Model 2221, 2350-1 or 2360 portable survey meter or equivalent with a Ludlum Model 44-10, FIDLER or equivalent detector	4 inches above ground surface/source
Beta/Gamma	Ludlum Model 2360 portable survey meter or equivalent with a Ludlum Model 43-37, 43-68, 43-89 or equivalent detector; Ludlum Model 3 portable survey meter with a Ludlum Model 44-9 G-M probe or equivalent	¼ inch above ground surface/source
Alpha/Beta	Ludlum 2360 portable survey meter or equivalent with a Ludlum 43-37, 43-68, 43-89 or equivalent detector	¼ inch from surface/source

Notes:

[a] Field readings with exposure/dose rate instruments are conducted at 1 meter from the from the ground or floor surface, 30 centimeters (1 foot) from the radiation source, or 30 centimeters from any surface that the radiation penetrates; background determination, chi-square test, and operational checks are typically performed at a more convenient distance. Geometry should be documented as appropriate on the relevant data forms and logs.

When required, background determinations will be documented on Attachment 1, or equivalent, as specified in the work-specific procedures. The form should include the following information, at a minimum:

- Identification information (i.e., model and serial numbers) for the instrument and detector.
- Conditions used for determination (geometry, radiation type, operating voltage, etc.).
- Identification of the background reference area for media-specific backgrounds (e.g., soil, concrete, asphalt, date and time of determination).
- Identification and signature, or initials, of the technician.
- Identification and signature of reviewer.

The end result of a background determination should be to obtain an acceptance range for subsequent background checks.

5.4 Chi-Square Test

When chi-square tests are required in work-specific documents, the procedure described below shall be followed. However, any specific instructions for chi-square testing that govern work-specific documents shall take precedence over the instructions provided in the work-specific document. When required, chi-square tests shall be performed annually (± 15 days), following calibration, or if there is reason to suspect that the instrument calibration may no longer be valid (i.e., inability to obtain a valid range of chi-square values). Chi-square testing is not required for exposure rate instruments (e.g., Ludlum Model 19 or RO-20) or personnel contamination “frisking” instrument/detector combinations (e.g., Ludlum Model 3 or 177 with 44-9), unless specified in work-specific documents.

The chi-square (χ^2) analysis is used to determine if an instrument is not in control and is potentially giving false data. This determination is performed by conducting a series of measurements of a check source and applying the χ^2 test to the count data. The χ^2 analysis is a quality control check used to determine if the distribution of the instrument’s counts fits a Poisson distribution to a specified level of confidence. If the instrument fails the χ^2 analysis there may be a potential aberration in the instrument’s response to radiation.

Chi-square tests shall be performed with sources that use an isotopic content appropriate to the detector being evaluated and the anticipated contaminants in the survey area. The source should be of sufficient activity to yield a counting rate of 1,000 to 50,000 counts per minute (cpm). The source should not exceed 50,000 cpm.

The χ^2 analysis is performed as follows.

1. Select the level of significance (α). Typically $\alpha = 0.95$ but other values may be allowed if specified in authorized project-specific plans and data quality objectives.
2. Use a NIST traceable, or equivalent, check source with a long half-life, >20 years.
3. For each measurement of the check source, the count time must be long enough to acquire 1,000 to 50,000 counts. Use exactly the same count time and counting geometry for each measurement.
4. The number of measurements is defined as N.
5. Each individual count measurement is defined as X_i, where the first measurement is X_1, the second measurement is X_2 and so on.

6. Calculate the average number of counts, $\bar{X}$.
7. Calculate the χ2 statistic as follows:

$$\chi^2 = \frac{1}{\bar{X}} \sum_{i=1}^{N} (X_i - \bar{X})^2$$

The calculated χ2 value is compared to the critical values listed in Table 1. For a significance level of α = 0.05 for N-1 degrees of freedom, the χ2 should exceed the value listed in the column α = 0.05 and be less than the value in the column α = 0.95.

For example, assume 20 measurements (N = 20) were taken of the check source, and the data quality objective requires a significance level of α = 0.05. The degrees of freedom = N – 1 = 19. For α = 0.05 and N – 1 = 19, the instrument performance is acceptable if the calculated χ^2 exceeds 10.12 but is less than 30.14. For a significance level of 0.10 for 20 measurements, the instrument performance is acceptable if calculate χ2 exceeds 11.65 but is less than 27.20.

When required, chi-square tests should be documented in Attachment 2, or equivalent, or as specified in the work-specific documents. The form should include the following information at a minimum:

- Identification information (i.e., model and serial numbers) for the instrument and detector
- Conditions used for the test (geometry, radiation type, operating voltage, etc.)
- Source ID number
- Date and time of determination
- Identification and signature, or initials, of technician
- Identification and signature of reviewer

The RSOR should be notified if the calculated χ2 value is outside the range of the critical values. In that instance, the RSOR should assist in planning a course of action. In cases of chi-square testing for large-area gas-proportional detectors, such as the Ludlum 43-37 series detectors, the initial recommendation is to increase the number of measurements from 20 to 30 (or more), and use the table to determine the chi-square acceptable values. For instance, for 30 measurements, the χ^2 value must be between 17.71 and 42.56 in order to acceptably pass the chi-squared test.

Table 1. Critical Values for the Chi-Square Test

	Lower Critical Value		Maximum Critical Value	
N - 1	α = 0.05	α = 0.10	α = 0.90	α = 0.95
14	6.57	7.79	21.06	23.68
15	7.26	8.55	22.31	25.00
16	7.96	9.31	23.54	26.30
17	8.67	10.09	24.77	27.59
18	9.39	10.86	25.99	28.87
19	10.12	11.65	27.20	30.14
20	10.85	12.44	28.41	31.41
21	11.59	13.24	29.62	32.67
22	12.34	14.04	30.81	33.92
23	13.09	14.85	32.01	35.17
24	13.85	15.66	33.20	36.42
25	14.61	16.47	34.38	37.65
26	15.38	17.29	35.56	38.89
27	16.15	18.11	36.74	40.11
28	16.93	18.94	37.92	41.34
29	17.71	19.77	39.09	42.56
30	18.49	20.60	40.26	43.77

For further insights into the applications of the χ2 statistic in the proper functioning of a radiation counting system, consult the October 1999 edition of *Health Physics* (Tries et al. 1999)

5.5 Instrument Efficiency for Portable Instruments

The instrument efficiency is defined as the ratio between the net count rate of the instrument and the surface emission rate of a source for a specified geometry, and is expressed in units of counts/particle. The surface emission rate, $q_{2\pi}$, is defined as the "number of particles of a given type above a given energy emerging from the front face of the source per unit time" (ISO 1988). The surface emission rate is the 2π particle fluence that embodies both the absorption and scattering processes that affect the radiation emitted from the source until the radiation reaches the face of the detector. The instrument efficiency, ε_i, is calculated using the following equation.

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi}\left(W_A / S_A\right)}$$

Where,

ε_i = the instrument efficiency (counts per disintegration)
R_{S+B} = the gross count rate of the efficiency check source, measured in cpm
R_B = the background count rate in cpm
$q_{2\pi}$ = the 2 π surface emission rate of the calibration source (NIST traceable)
W_A = the active area of the probe window in square centimeters (cm^2)
S_A = the area of the source in cm^2

Note: This equation assumes that the detector window is placed directly on the efficiency check source and the dimensions of the efficiency check source are sufficient to cover the window of the instrument detector. If the detector window is not placed directly on the source, then $q_{2\pi}$ must be adjusted for attenuation and scatter. If the dimensions of the efficiency check source are smaller than the detector's window, set W_A equal to the dimensions of the efficiency source (i.e., set the quotient of W_A and S_A equal to 1).

Instrument efficiency shall be determined for all instruments and radiation and contamination survey meters that are to be used for alpha and beta surveys prior to use for field operations. Instrument efficiency is dependent upon the energy of the incident radiation. Multiple energy-specific instrument efficiencies may be determined when isotopes with significantly varying energies are analyzed.

If the equipment manufacturer provides a procedure to use to determine the instrument efficiency, that procedure shall be followed. In instances where governing work-specific documents specify a means or expanded scope of inclusion for instrument efficiency determination, they shall take precedence.

All instrument efficiency determinations should be documented on an approved subcontractor form, or as specified in the work-specific documents. The form should include the following information, at a minimum:

- Identification information (i.e., model and serial numbers) for the instrument and detector
- Conditions used for determination (geometry, radiation type, operating voltage, etc.)
- Source-specific information (ID number, surface emission rate, area)
- Detector window area
- Date and time of determination
- Identification and signature, or initials, of technician
- Identification and signature of reviewer (typically the RSOR)

The resulting efficiency should be reported in units of counts per disintegration.

5.6 Operation Check

An operation check for each instrument should be performed at the beginning of each workday that a particular instrument is used. The operations check should include the following checks at a minimum:

- Check that the instrument calibration is still valid (date on sticker not yet passed)
- Check the instrument (including the detector) for physical defects (knobs, displays, cables, connectors, Mylar windows, dented/damaged enclosure, etc.)
- Check of instrument battery (per manufacturers' instructions)
- Check the source (should give consistently reproducible results using the same source)
- Check the background count rate, exposure rate, or dose rate as appropriate

Instructions for performing operation checks for specific instruments and detectors are included in Attachment 3 of this procedure. Failure of any of the above checks shall result in the instrument

being removed from active service until the condition can be addressed. The RSOR should be notified of any instrument failing an operations check for reasons other than failure of a battery check. In cases of battery check failure, the battery should be replaced and the check repeated.

The specified checks should each be performed every day an instrument is in use, and documented. A separate check log shall be maintained for each instrument type. The check log shall contain the following information, at a minimum:

- Identification information (i.e., model and serial numbers) for the instrument and detector
- Conditions used for the check (geometry, radiation type, etc.)
- Source ID number
- Source check readings in appropriate measurements
- Verification of current calibration
- Verification of physical condition
- Verification of battery check
- Verification that the source check observation is within the acceptance range
- Verification that the background is within the acceptable range
- Date of operational check
- Signature or initials of technician
- Identification and signature of reviewer

Of the required information given above, only the verifications, date and signature, or initials need to be completed on a daily basis. The remaining information can be completed once and kept in the check log with the additional pages for daily checks, provided that none of the information changes. If the information changes, then a new check log should be started.

A sticker annotating that daily operation checks have been completed satisfactorily shall be affixed to each instrument. The sticker shall contain the following information at a minimum:

- Initials of technician
- Date of operational check

5.7 Maintenance

Instruments shall be stored in areas that provide protection against damage by movement, and accumulation of moisture, or dust. Detector covers shall be used for storage when practical. Instrument maintenance (except external adjustments and cable or Mylar window replacements) shall be performed by the manufacturer or an approved vendor.

6.0 RECORDS

Records that are generated may include forms that document background determinations, chi-square tests, instrument efficiency, instrument calibration and check logs. Record forms are provided in the attachments to this procedure, or can be obtained from equivalent electronic versions, or from forms specified in work-specific plans and instructions.

7.0 REFERENCES

Reference	***Title***
IEEE, 2010	American National Standard for Performance Specifications for Health Physics Instrumentation – *Portable Instrumentation for Use in Normal Environmental Conditions*, ANSI N42.17A-2010, IEEE, New York, NY.
IEEE, 2003	American National Standard for Radiation Protection Instrumentation Test and Calibration, *Portable Survey Instruments for Near Background Operation*, ANSI N323B-2003, IEEE, New York, NY.
ISO, 1988	International Organization for Standardization, Evaluation of Surface Contamination – Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. ISO 7503-1
Tries M. A., K. W. Skrable, C. S. French, and G. E. Chabot, 1999	*Basic Applications of the Chi-Square Statistic Using Counting Data*, Health Phys. 77(4):441-454, Lippincott Williams & Wilkins, Baltimore, MD.

8.0 ATTACHMENTS

Attachment 1, Instrument/Detector Background Form

Attachment 2, Chi-Square Form

Attachment 3, Instrument and Detector Operational QC Checklist

ATTACHMENT 1 – INSTRUMENT/DETECTOR BACKGROUND FORM

Instrument Model:			**Instrument Serial No.**	
Cal due date			**Data Type**	
Detector Model:			**Detector Serial No.:**	
Today's Date:			**Data Collected by:**	

Count Number	**Background**	**Comments:**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
Total		
Mean Count:		Mean +20%
Standard Deviation:		Mean - 20%
Mean + 3 σ Value:		

Calculations Completed by:	Date:
Reviewed by:	Date:

ATTACHMENT 2 – CHI-SQUARE FORM

Instrument Model:				Instrument Serial No.		
Cal due date				Data Type		C B
Detector Model:				Detector Serial No.:		
Today's Date:				Data Collected by:		
Source ID:		Activity	dpm			
Radionuclide:		CPM	CPM			
Count Number	Background	(Gross) C_G	(Net) C_I	$\overline{X_i - X}$	$(X_i - \bar{X})^2$	
1						+20%
2						-20%
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20					$\frac{1}{\bar{X}}\sum_{i=1}^{N}(X_i - \bar{X})^2$	
Total						
Mean Count:		$\bar{X}$				
Chi Squared Value (χ^2):			10.11 - 30.14	Standard Deviation:		
+ 2 σ Value:		- 2 σ Value :				
Calculations Completed by:						Date:
Reviewed by:						Date:

ATTACHMENT 3 – INSTRUMENT AND DETECTOR OPERATIONAL QC CHECKLIST

SURVEILLANCE NUMBER	RATEMETER/SCALER/DATA LOGGER MODEL/ID NUMBER	DETECTOR MODEL/ID NUMBER
TITLE/ACTIVITY		PROJECT NAME/PROJECT NUMBER
ORGANIZATION/SUPPLIER		LOCATION
QC CHECK PERFORMED BY _____ NAME TITLE SIGNATURE DATE		
CONTACTS		

Item No.	***Requirement***	***Comments***	***Sat.***	***Unsat.***
1	Verify correct data logger/scaler/ratemeter/detector is being used for the survey, as specified in the work plan/WI			
2	Verify instrumentation mating/matching I.D. numbers (detectors must be mated with its assigned meter)			
3	Verify instrument calibration is current			
4	Verify backgrounds have been taken for instrumentation			
5	Verify daily instrument response check is successfully performed			
6	Verify voltage settings agree with manufacturer's recommendations			
7	For gas flow instruments, verify the inflow and outflow rates are essentially equal and correct			
8	Verify that chi-square test and results comply with Section 5.4 of this SOP			
9	Check the instrument (including detector) for physical defects of the knobs, displays, cables, connectors, Mylar windows, and dented/damaged enclosure			
10	Check instrument battery per manufacturers' instructions			

ATTACHMENT 2 – CHI-SQUARE FORM

Instrument Model:				Instrument Serial No.		
Cal due date				Data Type		C B
Detector Model:				Detector Serial No.:		
Today's Date:				Data Collected by:		
Source ID:		Activity	dpm			
Radionuclide:		CPM	CPM			
Count Number	Background	(Gross) C_G	(Net) C_I	$\overline{X_i - X}$	$(X_i - \bar{X})^2$	
1						+20%
2						-20%
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20					$\left\lvert \frac{1}{\bar{X}} \sum_{i=1}^{N} (X_i - \bar{X})^2 \right\rvert$	
Total						
Mean Count:		$\bar{X}$				
Chi Squared Value (χ^2):			10.11 - 30.14	Standard Deviation:		
+ 2 σ Value:		- 2 σ Value :				
Calculations Completed by:						Date:
Reviewed by:						Date:

ATTACHMENT 3 – INSTRUMENT AND DETECTOR OPERATIONAL QC CHECKLIST

SURVEILLANCE NUMBER	RATEMETER/SCALER/DATA LOGGER MODEL/ID NUMBER	DETECTOR MODEL/ID NUMBER
TITLE/ACTIVITY		PROJECT NAME/PROJECT NUMBER
ORGANIZATION/SUPPLIER		LOCATION
QC CHECK PERFORMED BY _____ NAME TITLE SIGNATURE DATE		
CONTACTS		

Item No.	***Requirement***	***Comments***	***Sat.***	***Unsat.***
1	Verify correct data logger/scaler/ratemeter/detector is being used for the survey, as specified in the work plan/WI			
2	Verify instrumentation mating/matching I.D. numbers (detectors must be mated with its assigned meter)			
3	Verify instrument calibration is current			
4	Verify backgrounds have been taken for instrumentation			
5	Verify daily instrument response check is successfully performed			
6	Verify voltage settings agree with manufacturer's recommendations			
7	For gas flow instruments, verify the inflow and outflow rates are essentially equal and correct			
8	Verify that chi-square test and results comply with Section 5.4 of this SOP			
9	Check the instrument (including detector) for physical defects of the knobs, displays, cables, connectors, Mylar windows, and dented/damaged enclosure			
10	Check instrument battery per manufacturers' instructions			

Standard Operating Procedure

RELEASE OF MATERIALS AND EQUIPMENT FROM RADIOLOGICALLY CONTROLLED AREAS

SOP-003

Revision 3

Approved By:

Steven Adams, CHP Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/15/12	0	E. Abkemeier	Original	All
2/5/14	1	E. Abkemeier	Provided general clarifications	4,5
2/27/15	2	S. Adams	Added roles and responsibilities, specified requirements for allowing waste and materials and equipment into radiologically controlled areas RCAs), and unconditional releases from RCAs	3–6, 8, 9
7/17/15	3	S. Adams	Corrected table of contents to agree with text, revised Radiation Safety Officer responsibilities	3–9

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1 PURPOSE

The purpose of this procedure is to specify the process for accepting material and equipment into a radiologically controlled area (RCA) and the radiological survey requirements for releasing materials and equipment from an RCA. Materials and equipment meeting the release criteria listed in Table 4-1, *Release Criteria for Materials and Equipment* need not be controlled as radioactively contaminated material.

2 SCOPE

This procedure will be used by Tetra Tech EC, Inc. (TtEC) personnel and its subcontractors to accept and release materials and equipment from RCAs.

3 DEFINITIONS AND ABBREVIATIONS

Client Agency – Client agency is the organization given the authority to approve or reject a decision to allow free release of material or equipment, e.g., state or federal regulatory agency, Navy Radiological Affairs Support Office.

Client Representative – Client decision maker that may approve or reject a decision to allow free release of material or equipment as defined in the appropriate work control document, e.g., client radiation safety officer, project manager, or program manager. The client representative may be an individual in the client agency.

Contamination – Radioactive material in any place it is not desired. Contamination may be due to the presence of alpha particles, beta particles, or gamma-ray-emitting radionuclides.

Fixed-surface Contamination – Radioactive material that has been deposited onto a surface and cannot be readily removed by non-destructive means, such as casual contact, wiping, brushing, or laundering. Fixed contamination does not include radioactive material that is present in a matrix, such as soil or cement, or radioactive material that has been induced in a material through neutron activation processes. Fixed-surface contamination cannot be measured directly.

Radiologically Controlled Area – An area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials and/or to prevent the release of radioactive materials to the uncontrolled areas.

Release for Unrestricted Use – The authorization to remove or reuse equipment and/or material from an RCA. Such authorization will be based on a review of survey data confirming that the material and/or equipment being released does not exhibit surface contamination levels exceeding those identified in Table 4-1. Also referred to as “free release” or “unconditional release.”

Removable Surface Contamination – Radioactive material that has been deposited onto a surface that is readily removed from a surface by non-destructive means, such as casual contact, wiping, brushing, or washing. Removable surface contamination is also referred to as “loose surface contamination”. Removable surface contamination is to be identified in accordance with Section 5.2.2 of SOP 001, *Radiation and Contamination Surveys*.

Total Surface Contamination – The sum of the fixed and removable surface contamination. The total surface contamination is measured using scan and static surveys in accordance with Section 5.2.3 of SOP 001.

Work Control Documents – An authorized document that defines the criteria and data quality objectives for performing surveys, sampling, and radioanalysis used to release material and equipment that may be more stringent than the requirements in this Standard Operating

Procedure (SOP), e.g., Task-specific Plans, Sampling and Analysis Plans, Radiation Protection Plans, Characterization and Remediation Plans, and Final Status Survey Plans.

4 ROLES AND RESPONSIBILITIES

The roles and responsibilities of the individuals performing activities in accordance with this SOP are described below.

4.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision. The RSO periodically will review project survey programs to ensure compliance with approved SOPs and work control documents. In the event the Radiation Safety Officer Representative (RSOR) is not available on site to perform the required duties, the RSO is to designate a temporary RSOR.

4.2 Radiation Safety Officer Representative

Prior to accepting any waste material from other contractors for staging in a TtEC RCA, the RSOR shall review and approve documentation supporting the identified waste category. The RSOR will ensure that no waste, material, or equipment leaves a TtEC RCA for unconditional release without reviewing and approving survey and sampling data that demonstrates compliance with the limits listed in Table 4-1. When required in authorized project documents, the RSOR will obtain documented concurrence for unconditional release from the RSO, client, and regulatory agent representative prior to release. The RSOR shall submit information regarding any changes in the location where waste is staged in TtEC RCAs to the project manager or his/her designee to enable revisions to be made to the appropriate project figures, documents, and databases.

4.3 Radiation Control Technicians

The Radiation Control Technicians will ensure all surveys and sampling activities are performed and documented in accordance with SOP-001, *Radiation and Contamination Survey*. The RTC will prevent unauthorized waste, material, or equipment from being brought into or out of a TtEC RCA, and will notify the RSOR as soon as practicable regarding any unauthorized activities.

TABLE 4-1

RELEASE LIMITS FOR MATERIALS AND EQUIPMENT

Radiation Type	Release Limits[1] (Total) (dpm per 100 cm^2)	Release Limits[1] (Removable) (dpm per 100 cm^2)
Alpha (α) Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	20
Beta (β-) Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	200
Beta-Gamma (β-γ) Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	1,000

Notes:

[1] These limits are based on AEC Regulatory Guide 1.86 (AEC 1974)

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm^2 – square centimeters
dpm – disintegrations per minute

5 PROCEDURE DETAILS

The procedures to follow in conducting activities under this SOP are provided below.

5.1 General

Contractors are required to declare the status of any waste material to the RSOR prior to staging it in the RCA. The waste material categories are: radiologically impacted, potentially impacted, or cleared. TtEC is not to stage cleared non-radioactive waste in a TtEC RCA. Surveys for total and removable surface contamination shall be conducted and documented in accordance with SOP-001, *Radiation and Contamination Surveys*. Items presented for release shall be surveyed in an area of relatively low background.

5.2 Limitations

This procedure shall not be used for personnel surveys. Personnel will be surveyed in accordance with SOP-005, *Radiological Protective Clothing Selection, Monitoring, and Decontamination*. This procedure shall not be used to release uncontaminated dispersible material, e.g., soil and construction debris, from an RCA. The methods for releasing uncontaminated dispersible material from an RCA are defined in SOP 011, *Gamma Screening of Trucks Loaded with Dispersible Material Using the Stationary Portal Monitor and Using Portable Survey Instruments*. This procedure shall not be used to release dispersible radioactive material from an RCA. The methods for releasing dispersible radioactive material are described in project-specific work control documents.

5.3 Release Procedure

The procedures to follow for releasing materials and equipment from RCAs are discussed below.

5.3.1 Material History

Prior to staging waste in an RCA, the location and radiological status of the waste must be confirmed by the RSOR. The latest figure provided in the work control document may be used to confirm whether the waste is impacted or potentially impacted based on the location from which it was removed.

The area containing stockpiled waste that is known to consist of radiologically impacted materials should be roped off using yellow or yellow and black rope, with signage reading “CAUTION, RADIOACTIVE MATERIALS”. Stockpiled waste that has not been cleared, but may be radiologically impacted, can be roped off as described above, but the signage should read “CAUTION, POTENTIAL RADIOACTIVE MATERIALS PENDING ANALYSIS.” Stockpiled waste that has been documented to have been cleared does not need to be roped off, but should be marked with signs stating “CLEARED WASTE.” Cleared stockpiled waste should be removed from an RCA as soon as practicable.

Upon receipt of an item presented for release from RCAs, the history of the item should be determined. This determination should include, if possible:

- The current and past use of the item.
- The location(s) in which the item was used or stored.
- Whether the item was in an area where radioactive material was used or stored.

This history will be used, if applicable, to evaluate the potential for contamination to be present on inaccessible surfaces of the item.

5.3.2 Contamination Surveys

All accessible surfaces will be surveyed for removable and fixed-surface contamination in accordance with Section 5.2 of *SOP-001, Radiation and Contamination Surveys*. Swipes collected for removable surface contamination shall be analyzed with a Ludlum Model 2929 scaler with a Model 43-10-1 ZnS(Ag) scintillation probe (or equivalent) or Protean Alpha/Beta Gas Flow Proportional Counter (or equivalent).

Scan surveys will be conducted on all accessible surfaces of the material or equipment that may have come in direct contact with radioactively contaminated material. Whenever practical, 100 percent of these areas will be scanned for alpha and beta contamination.

Following the scan survey, the number of static survey measurements to be collected shall be determined based on the following criteria:

- Size and history of the item.
- Preliminary results of scan surveys.
- Whether an increase in the audible and/or digital/analog count rate was detected.
- If, during the survey, the Radiological Control Technician determines that there may be fixed activity present.
- If, in accordance with work control documents, approval from client agencies and specific client representatives is required prior to unconditional release of material and equipment from an RCA.

5.3.3 Inaccessible Surfaces

If inaccessible surfaces are present that may have been exposed to contamination, or if it is not known whether the inaccessible surfaces have been exposed to contamination, such items should be disassembled as completely as possible to facilitate completion of the release survey. Items having inaccessible surfaces will not be released from an RCA unless evaluated and documented by the RSOR, or designee. In accordance with the work control document, approval from client agencies and specific client representatives may be required prior to unconditional release from an RCA of material and equipment having inaccessible surfaces.

5.3.4 Release of Material and Equipment

The following steps shall be taken for release of material and equipment:

1. If the results of the swipe, scan, and static surveys do not exceed the limits provided in Table 4-1, then the material may be released for unrestricted use.
2. If the swipe, scan, or static survey results indicate contamination is present that exceeds the limits provided in Table 4-1, the material shall not be released for unrestricted use. Material and equipment that cannot be released for unrestricted use will be evaluated for decontamination in accordance with SOP-007*, Decontamination of Equipment and Tools*, or packaged for disposal.
3. Results of the swipe, scan, and static surveys shall be documented in accordance with SOP 001.
4. If the equipment and/or materials are being returned to a vendor or removed from the site, a completed Attachment 1 – Unconditional Release of Equipment or Materials Form – or copy of the Radiation/Contamination Survey and Supplement form (Attachments 1 and 2 from SOP-001*, Radiation and Contamination Surveys*) containing the statement "Equipment or materials have been surveyed and found to be within acceptable surface contamination levels for unconditional release as required by AEC Guide 1.86" written or stamped on the Radiation/Contamination Survey Form or equivalent will accompany the equipment and/or material.
5. Dispersible radioactive material will be released in accordance with the requirements of the work control document.

5.3.5 Release of Trucks from a Radiologically Controlled Area

Trucks leaving an RCA will be hand scanned in accordance with Sections 4.3 and 4.4 of SOP-011. The truck survey data will be recorded in accordance with Section 5.0 of SOP-011.

6 RECORDS

Records that are generated for the work activities described in this SOP should be prepared in accordance with the guidance provided herein.

7 REFERENCES

Number	***Title***
AEC Regulatory Guide 1.86	*Termination of Operating Licenses for Nuclear Reactors*
SOP-001	*Radiation and Contamination Surveys*
SOP-011	*Gamma Screening of Truckloads Using the Stationary Portal Monitor and Using Portable Survey Instrumentation*

8 ATTACHMENTS

Attachment 1, Unconditional Release of Equipment or Materials Form

ATTACHMENT 1

UNCONDITIONAL RELEASE OF EQUIPMENT OR MATERIALS FORM

Survey #:	Date:

Description of equipment or materials:

SURVEY EQUIPMENT:

Model No:	S/N:	Background:	Eff:	Cal Due Date:
Model No:	S/N:	Background:	Eff:	Cal Due Date:
Model No:	S/N:	Background:	Eff:	Cal Due Date:

CONTAMINATION LEVELS:

	dpm/100 cm^2 $\beta\gamma$	Removable
	dpm/100 cm^2 α	Removable
	dpm/100 cm $\beta\gamma$	Fixed
	dpm/100 cm^2 α	Fixed

This is to certify that the above-described equipment or materials have been surveyed and found to be within acceptable surface contamination levels for unconditional release as required by Atomic Energy Commission Regulatory Guide 1.86.

Radiological Control Technician:	Date/Time:

Disposition of equipment or materials:

Reviewed By:	Date:

Standard Operating Procedure

RADIOLOGICAL RECORDS

SOP-004

Revision 2

Approved By:

Steven Adams, CHP,
Corporate Radiation Safety Officer

7/17/2015
Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/15/12	0	E. Abkemeier	Original	All
2/5/14	1	E. Abkemeier	Clarification, addition of Washington state license	4, 7, 8
7/17/15	2	S. Adams	Clarification, corrected Nuclear Regulatory Commission Radiation Material License number, location of corporate headquarters	4,6, 8

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1.0 PURPOSE

The purpose of this procedure is to define Tetra Tech EC, Inc.'s (TtEC's) standards for the maintenance and retention of radiological records, including personal protection.

2.0 OVERVIEW

Radiological records provide valuable historical data on the dose and exposure rates in controlled and uncontrolled areas, concentration of radionuclides in environmental media, and the radiological conditions of material, equipment, and waste that enters and leaves radiologically controlled areas. These records are valuable for use in future site operations, health studies, and litigation support. The following types of radiological records are required to be maintained:

- Radiological control procedures
- Radiological control (RadCon) personnel training (course records and individual records including refresher training)
- Radiological instrumentation test, repair, and calibration records
- Radiological surveys
- Radionuclide concentrations in samples of environmental media
- Dosimetry results
- Doses to members of the general public
- Radiological work permits
- Radiological incident reports
- The results of internal audits and other reviews of program content and implementation
- Written declarations of pregnancy, including the estimated date of conception
- Records for release of material from radiologically controlled areas
- Records of waste disposal

3.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this SOP are defined below.

3.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for:

- Ensuring effective implementation of the RadCon records management program and ensuring that the program is in compliance with regulatory requirements.
- Maintaining, revising, reviewing, and approving changes to this standard operating procedure (SOP).
- Making an exemption to or variance from portions of this SOP either directly or through a subject matter expert, at the request of line management. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

3.2 Radiation Safety Officer Representative

The Radiation Safety Officer Representative (RSOR) is responsible for the following:

- Directs and assists Radiological Control Technicians and project personnel in proper completion of radiological records.
- Ensures that records are in compliance with the quality standards outlined in this procedure.
- Ensures timely and thorough review of records in accordance with this procedure, prior to approval.
- Approves records with verifiable signature and date once the records meet the quality standards.
- Ensures that records are transferred or transmitted to the San Diego TTEC office following completion.

3.3 Other Project Personnel

Other project personnel are responsible for the following:

- Create, review, or transmit radiological records for retention.
- Ensure that all document quality standards are met.

4.0 REQUIREMENTS

The requirements associated with this SOP are identified below.

- All records must be retrievable and maintained for their prescribed retention time.
- Completed records awaiting transfer to storage shall be stored in an appropriate manner to minimize loss and damage that could result from exposure to weather, fire, or other conditions.
- All personnel who create, review, and approve radiological records must sign and date the records and follow all quality standards in accordance with this procedure.
- If working copies of records are used for reference, they will be stored separately from the original.

5.0 DOCUMENT QUALITY STANDARDS

Records shall be legible and prepared with an indelible ink, and shall be reproducible and legible. Records shall be dated and shall contain the signature of the originator that is verifiable. Errors shall be corrected by marking a single line through the error and initialing and dating the correction. Radiological records shall not be corrected using an opaque substance. Shorthand, or other nonstandardized terms, may not be used.

To ensure retrievability, each record shall clearly indicate:

- Name of the facility
- Specific location
- Function and process

- Document number (if applicable)

To the maximum extent possible, electronic copies of radiological records should be uploaded to the TtEC SharePoint site to ensure retrievability by the RSO and RSORs in the event of program audits or inspections.

The quantities used in records shall be clearly indicated in standard units (curie, rad, rem, disintegrations per minute), including multiples and subdivisions of these units.

6.0 PROCEDURE

The procedures associated with this SOP are described below.

6.1 Preparation of Radiological Records

Radiological records shall be prepared in accordance with the following requirements.

- Prior to preparing a document for which a standard form exists, the preparer shall verify that the form is current and verify that copies of the master form are in good quality.
- The document should be prepared in accordance with the applicable guidance for that specific document, if any, and in accordance with the quality standards established in this procedure.
- The completed document should be reviewed for accuracy with regard to calculations, legibility, proper units, proper forms, internal consistency;
- The completed document must comply with the requirements of the SOP(s) controlling the documented activity.
- The completed document should meet all quality standards before it is submitted for final review and approval.

6.2 Review of Records

The RSOR, or his/her designee, shall ensure that the records review focuses on identification of trends, validity of recorded data and information, and identification of originators. Subsequent quality reviews should include verification that the documents are complete, legible, and in compliance with the quality standards outlined in this procedure.

6.3 Approval of Records

The RSOR shall verify that all documents created under the radiation safety program are correct and in compliance with this procedure, authorized work documents, the Radioactive Materials License, and applicable regulatory requirements prior to transmittal of the records to storage.

6.4 Individual Monitoring

The individual monitoring records required in accordance with this SOP will be protected from public disclosure because for reasons of personal privacy. The results of any individual external and internal dose monitoring that is performed will be recorded at least annually, including doses received during planned special exposures, unplanned doses exceeding TtEC dose limits, and authorized emergency exposures.

Monitoring records will be maintained on Nuclear Regulatory Commission (NRC) Form 5, or on other forms that are clear and legible and contain all of the information required in NRC Form 5. Data necessary for future verification or reassessment of the recorded doses will be recorded. Individual monitoring records will be readily available to that individual.

6.4.1 Monitoring Records

For personnel whose occupational dose is monitored, reasonable efforts will be made to obtain records of the current year for occupational internal and external doses. If complete records documenting previous occupational doses during the year cannot be obtained, a written estimate signed by the individual may be accepted to demonstrate compliance.

External dose records include the following:

- The effective dose equivalent from external sources of radiation (deep dose equivalent may be used as effective dose equivalent for external exposure).
- The lens of the eye dose equivalent.
- The shallow dose equivalent to the skin.
- The shallow dose equivalent to the extremities.

Internal doses from intakes received during the year include the following:

- An estimate of the identified intake of radionuclides.
- Committed effective dose equivalent.
- Committed dose equivalent to any organ or tissue of concern.

A summation of external and internal doses should be calculated, and should include:

- Total effective dose equivalent in a year.
- The sum of the deep dose equivalent from external exposures and the committed dose equivalent to that organ or tissue for any organ or tissue assigned an internal dose during the year.
- The dose equivalent to the embryo/fetus of a declared pregnant worker; this information will be included with the records of the dose to the declared pregnant woman.
- Incident reports, findings, conclusions, or other information describing off-normal events in which the employee was involved. These include, but are not limited to, cases of accidental exposures, skin contamination, failure of personal protective equipment, exposures exceeding TtEC dose limits (unauthorized), injuries inside a radiological area, or positive bioassays.

6.4.2 Other Monitoring Records

Other information that must be documented and maintained includes:

- Results of area monitoring
- Results of dosimetry, surveys, air sampling/monitoring, and bioassay results used to determine individual doses
- Results of monitoring for the release and control of material and equipment; the records of released property will include:
  - (a) A description or identification of the property
  - (b) The date of the survey
  - (c) The identity of the individual who performed the monitoring activities
  - (d) The type and identification number of monitoring instruments

(e) The results of the monitoring operation

- Results of maintenance and calibration performed on instruments and equipment
- Results of monitoring and documentation of approval for planned special exposures

7.0 RECORDS

All radiation records will be retained by TtEC for a minimum of 3 years from the date of the generation of the record. Dosimetry records will be maintained indefinitely.

Radiological records will be transferred to the project file located in TtEC's San Diego office, (and/or electronically maintained on a designated SharePoint site) following completion for projects completed under California Agreement State Radioactive Material License (RML) number 7909-01, and transferred to the Corporate Headquarters in San Diego (and/or electronically maintained on a designated SharePoint site) for projects completed under NRC RML number 29-31396-01 or Washington Agreement State RML number WN-L0244-1. Records for RMLs issued by Agreement States in the future will be forwarded to the Corporate Headquarters in San Diego (and/or maintained electronically on a designated SharePoint site).

8.0 REFERENCES

None.

9.0 ATTACHMENTS

None.

Standard Operating Procedure

RADIOLOGICAL PROTECTIVE CLOTHING SELECTION, MONITORING, AND DECONTAMINATION

SOP-005

Revision 2

Approved By:

Steven Adams, CHP, Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/15/12	0	E. Abkemeier	Original	All
2/5/14	1	E. Abkemeier	Added medical clearance required for respirator use	7
7/17/15	2	S. Adams	Added roles and responsibilities; added details regarding donning and doffing of PPE, and surveying personnel	5, 8–10

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1.0 PURPOSE

This procedure provides the guidance for selecting protective clothing, performing personnel surveys, and decontaminating personnel.

2.0 SCOPE

This procedure will be used by Tetra Tech EC, Inc. (TtEC) personnel and its subcontractors while performing activities in areas with known or suspected radioactive contamination.

3.0 DEFINITIONS AND ABBREVIATIONS

Contaminated Area – Any area where removable surface contamination levels exceed the limits provided in Table 3-1, below.

Hot Particle – A discrete, minute, fragment of radioactive material.

Radiologically Controlled Area – An area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials and/or to prevent the release of radioactive materials to the uncontrolled areas.

TABLE 3-1

EQUIPMENT AND MATERIAL SURFACE CONTAMINATION LIMITS

Radiation Type	Release Limits[1] (Fixed) (dpm per 100 cm^2)	Release Limits (Removable) (dpm per 100 cm^2)
Alpha (α)[2] Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	20
Beta (β-) Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	200
Beta-Gamma (β-γ) Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	1,000

Notes:

[1] Limits for equipment and materials based on Regulatory Guide 1.86 (AEC 1974)

[2] Types of radiation: α - alpha, β - beta, γ - gamma

Acronyms and Abbreviations:

AEC – Atomic Energy Commission

cm^2 – square centimeter

dpm – disintegration per minute

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this SOP are defined below.

4.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is the responsible manager for maintaining, revising, reviewing, and approving changes to this standard operating procedure (SOP). Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

4.2 Radiation Safety Officer Representative

The Radiation Safety Officer Representative (RSOR) is responsible for the following:

- Identifying the radiological personal protective equipment (PPE) and, when appropriate, ensuring that the radioactive work permit lists the proper radiological PPE.
- Providing guidance and direction for decontamination of personnel.
- Notifying the corporate RSO of any personnel contamination event.
- Reviewing the Personnel Contamination Report and verifying all information is accurate.
- Requesting support from the qualified medical personnel regarding management of personnel who have been exposed to radiological contamination, when appropriate.
- Determining reimbursements and disposition of personal property that cannot be decontaminated.

4.3 Radiation Control Technician

The Radiation Control Technician is responsible for ensuring that workers don and doff the correct PPE properly, and performing decontamination of personnel under the guidance and direction of the RSOR.

5.0 PROCEDURE DETAILS

The procedures to follow in conducting activities under this SOP are provided below.

5.1 Selection of Personal Protective Equipment

The following factors should be considered when selecting PPE:

- The levels and types of radiological material present, or expected, in the work area
- The presence of chemical hazards
- The base in which the contamination is carried (dry, wet, oily)
- The work to be performed, or work in progress
- The location of the contamination (e.g., floor, walls, overhead, air handling systems, sewer systems)
- The physical configuration of the work area
- The environmental conditions, such as heat and humidity

- The exposure situation (vapor, pressured splash, liquid splash, intermittent liquid contact, and continuous liquid contact)
- The toxicity of the radioactive materials and/or chemical(s) (i.e., ability to permeate the skin, and systemic toxicity)
- The physical properties of the contaminant (vapor pressure, molecular weight, and polarity)
- The functional requirements of the task (dexterity, thermal protection, fire protection, and mechanical durability requirements)

Table 5-1 provides guidance for the selection of PPE when radiological hazards are present or suspected.

TABLE 5-1

GUIDE FOR THE SELECTION OF RADIOLOGICAL PROTECTIVE CLOTHING

Removable Contamination Levels	Clothing for Access Only No Work *	Clothing for Work or Access During Work *
General contamination levels < 1,000 dpm/100 cm^2	Level D PPE	Level D PPE
General contamination levels > 1,000 dpm/100 cm^2, but ≤ 10,000 dpm/100 cm^2	Glove liners Gloves Booties, cloth or PVC Tyvek Rubber shoe covers**	Glove liners Gloves Booties, cloth or PVC Tyvek Rubber shoe covers**
General contamination levels > 10,000 dpm/ 100 cm^2, but ≤ 100,000 dpm/100 cm^2	Glove liners Gloves Booties, cloth or PVC Tyvek Cap (or hood) Rubber shoe covers**	Glove liners Gloves Booties, cloth or PVC Tyvek Cap (optional) Hood Rubber shoe covers**
General contamination levels > 100,000 dpm/100 cm^2 See Note ***	Glove liners Gloves (2 pairs) Booties, cloth or PVC Tyvek Cap (optional) Hood Rubber shoe covers**	Glove liners Gloves (2 pairs) Booties (2 pairs), cloth or PVC Tyvek (2 pairs) Cap Hood Rubber shoe covers**

Notes:

* Plastics or partial plastics may be required any time water or liquid chemicals are present, such as when handling wet components.

** Composition of rubber shoe covers will be selected based on work area conditions and presence of any chemical hazards.

*** General contamination levels exceeding 250,000 dpm/100 cm^2 requires written concurrence (e.g., e-mail) of radiological protective clothing selection

Abbreviations and Acronyms:

cm^2 – square centimeter
dpm – disintegrations per minute
PPE – personal protective equipment
PVC – polyvinyl chloride

The guidelines for PPE selection specified in Table 5-1 may be modified under certain circumstances, such as the following:

- Wet areas – Where splashing water or spray is present, use rain suits in addition to the protective clothing listed in Table 5-1. A second set of coveralls may not be necessary when a rain suit is worn.
- Standing water – In addition to the clothing requirements for wet areas, use hip boots or waders for deep standing water areas.
- Face shields – Consider for use when there is significant beta radiation, or a likelihood of water splashing and respirators are not required.
- High temperature areas – Consult with the RSOR and Site Health and Safety Specialist (SHSS) prior to working in high temperature areas.

5.2 Procedure Process

The processes to follow when working in areas where radiological hazards are present or suspected are described below.

5.2.1 Donning Protective Clothing

1. Select the appropriate PPE.
2. Inspect coveralls, cotton glove liners, gloves, shoe covers, and hoods for rips, tears, and holes, or other indications of damage. If damaged, do not wear the damaged PPE and remove the PPE from service.
3. Do not wear PPE that does not fit properly.
4. Place dosimetry, if worn, in the upper body area on the interior of the breast tab with the window of the dosimeter facing out. When coveralls that do not have a breast tab or pocket are worn, dosimetry should be attached per the direction of the RSOR or designee. The dosimeter shall not be worn inside clothing or placed in pockets if exposure of bare skin to beta radiation is expected.
5. If a respirator is specified in the Radiation Work Permit (RWP), then ensure that:
   - The individual using the respirator has been medically cleared for respirator use and is respirator qualified.
   - The respirator fit test has been performed.
   - The respirator is the correct size and has the appropriate cartridges, as defined in the RWP.
6. Prior to donning the respirator, perform the following inspections:
   - Stretch out the straps/headbands, check to make sure there are no rips, tears, or cracks within or along the grooves.
   - Check to make sure there are no tears or cracks in the tabs.
   - Check the buckles to make sure they are not broken, rusty, bent, or loose.
   - Check the lenses/faceplate to make sure there are no deep scratches, pits, cracks, or holes, and that you can see clearly through the lens.

- Make sure the cartridge is the correct type, is not cracked or otherwise damaged, and is screwed in tightly.
- Make sure the receptor housing is not cracked or misshapen.
- Make sure the gasket is flexible, in place, has no tears or holes, and fits properly and securely.
- Make sure the inhalation valve is present, is in good position, and is not being held open.
- Make sure the harness has no tears or holes, and is in good condition.
- Ensure that any required surgeon's cap or hood is situated such that it will not interfere with the respirator face-to-facepiece seal area.
- Don the respirator.
- Don the hood, if required, allowing it to overlap the rubber around the lens of the face piece and fall over the shoulder.
- If required, tape the hood to the respirator and to the coveralls.
- Ensure that any required hood is slack enough around the shoulders to allow for full head movement.

7. Don rubber gloves.
   - More than one pair of rubber gloves may be required for certain jobs.
   - Tape the innermost pair of rubber gloves to the coverall sleeves.
   - Leather work gloves may be substituted for outer rubber gloves on some jobs as specified in the corresponding radiation work permit.
8. If specified on the RWP, don additional PPE as required.

5.2.2 Removal of Protective Clothing

Before stepping out of the contamination area or airborne radioactivity area to the step-off pad, the worker should:

- Remove exposed tape and place it in the appropriate container.
- Remove rubber overshoes and place them in the appropriate container.
- Remove the outer pair of gloves and place them in the appropriate container.
- Remove the hood, from front to rear, and place it in the appropriate container.
- Remove coveralls, inside out, touching the inside only and place them in the appropriate container.
- Remove the respirator, as applicable, by bending forward at the waist slightly, pulling the respirator away from the face, and then rolling the straps/headbands to remove the respirator, and place it in the appropriate container.
- Take down the barrier closure, as applicable.

- Remove any tape or fastener from the inner shoe cover and place it in the appropriate container.
- Remove a shoe cover and place it in the appropriate container while simultaneously stepping onto the clean step-off pad with the shoe whose shoe cover was just removed. Repeat this process with the other shoe.
- Remove the cloth glove liners and place them in the appropriate container.
- Replace the barrier closure, as applicable.
- Have the Radiological Control Technician (RCT) commence whole body frisking.
- Monitor the dosimeter.

The sequence for the removal of primary and supplemental dosimetry is dependent upon where the dosimetry was worn and the potential for contamination. The sequence for removal of respiratory protection devices may be altered if it is determined that the potential for inhalation of airborne contamination or the spread of surface contamination is reduced by keeping respiratory protection devices on until all protective garments have been removed.

The sequence for protective clothing removal may vary from that described above, under the following circumstances:

- At the discretion of the RCT providing job coverage.
- As designated in the assigned RWP.
- Depending on radiological and hazardous material conditions encountered during the work evolution.

It is important to be aware that pushing clothing or trash into an already full collection container to compress the contents is forbidden as the act can result in the potential for airborne radioactivity.

5.2.3 Monitoring

The conditions under which monitoring should be performed are described below.

5.2.3.1 Exit Surveys

During exit surveys, the following procedures should be followed.

1. Use the portable instrument staged for the area of concern, which should have both a visual and an audible response.
2. Ensure that the instrument is set on slow response, if available, and operating with an audible response.
3. Verify that the instrument is operational on the lowest scale and that the area background count rate is acceptable.
4. Hold the detector with the window approximately 1/4 inch from the surface being monitored.
5. Move the detector over the surface being monitored at a rate not to exceed 2 inches per second. It should take at least 3 minutes to perform a whole body frisk.

6. If an increase in the audible response is noted, then cease moving the detector and allow the meter 5 to 10 seconds to stabilize.
7. Pause (approximately 5 seconds) at the nose and mouth area to check for indications of inhalation/ingestion of radioactive material.
8. Pay particular attention to hands, feet (shoes), elbows, knees, or other areas with a high potential for contamination.
9. If no contamination can be detected, as indicated by an alarm or by an audible or visual response distinguishable from background, then exit the area.
10. If an audible or visual response distinguishable from background is noted, then the RCT will further investigate to verify if contamination is present.
11. If personnel are found to be contaminated, proceed to the procedures outlined in Section 5.2.3.2.

Note: Site conditions may merit only a hand and foot survey. If this is the case, only the hands and shoe bottom should be surveyed by the RCT.

5.2.3.2 Contaminated Personnel

When dealing with contaminated personnel, the following procedures should be followed.

1. Notify the RSOR of any individual with known or suspected contamination.
2. If the contamination is on a personal article of clothing, then perform the following:
   - Survey the inside surface that was against the skin.
   - Verify that no contamination was transferred to the skin.
3. If the contamination is on the skin, determine if the contamination is in the form of a hot particle.
4. If the contamination is a hot particle, then:
   - Quickly evaluate the particle size, radiation type, and visible characteristics.
   - Attempt to collect and retain the particle for subsequent evaluation.
   - Decontaminate the individual in accordance with Section 5.2.4.
5. If the contamination is not a particle, then:
   - Evaluate the contamination levels.
   - Decontaminate the individual in accordance with Section 5.2.4.
6. Complete the applicable parts of the Personnel Contamination Report (Attachment 1).

5.2.4 Personnel Decontamination

The steps to follow for personnel decontamination are presented below.

1. Perform personnel decontamination in a manner that prevents the spread of contamination to other body parts, or the ingestion or inhalation of radioactive material.

2. Take appropriate precautions to minimize the spread of contamination when proceeding from the control point or step-off pad to the decontamination area.
3. Refrain from releasing personnel if detectable skin contamination is present, unless authorized by the RSOR.
4. Perform skin decontamination as follows:

   - Exercise care to avoid damaging the skin.
   - Discontinue the decontamination and notify the RSOR if skin irritation becomes apparent.
   - Record results after each decontamination attempt.
   - Indicate the method of decontamination used.
   - Decontaminate ears, eyes and mouth using damp swabs, water, or saline solution rinses that are performed by the individual. Perform further decontamination under the direction of qualified medical personnel.
   - Decontaminate nasal passages by having the individual repeatedly blow the nose. Perform supplemental nasal irrigations under the direction of qualified medical personnel, as required.
   - Use decontamination processes or materials other than those listed in Table 4-2, only under the specific direction of qualified medical personnel.
   - Report incidents of individual contamination immediately to the RSOR.
   - Note the final survey results and time of the survey.
   - Record the area of the skin contaminated in square centimeters (cm^2) on the Personnel Contamination Report (Attachment 1).
   - Assume the measured activity is distributed over the probe area (the area of a typical pancake probe is 15.5 cm^2) for contamination distributed over an area greater than or equal to the area of the probe.
   - Determine the actual area of the activity if the area of contamination is less than the area of the probe but greater than 1 cm^2,
   - Assume an area of 1 cm^2 if the contamination area is less than or equal to 1 cm^2.
   - Obtain the information needed to complete the Personnel Contamination Report (Attachment 1) when skin decontamination has been successfully completed.
   - Complete the applicable parts of the Personnel Contamination Report (Attachment 1).

Note: First aid measures take precedence over decontamination efforts. The RCT shall request support from qualified medical personnel when an injured person requires decontamination.

TABLE 4-2

PERSONNEL DECONTAMINATION METHODS

METHOD	EFFECTIVE FOR	INSTRUCTIONS
Masking Tape	Dry contamination, hot particles	Apply tape to skin by lightly patting. Remove carefully.
Waterless Hand Cleaner	All skin contamination	Apply to affected area and allow it to melt onto the skin. Remove with cotton or soft disposable towel.
Soap and Tepid Water	All skin contamination except tritium	Wash area with soap and lukewarm water. Repeat until further attempts do not reduce the level. A cloth or surgical hand brush may be used with moderate pressure.
Soap and Cool Water	Tritium contamination	Wash area with soap and cool water. Repeat until further attempts do not reduce the level. A cloth may be used with moderate pressure.
Carbonated Water	All skin contamination	Apply to affected area with cotton or soft disposable towel and wipe with dry towel.
Cornmeal Detergent Paste	All skin contamination	Mix cornmeal and powder detergent in equal parts with enough water to form a paste. Rub onto affected area for 5 minutes. Remove with cotton or disposable towel. Rinse skin.
Shampoo	Hair contamination	Wash hair and rinse. Repeat as necessary.
Parafilm	All particulate contamination	Apply to affected area of skin. Remove.
Sweating	All skin contaminations	Cover affected area with impermeable cover (plastic, glove, Parafilm) to cause sweating. Remove after sweating has occurred and wipe area.

5.2.5 Radiological Follow-up

After the personnel decontamination incident has been managed, the following procedures should be completed by the RCT, RSOR and Site Health and Safety Specialist (SSHS).

The RCT shall:

1. Ensure that the Personnel Contamination Report (Attachment 1) has been completed.
2. Check the location of the contamination event (e.g., contaminated area, hot particle area, clean area inside a RCA, or clean area outside RCA).
3. Enter any additional pertinent information.
4. Complete the “Contamination Event Description and Cause” sections of Attachment 1.
5. If the event was directly related to wearing PPE, then complete Section A, “Event Directly Related to Wearing PPE.”
   - Check the appropriate Contamination Event Description.
   - Check the appropriate Basic Cause.

6. If the contamination occurred while removing PPE, then complete Section B, “Event Occurred While Removing PPE.”
   - Check the appropriate “Contaminating Event Description.”
   - Check the appropriate “Basic Cause.”
7. If the contamination event was not related to wearing PPE, then complete Section C, “Event Not Directly Related to Using PPE.”
   - Check the appropriate “Contaminating Event Description.”
   - Check the appropriate “Basic Cause.”
8. Review the report with the individual and have them sign and date the form.
9. Sign and date the form.

The RSOR shall:

1. Review the Personnel Contamination Report to verify that all required information has been accurately recorded.
2. Complete the “RSOR” section.
   - Check the appropriate brackets ([ ]) to indicate actions taken.
   - Enter any comments.
3. Sign and date the form.
4. Request support from the qualified medical personnel when:
   - The personnel decontamination methods provided in this procedure are ineffective; or
   - Injured personnel require decontamination.
5. Determine reimbursements and disposition of personal property that cannot be decontaminated.
6. Forward the completed Personnel Contamination Report to the SHSS for review.

The SHSS shall:

1. Review and sign the Personnel Contamination Report (Attachment 1).
2. Conduct an investigation into the cause of the contamination.
3. Conduct training on the cause of the contamination and lessons learned and preventive measures.
4. Sign and transmit the Personnel Contamination Report (Attachment 1) to the RSO for review.

6.0 RECORDS

The administrative form included in this procedure (Personnel Contamination Report) shall not be modified without the written authorization of the Project Manager and the documented concurrence of the RSO or designee. In no case shall modifications reduce the content required in the original form.

7.0 REFERENCES

Number	*Title*
AEC Regulatory Guide 1.86	*Termination of Operating Licenses for Nuclear Reactors*

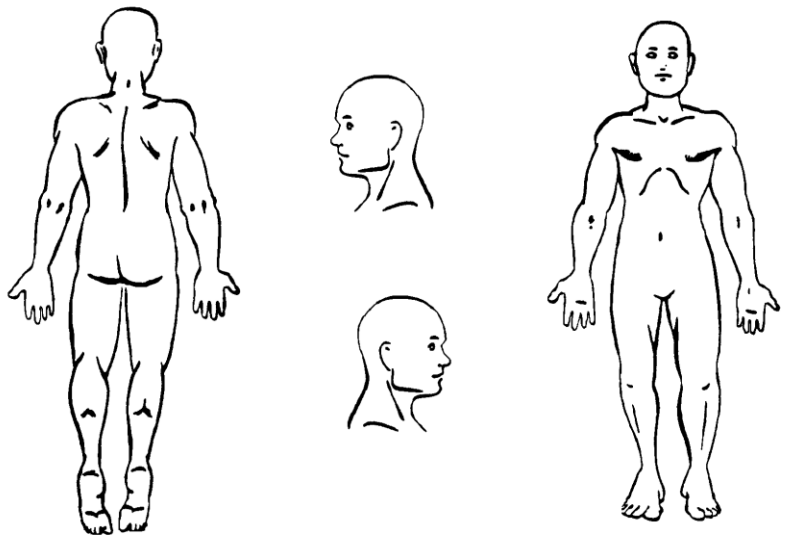
8.0 ATTACHMENTS

Attachment 1, Personnel Contamination Report

ATTACHMENT 1

PERSONNEL CONTAMINATION REPORT

Name		Company	Date	Time
EID	Dosimeter#	Dept.	Supervisor	
Instrument		Serial #	Cal. Due Date	
Probe		Serial #	Cal. Due Date	
Location of Personnel Contamination			RWP # Survey #	



Contamination Levels (Use # to reference drawing)					
Number	Time	Initial Count Rate	Size of Area (cm^2)	Time	Final Count Rate
Decontamination Methods	__ Wash __ Number of washes			__ Other:	
	__ Shower __ Number of showers				
Radiological Control Technician Signature:				Date	
I acknowledge the above information represents the contamination event.					
Individual Signature:				Date	

Name **EID**

CLOTHING CONTAMINATION

Item:	Max cpm	[ ] Decon/Return	[ ] Contaminated/Retained
Item:	Max cpm	[ ] Decon/Return	[ ] Contaminated/Retained
Item:	Max cpm	[ ] Decon/Return	[ ] Contaminated/Retained
RADIOLOGICAL FOLLOW-UP			
Location of Event:	[ ] Contamination Area	[ ] Clean area inside RCA	[ ] Clean area outside RCA
Follow-up actions:			
Additional information:			

CONTAMINATION EVENT DESCRIPTION and CAUSE

A - Event Directly Related To Wearing PPE

Contaminating Event Description	Basic Cause
[ ] Contaminated by physical compromise of PPE (tear, etc.)	[ ] Improper donning of PPE
[ ] Contamination penetration of intact PPE	[ ] Improper PPE use related to worker knowledge/experience
[ ] Contamination came from PPE	[ ] Work area not deconned to extent practicable
[ ] Contaminated skin by touching contaminated item	[ ] Practical limitation of available alternatives
[ ] Contamination came from contaminated liquid	[ ] Improper PPE requirement on RWP
[ ] Contamination came from airborne radioactivity	[ ] Improper control by RCT of worker activity in PPE
	[ ] Improper laundry/monitoring of PPE

B - Event Occurred While Removing PPE

Contaminating Event Description	Basic Cause
[ ] Contaminated during removal of hood	[ ] Lack of knowledge in proper methods to remove PPE
[ ] Contaminated during removal of respiratory equipment	[ ] Lack of knowledge in proper methods to remove respirator
[ ] Contaminated during removal of outer PPE	[ ] [ ] Worker actions while removing PPE - accident
[ ] Contaminated during removal of inner PPE	[ ] RCT technician actions
[ ] Contaminated during removal of plastics	[ ] [ ] Improper monitoring of PPE
[ ] Contamination came from airborne radioactivity	

C - Event Not Directly Related To Using PPE

Contaminating Event Description	Basic Cause
[ ] Contaminated while in area designated as clean RCA	[ ] Noncompliance with postings/rad controls
[ ] Contaminated while in area designated clean non - RCA	[ ] Improper monitoring/control of rad material by worker
[ ] Contaminated by liquid	[ ] Improper actions at work area (sitting, lying)
[ ] Contamination spread to area and not identified	[ ] Accidental contact with contamination beyond worker control
[ ] Improper control of airborne radioactive material	[ ] Surveys not appropriate for existing conditions

Radiation Safety Officer Representative

[ ] Interview with job coverage RCT	[ ] Released with residual contamination
[ ] Exclude individual from further RCA access	[ ] Initiated skin dose calculation
[ ] Discussed with individual and supervisor	[ ] No further action required, routine close out

RSOR _____ / _____ _____
Print Sign Date

SHSS _____ / _____ _____
Print Sign Date

RSO _____ / _____ _____
Print Sign Date

Standard Operating Procedure

SAMPLING PROCEDURES
FOR RADIOLOGICAL SURVEYS

SOP-006

Revision 2

Approved By:

Steven Adams, CHP, Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/9/12	0	E. Abkemeier	Original	All
8/18/14	1	E. Abkemeier	Clarifications	5, 7
7/17/15	2	S. Adams	Additional details on sampling, packaging, and transport	5–8

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1.0 PURPOSE

This procedure will be used by Tetra Tech EC, Inc. (TtEC) personnel and its subcontractors to perform swipe sampling and sampling of various types of media, including soil and water.

2.0 SCOPE

This procedure shall be implemented by TtEC staff and subcontractor personnel when collecting samples on field projects related to radiological surveys.

3.0 DEFINITIONS AND ABBREVIATIONS

Liquid Samples – Liquid collected for analytical purposes from sinks, drain piping, sewer systems, rinsate, groundwater, leachate, liquid investigation-derived waste, and low-point accumulation areas on the interiors of buildings, sumps, and excavation pits.

Sediment Samples – A collection of clay, silt, sand, and/or gravel deposited by water, wind, or glaciers used for analytical purposes.

Soil Samples – Soil collected for analytical purposes. Soil samples will be collected from the top 15 centimeters (cm) (6 inches) of the surface, unless otherwise noted in the applicable work-planning document (e.g., a Task-Specific Plan, Work Instruction, or Work Plan).

Solid Material Samples – Pieces of concrete, brick, porcelain, wood, or any other hard material collected for analytical purposes from buildings or surrounding areas. The samples could include accumulations from ventilation systems or drain systems.

Swipe Samples – Materials that after being wiped over a surface are analyzed to determine the presence of removable radioactivity on the surface area that was wiped.

4.0 ROLES AND RESPONSIBILITIES

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

5.0 SAMPLING PROCEDURE DETAILS

The procedures to follow during sampling of various media are provided below.

5.1 General Procedures

Field instruments used for measurements required in this SOP shall be function checked daily using National Institute of Standards and Technology (NIST) traceable standards, and verified to have current calibration. Any time this procedure is in effect, the RSOR (or qualified designee) should ensure, through periodic personal observation, that samples are appropriately collected and controlled. Surface scan surveys are to be performed at each location before initiating sampling. This will identify the presence of gross contamination, which will require that samples and equipment be treated as radioactive, and handled in accordance with applicable license requirements. Samples will be recorded on a chain-of-custody (COC) form.

5.2 Sampling Procedure Process

Sample activities will be recorded in the field logbook as directed in the applicable Sampling and Analysis Plan (SAP).

5.2.1 Swipe Sampling

Swipe samples will be obtained in accordance with SOP 001, *Radiation and Contamination Surveys*. Swipe samples will be documented in a logbook as applicable. Sample COC records shall be completed in accordance with the applicable SAP.

5.2.2 Soil Sampling

Because standard surface soil contamination criteria for radionuclides are applicable to the average concentration in the upper 15 cm of soil, the sampling protocol described herein is based on obtaining a sample of this upper 15 cm. Special situations, such as sampling at depths greater than 15 cm, evaluating trends or airborne deposition, determining near-surface contamination profiles, and measuring non-radiological contaminants, may require special sampling procedures. These special situations will be evaluated and incorporated into work plans or work instructions as the need arises.

Samples will be collected with a hand auger, hollow-stem auger, split-spoon sampler, disposable scoop, or equivalent. The soil removed for sampling must be sufficient to yield a sample of sufficient volume for the sample container being used. Soil samples will be collected and handled as follows:

1. Loosen the soil at the selected sampling location to a depth of approximately 15 cm using a clean trowel or other digging instrument. In rocky terrain, a pick axe or mechanical means, such as a Hilti gun, may be used to remove soil for sampling. If an excavator is used due to health and safety reasons, extreme care should be taken to ensure that the soil collected is from the upper 15 cm of the original surface.
2. Remove large rocks, vegetation and foreign objects. In some cases, these objects may be the source of the contamination and should be collected as separate samples for characterization.
3. Confirm that sample containers for soil are certified pre-cleaned in accordance with United States Environmental Protection Agency protocols.
4. Obtain a new (unused) disposable sampling scoop (or other non-disposable decontaminated sampling equipment). Put on a new (unused) pair of sampling gloves and other appropriate personal protective equipment.
5. Place as much soil as practical into a 250-milliliter (mL), wide-mouth plastic bottle, 500-mL plastic Marinelli container, plastic Ziploc® bag, or other suitable collection device. Approximately 1,000 grams may be necessary for soil with significant moisture (approximately 3 “tuna cans” full). Note that if a “split sample” is necessary in order for a regulatory agency to perform confirmatory analysis, collection of up to 2,000 grams of soil will be necessary. Ensure that the material collected is from the upper 15 cm of soil. Note that this may require digging a hole wider, as opposed to deeper.
6. Tape the cap of the container in place or seal the Ziploc plastic bag.
7. Label the sample container in accordance with the applicable SAP.
8. Document all samples collected in the sample logbook as applicable. Sample COC records shall be completed in accordance with the applicable SAP.

9. Transport samples to the laboratory, if an on-site laboratory is present, for analysis as soon as possible after sample collection. Sample packaging and shipment procedures for transporting samples to an off-site laboratory are described in Section 4.3 of this procedure.
10. Use clean or decontaminated tools at each sampling location. Sampling tools will be decontaminated as described in the applicable SAP.
11. Change nitrile gloves shall between sampling evolutions to avoid cross contamination.

5.2.3 Sediment Sampling

Several methods are available to collect sediment samples. The tools used will be appropriate to the circumstances and may include use of trowels, augers, or other hand tools. Sediment sampling will be conducted as follows:

1. A hand-auger, trowel, or similar device will be used to access each sampling location. The sample collection tool will be selected based on the physical limitations present while accessing the sample location.
2. Place as much material as practical into a 250-mL, wide-mouth plastic bottle, 500-mL plastic Marinelli container, plastic Ziploc bag, or other suitable container.
3. Follow steps 4 through 9 of Section 5.2.2 to complete sample collection.

5.2.4 Solid Material Sampling

Several methods are available to collect solid material samples. To collect samples, solid materials may need to be broken into smaller pieces. Solid materials will be collected as follows:

1. Break up the material into small enough pieces to fill a 250-mL, wide-mouth plastic bottle, 500-mL plastic Marinelli container, plastic Ziploc bag, or other suitable container. A pick axe or mechanical means, such as a Hilti gun, may be used to remove solid material for sampling. At no time shall an excavator be used to collect samples.
2. Follow steps 4 through 9 of Section 5.2.2 to complete sample collection.

5.2.4.1 Pipe and Drain Line Sampling

Pipe and drain line sampling is conducted to assess residual radioactivity that may be on the interior of drain lines or materials within sanitary sewer and storm drain systems. Since the type of material found inside drain lines varies, no specific method is used to collect these samples. Samples may be collected using a plumber's snake, swabs, scraper, trowel, etc.

1. Place as much material as practical into a 250-mL, wide-mouth plastic bottle, 500-mL plastic Marinelli container, plastic Ziploc bag, or other suitable container.
2. Follow steps 4 through 9 of Section 5.2.2 to complete sample collection.

5.2.4.2 Ventilation Sampling

Ventilation sampling will be performed to identify if the system is impacted and assess the residual radioactivity that may be present. Samples from ventilation systems will be collected as follows:

1. If visible dust is present inside the ventilation system, use a masslin cloth to collect the material into a pile.
2. If no visible dust is present, collect a swipe sample as discussed in SOP 001, *Radiation and Contamination Surveys*.
3. Using a flat utensil, such as a piece of paper or scraper, carefully place as much material as possible into a 250-mL, wide-mouth plastic bottle, 500-mL plastic Marinelli container, plastic Ziploc bag, or other suitable container.
4. Follow steps 4 through 9 of Section 5.2.2 to complete sample collection.

5.2.5 Water Sampling

Water samples will be collected as follows:

1. Collect water using any of the following sampling equipment: disposable bailer, pump, coliwassa-type tube sampler, or equivalent. Care should be taken to avoid collection of bottom sediment or vegetation.
2. Fill completely a 250-mL, wide-mouth plastic bottle, 500-mL plastic Marinelli container, or 2-liter plastic bottle.
3. Follow steps 4 through 9A of Section 5.2.2 to complete sample collection.

5.3 Sample Packaging and Transport

Samples will be delivered for analysis to the laboratory via a box, cooler, or similar container (ice is not required if only radiological analysis will be performed), along with the COC documentation completed as described in the applicable SAP.

Samples being analyzed for non-radiological chemicals will be shipped in a cooler with a temperature blank. Ice, double bagged in resealable bags, will be added to the cooler in sufficient quantity to keep the samples cooled to 4 ± 2 degrees Celsius for the duration of the shipment to the laboratory. Sample cooler drain spouts will be taped from the inside and outside of the cooler to prevent any leakage. Saturday deliveries will be coordinated with the laboratory.

Samples will be shipped to the analytical laboratory by land delivery services according to U.S. Department of Transportation regulations. The International Air Transportation Association regulations will be adhered to when shipping samples using an air courier service. Transportation methods will be selected to ensure that the samples arrive at the laboratory in time to permit testing according to established holding times and project schedules. The receiving laboratory will only accept samples with a properly prepared COC record and properly labeled and sealed shipping container(s).

If samples are picked up by a laboratory courier service, the COC record will be completed and signed by the laboratory courier. The cooler will then be released to the courier for transportation to the laboratory.

If a commercial carrier is used, the COC record will include the airbill number in the “transfers accepted by” column, and will be sealed in a resealable bag. The COC record will then be taped to the inside of the sample cooler lid. The cooler will be taped shut with strapping tape, and two

custody seals will be taped across the cooler lid: one seal in the front and one seal in the back. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. A copy of the courier airbill will be retained for documentation.

Prepared packages will be surveyed prior to shipment using an appropriate exposure rate meter in accordance with SOP 001, *Radiation and Contamination Surveys*.

6.0 RECORDS

Sample collection records will include field logbooks and COC documentation. These records will be completed and maintained in accordance with the SAP.

7.0 REFERENCES

Number	***Title***
SOP 001	Radiation and Contamination Surveys

8.0 ATTACHMENTS

None.

Standard Operating Procedure

DECONTAMINATION OF EQUIPMENT AND TOOLS

SOP-007

Revision 2

Approved By:

Steven Adams, CHP, Corporate Radiation Safety Officer	7/17/2015 Date

Revision History

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11/15/12	0	E. Abkemeier	Original	All
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7/17/15	2	S. Adams	Inserted new Section 4.0 Roles and Responsibilities, minor editorial revisions	4–10

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1.0 PURPOSE

This procedure provides instruction and methods for the decontamination of equipment and tools.

2.0 SCOPE

This procedure describes the methods Tetra Tech EC, Inc. personnel and its subcontractors will use for decontamination of equipment and tools that are contaminated with radioactive material.

3.0 DEFINITIONS and ABBREVIATIONS

Decontamination – The processes whereby contamination can be safely and effectively removed from equipment and tools.

HERCULITE® – A plastic or polyethylene floor covering and containment material used for decontamination operations. HERCULITE is a brand name.

Material Safety Data Sheet – Manufacturer directions, safety information, and limitations for use of decontamination-related solvents or cleaning solution.

4.0 ROLES AND RESPONSIBILITIES

The Radiation Safety Officer Representative (RSOR), or his/her designee, is responsible for ensuring that workers are following this procedure and for the oversight of the decontamination operations in the field. In addition, the RSOR, or his/her designee, is responsible for addressing any issues or suggested modifications with the decontamination process.

5.0 PROCEDURE DETAILS

The procedures to follow in conducting activities under this SOP are provided below.

5.1 General

The precautions and limitations to be considered while decontaminating equipment and tools used for radiation-related activities are described below.

5.1.1 Precautions

The following precautions shall be observed during decontamination activities:

- Decontamination of contaminated tools or equipment shall be performed under the supervision of the Radiological Control Technician (RCT) providing the job coverage.
- Controls used to contain the spread of loose contamination during the decontamination activities shall be planned and established prior to the decontamination of equipment, material, and tools.
- Use of chemicals or solvents for decontamination purposes that have the potential to produce mixed waste shall be avoided whenever possible. Use of these chemicals or solvents requires the prior approval of the RSOR and Radiological Affairs Support Office (RASO).
- Survey instruments that will be used to survey suspected contaminated equipment or tools should be protected (wrapped in plastic, etc.) against possible contamination before use.
- Abrasive substances should only be applied to surfaces that are not critical for operation of devices being returned to working condition.

- Electric power tools should not be used on a wet working surface. Liquids should be kept away from areas where electric power tools are being used.

5.1.2 Limitations

The following limitations apply to decontamination activities:

- Protective clothing worn by the personnel involved in decontamination activities is listed in the applicable radiation work permit, in accordance with SOP 010, *Issue and Use of Radiation Work Permits,* and must be approved by the RSOR.
- Decontamination cleaning solvents/solutions shall only be used in accordance with the directions and limitations listed on the manufacturer-supplied Material Safety Data Sheet (MSDS).
- Contamination controls shall be observed throughout any decontamination operation.
- Radiation and contamination surveys shall be performed in accordance with the provisions of SOP 001, *Radiation and Contamination Surveys*.
- Release of equipment and tools from the decontamination area shall be performed in accordance with SOP 003, *Release of Materials and Equipment from Radiologically Controlled Areas*.

5.2 Pre-Decontamination Preparation

The following steps shall be used to prepare for decontamination activities:

1. The RSOR, or designee, shall review available data regarding the item(s) requiring decontamination and develop a decontamination approach based on conditions of the Radiation Work Permit and the cost-effectiveness of the operation versus disposal costs.
2. A radiological survey shall be performed by an RCT to identify the level of radioactive contamination that is present on objects that are to be removed from a controlled area.

5.3 Establishment of Decontamination Areas

The RSOR, working with the Project Manager, shall select a location for setup of decontamination areas. As applicable to the specific decontamination activity being performed, a decontamination area may consist of and contain one or more of the following (as needed):

- Covered floor surfaces. A double-layer of HERCULITE (or equivalent) may be laid on the floor at the direction of the RCT. Note that any polyethylene or plastic sheeting used for protection of floor surfaces shall be a minimum thickness of 5 mil to prevent breakthroughs due to wear and tear.
- Covered (HERCULITE or equivalent) wall surfaces.
- Engineering controls (high-efficiency particulate air [HEPA] ventilation, vacuum cleaners, containment tent walls, glove bags, etc.). Engineering controls shall be determined on the basis of the *as low as reasonably achievable* philosophy.
- Safe, sturdy work stations with contamination-resistant surfaces; tables that will support decontamination of heavy pieces of equipment.
- Adequate lighting.
- Electrical and compressed air supply for the operation of electrical and/or pneumatic-driven equipment.

- Overhead lifting equipment.
- Adequate supply of approved cleaning solutions and solvents.
- Adequate supply of decontamination equipment such as:
  - Light-duty decontamination equipment, such as paper wipes, paper towels, masslin towels, etc.
  - Medium- to heavy-duty decontamination equipment, such as scrub pads, wire brushes, steel wool, files, sandpaper, etc.
  - Fully stocked hand tool kit for disassembly of contaminated equipment.
  - Power tools, such as drills, saws, needle-guns, electric screwdrivers, etc.
  - Radioactive material storage bags and stickers.
  - Buckets, barrels, or drums for the storage of contaminated liquids, sludges, or slurries.
  - Blotter paper or sorbent.
  - Approved absorbent material such as oil dry.
  - Storage drums/bags for the storage of contaminated protective clothing.
  - Proper surveillance instruments (air monitor/sampler, contamination monitor, friskers, exposure rate meter, etc.).
  - Adequate supply of personal protective clothing, gloves, respiratory equipment.
  - A designated area within the decontamination area for the segregation of radioactive waste.
    - Fire extinguisher(s).

5.4 Item Preparation for Decontamination

Contaminated or controlled items should always be transferred under escort and under the direction of a RCT to the decontamination area posted in accordance with SOP 012, *Radiologically Controlled Area Posting and Access Control*.

If an item is wrapped, position it so that the written information on the wrapping is visible, and perform the following:

- The RCT shall direct the removal of the item from the wrapping in such a manner (rolling plastic wrapping inside out, etc.) to control the spread of contamination.
- An item that is highly contaminated with removable contamination may need to be misted with an approved liquid to minimize the possibility of creating airborne contamination.
- Once the item has been removed from the wrapping and has been properly positioned, discard the wrapping as radioactive waste.

The following conditions shall be considered for the decontamination of equipment and tools:

- Any equipment with inaccessible areas shall be dismantled so that all surfaces are accessible for decontamination and survey.
- Decontamination shall be performed in a safe, effective manner.

- The RSOR shall be notified immediately if the job conditions change (e.g., suspected asbestos is found, mercury is present in a switch or a light bulb, a fluid is leaking, or any other special circumstances).
- A fire watch shall be assigned to watch if any spark-producing decontamination techniques (grinding, etc.) are used. A dedicated fire extinguisher shall be located within the decontamination area.
- The decontamination area shall remain organized and free of debris. The Radiological Control/Decontamination Technicians shall “clean as they go.”
- Air monitoring for airborne radioactivity shall be conducted, as needed, or as directed by the RSOR in accordance with SOP 009, *Air Sampling and Sample Analysis*.
- A HEPA vacuum cleaner may be used during the decontamination operation.

5.5 Decontamination of Removable Contamination

When an item is properly positioned for decontamination and the pre-survey activities have been completed, the RCT will perform one or more of the following activities in accordance with the decontamination action approach approved by the RSOR:

- Moisten the surface of the item with an approved liquid.
- Fold a paper or cloth wipe into sections. Using one surface of the wipe, gently wipe contamination off in one direction, away from the user's body to reduce the possibility of personnel contamination.
- Re-fold the paper or cloth wipe so that a clean surface is available to prevent cross-contamination and continue until item is ready for survey.
- For some equipment or tools, duct tape will effectively remove removable contamination. Wrap the duct tape loosely around the gloved hand, adhesive side out. Roll the tape over the contaminated area.

5.6 Decontamination of Fixed Contamination

Many techniques can be used to remove fixed contamination. The general idea is to remove the material that is fixing the activity to the surface, or remove a very thin layer of the surface material. It is very important to note that fixed contamination decontamination methods can, and do, result in the creation of removable surface contamination. This creates a condition that may generate airborne radioactive materials. The activities should be controlled in such a manner that airborne radioactivity is minimized. Air sampling shall be performed during these operations in accordance with SOP 009 to properly evaluate any resultant airborne radioactivity.

For the purposes of this procedure, the potential removal techniques have been divided into the following two categories:

- Abrasive hand decontamination
- Power tool decontamination

In addition, the following methods could be used, but are not defined in this procedure and would require the development of a Task-Specific Plan or Work Instruction:

- Machine decontamination (use of abrasive bead blasters, grit blasters, high-pressure water wash systems, etc.)
- Cleaning solutions/solvents (use of ultrasonic cleaners, acid baths, electropolishing, etc.)

The actual method or combination of methods applied will be in accordance with the decontamination approach approved by the RSOR.

5.6.1 Abrasive Hand Decontamination

Abrasive hand decontamination shall be performed in the following manner:

1. Remove as much removable contamination as possible, as indicated in Section 5.5 of this procedure.
2. Moisten the surface of the item(s) to help contain contamination.
3. Use an abrasive cleaning tool (e.g., sandpaper, steel wool, steel brush, hand grinder, etc.) to loosen fixed contamination.
4. Clean in one direction only, away from the body, to prevent personal contamination.
5. Continue to moisten the surface of the item(s) to contain contamination.
6. Remove as much of the loosened contamination as possible in accordance with Section 5.5 of this procedure.

5.6.2 Power Tool Decontamination

Power tool decontamination shall be performed under the direction of the RCT, with concurrence from the RSOR.

5.6.2.1 Electric Power Tools

Electric power tools that may be used in decontamination operations are:

- Drills – used to drill out contaminated areas, to disassemble contaminated components, and, when used with grinding wheels or disks, may be used as an abrasive tool.
- Saws – used to separate contaminated pieces from clean pieces.
- Grinders – used to grind fixed contamination from surfaces.
- Electric screwdrivers – used in the disassembly of component parts.

5.6.2.2 Air-powered Tools

Air-powered tools that may be used in decontamination operations are:

- Needle gun – a pneumatic tool that can remove contamination from concrete and/or steel surfaces.
- Socket tools or impact hammer – used in disassembly of component parts.
- Jackhammer/rotary hammer – a pneumatic tool which can remove contamination from concrete and/or steel surfaces.

5.6.2.3 Decontamination Procedures

Power tool decontamination shall be performed in the following manner:

1. Remove as much removable contamination as possible, in accordance with Section 5.5 of this procedure.
2. Moisten the surface of the item lightly to help contain contamination. Use a spray bottle for moistening.
3. Whenever feasible, containment devices (e.g., glove box, etc.) should be used to contain the spread of contamination when using power tools for decontamination operations.
4. Use the power tool to remove fixed contamination. Clean in one direction only, away from the body, to prevent personnel contamination.

5.7 Post-Decontamination

Following completion of the decontamination procedures, the RCT shall perform a release survey. The survey will include the work area and any tools, equipment, and materials used during decontamination activities, and shall be conducted in accordance with SOP 003. Post-decontamination release shall be performed as follows:

1. If the item satisfies the criteria for release, remove the item to a holding area and document the results.
2. If the item remains contaminated, inform the RSOR and repeat the decontamination process.
3. If the item remains contaminated, attempt a third decontamination only by direction of the RSOR.

If an item cannot be effectively or economically decontaminated, the Project Manager may direct the crew to volume-reduce (reduce to component parts) the equipment, material, or tools as much as possible. If the item is expendable, the individual parts may be surveyed and released.

Any tools, equipment, or materials that cannot be decontaminated will be packaged in an appropriate waste container for subsequent disposal as radioactive waste. The waste containers will be staged in an area agreed upon by RASO and the Department of the Navy.

After decontamination operations have been completed, an RCT shall perform a release survey of the decontamination area in accordance with SOP 001 and equipment used in accordance with SOP 003.

6.0 RECORDS

The records generated as a result of following this procedure should be documented in accordance with the provisions of SOP 003.

7.0 REFERENCES

Number	***Title***
SOP 001	*Radiation and Contamination Surveys*
SOP 003	*Release of Materials and Equipment from Radiologically Controlled Areas*
SOP 009	*Air Sampling and Sample Analysis*
SOP 010	*Issue and Use of Radiation Work Permits*
SOP 012	*Radiologically Controlled Area Posting and Access Control*

8.0 ATTACHMENTS

None.

Standard Operating Procedure

CONTROL OF RADIOACTIVE MATERIAL

SOP-008

Revision 2

Approved By:

Steven Adams, CHP,
Corporate Radiation Safety Officer

7/17/2015
Date

REVISION HISTORY

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7/17/15	2	S. Adams	Inserted Section 4.0, Roles and Responsibilities, and made minor editorial revisions	3–13

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1.0 PURPOSE

The purpose of this procedure is to specify methods and requirements for tracking and controlling radioactive material (RAM) collected or generated during survey characterization and remediation activities at client facilities by Tetra Tech EC, Inc. (TtEC) and its subcontractors.

By using this procedure, TtEC and its subcontractors shall meet or exceed the requirements for the Nuclear Regulatory Commission or Agreement State Radioactive Materials License (RML), as applicable.

2.0 SCOPE

This procedure governs control of RAM and shall be implemented by TtEC staff and subcontractor personnel when handling RAM. The requirements identified in this procedure are limited to RAM collected or generated during survey, characterization, and remediation activities.

Procedures for the preparation and labeling of RAM for shipment are beyond the scope of this document. Packaging, labeling, and shipping of RAM shall be conducted in accordance with the requirements provided in 49 Code of Federal Regulations (CFR) and other applicable regulations, standards, and guides.

Radioactive waste will be packaged in an appropriate container. The waste containers will be maintained under TtEC's applicable RML until they are relinquished to an approved broker or client-approved contractor.

3.0 DEFINITIONS AND ABBREVIATIONS

Airborne Radioactivity Area – A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed radioactive material, exist in concentrations that exceed the derived air concentrations (DACs) specified in Appendix B to 10 CFR 20.1001-20.2401, or the concentrations that an individual present in the area without respiratory protective equipment could be exposed to, during the hours an individual is present in a week, at an intake of 0.6 percent of the annual limit on intake or 12 DAC-hours.

Client Agency – Organization given the authority to define the requirements for control of radioactive and non-radioactive material in a TtEC radiologically controlled area (RCA), e.g., state or federal regulatory agency, Navy Radiological Affairs Support Office.

Client Representative – Client decision maker given the authority to define the requirements for control of radioactive and non-radioactive material in a TtEC RCA. The client representative is defined in the appropriate work control document, e.g., client radiation safety officer, project manager, or program manager. The client representative may be an individual in the client agency.

Container – Any package or barrier that is used to enclose RAM so that it can be easily handled and contained. Examples of containers include drums, roll-off boxes, conex boxes, fiber, metal, wooden or cardboard boxes, plastic or glass jars, metal cans, bags (Ziploc® or open top), plastic sheeting, or any other package that meets the requirements of this definition.

Contamination Area – Any area accessible to individuals where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Table 5-1, below, but do not exceed 100 times those values.

Control – In relation to handling of RAM, having physical custody, being in the immediate vicinity of, or in line of sight of the RAM. Control also refers to being responsible for the securing of RAM to prevent unauthorized access.

Mixed Waste – Waste that contains a hazardous waste component and a RAM component.

Radiation Area – An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 millisievert in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radioactive Material – Any material (e.g. soil, demolition debris), solid samples or swipes, or equipment (tools, instruments, etc.), that has a radioactive component (total or removable) at or above the levels specified in Table 5-1, or the project-specific authorized work documents, or Sampling and Analysis Plan.

Radioactive Materials Area – Any designated area where RAM is stored or used. Posting of a radioactive materials area (RMA) is not required if the RAM is stored inside a posted radiation area, contaminated area, or airborne radioactivity area.

Radiologically Controlled Area – An area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials and/or to prevent the release of radioactive materials to the uncontrolled areas.

Removable Contamination – Radioactive contamination that is readily removed from a surface by non-destructive means, such as casual contact, wiping, brushing, or washing.

Samples – Aliquots (portions) of material deposited on or placed within a container for the purposes of transferring and performing a quantitative or qualitative analysis of that material.

Work Control Document – The authorized document(s) that defines the requirements and criteria for control of radioactive material, e.g., Task-Specific Plan, Radiation Protection Plan, Characterization and Remediation Plan, and Final Status Survey Plan.

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities associated with this Standard Operating Procedure (SOP) are described in the following paragraphs.

4.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

4.2 Radiation Safety Officer Representative

The Radiation Safety Officer Representative (RSOR) is responsible for ensuring that the inventory and data basis of radioactive material for the facility for which he/she is responsible is maintained and updated in accordance with work control documents, and, at a minimum, once per quarter. The RSOR is also is responsible for ensuring that the RAM waste is containerized, whenever possible, or otherwise protected and stored in pre-authorized areas.

4.3 Radiation Control Technicians

The Radiation Control Technicians (RTCs) are responsible for preventing unauthorized waste, material, or equipment from being brought into or out of a TtEC RCA, and are responsible for notifying the RSOR as soon as practicable when unauthorized waste is being brought in or out of a TtEC RCA. The RCTs also must inspect containerized RAM at least once per week, noting the physical status of the RMA where the RAM is being stored.

5.0 PROCEDURE DETAILS

Details regarding procedures to follow for truckload screening are provided below.

5.1 Classification and Identification of Radioactive Material

The methods for classifying and identifying radioactive material are described below.

5.1.1 Radioactive Material Limits

Table 5-1 identifies the limits of surface contamination for defining RAM. Activity concentrations defining RAM are the release criteria listed in the project-specific work control documents.

5.1.2 Identification of Radioactive Material

Determination of whether to classify material or equipment as RAM waste is accomplished by surveying and/or sampling the material or equipment. In the absence of survey data, material originating from impacted areas or RCAs shall be classified as RAM and handled accordingly until proven otherwise through instrument survey, or radioanalysis of smears or samples.

5.1.3 Mixed Waste

Mixed waste may be encountered or generated during surveys, characterization, remediation, or decontamination activities. If the radiological and chemical components in the waste can be easily separated by physical means, this shall be done to allow for each component to be handled separately. Work to be performed shall be conducted to minimize the creation of mixed waste. Chemicals used for chemical decontamination activities shall be selected to minimize the creation of mixed waste. When it is impossible to segregate hazardous and radioactive components of materials or equipment designated for disposal, then the item(s) must be handled as a mixed waste. Applicable precautions and guidance for handling both RAM and hazardous material must be used for mixed wastes.

TABLE 5-1

RADIOACTIVE CONTAMINATION RELEASE LIMITS FOR MATERIALS AND EQUIPMENT

Radiation Type	Release Limits[1] (Total) (dpm per 100 cm^2)	Release Limits[1] (Removable) (dpm per 100 cm^2)
Alpha (α) Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	20
Beta (β-) Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	200
Beta-Gamma (β-γ) Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	1,000

Notes:
[1] These limits are based on AEC Regulatory Guide 1.86 (AEC 1974)
Abbreviations and Acronyms:
AEC – Atomic Energy Commission
cm^2 – square centimeter
dpm – disintegrations per minute

5.2 Storage of Radioactive Material

Radioactive material must be stored in a posted area, as specified below, to communicate the material hazard present to personnel that may encounter the material. Posting will be done in accordance with SOP 012, *Radiologically Controlled Areas – Posting and Access Control*. RAM waste shall be containerized, whenever possible, or otherwise protected and stored in pre-authorized areas determined concurrently by the RSOR and the client, and in compliance with the work control documents and pertinent regulations, standards, and guides. Control must be maintained over all RAM to minimize personnel exposure and the spread of contamination. Requirements for containerizing, posting, and control of RAM are provided below.

5.2.1 Containerizing

To the greatest extent possible, RAM waste should be containerized for storage. To facilitate containerization, equipment that can be disassembled should be broken down into the smallest number of components practical. Sharp edges or projections should be blunted, taped, or otherwise covered to ensure that the integrity of the package will be maintained during subsequent handling operations.

If the size of the object does not allow for disassembly, and containerization is not possible, then a plastic covering can be used to minimize the potential for the spread of contamination.

For bulk dispersible items, such as soil and construction debris stockpiles, where containerization is not practicable, the items will be placed on an impervious material and covered or sprayed with a chemical compound to prevent the spread of the material. Items with surface contamination that exceeds 100 times the limits identified in Table 5-1 should be packaged such that two barriers exist (i.e., double-wrapped or bagged inside a rigid container). More rigid requirements for containerization of RAM may be necessary based on information provided in the project-specific work control documents, or direction from the client.

5.2.2 Posting

Posting will be done in accordance SOP 012. Signs must be displayed at the entrances to buildings containing RAM waste that indicate that the building is an RCA, and the RCA must be cordoned off and posted as the RMA. If RAM waste is stored in stockpiles or in large containers that are stored outdoors, the stockpiles or containers shall be located within an RCA. The immediate area around the stockpile or containers will be cordoned off and posted as an RMA.

5.2.3 Control

The control of RAM shall be performed in accordance with the provisions of 10 CFR 20, Standards for Protection Against Radiation; Agreement State Radiation Protection Regulations, as applicable, SOP 012, SOP 003, *Release of Materials and Equipment from Radiologically Controlled Areas*, and SOP 007, *Decontamination of Equipment and Tools*.

Radioactive material should be consolidated in common RMAs to the greatest extent practical to simplify the implementation of adequate materials control. Areas posted as RMA because of potentially radiologically impacted surface or subsurface soil, buildings, and associated equipment and materials that have not been remediated need not have locked entrances Control of RMAs with containerized RAM will include security measures (e.g., locks, fencing, packaging) to preclude unauthorized access to or removal of RAM. Access shall also be controlled to prevent non-radiation workers from gaining entry to RMAs. RMAs with containerized RAM will be inspected at least once per week by an RCT. RCTs shall note the physical status of RMAs including:

- Locked/secure status
- Labeling/posting
- Condition of containers

5.3 Radioactive Waste Inventory Management

A radioactive waste inventory (RWI) program will be used to track RAM waste generated during survey, characterization, and remediation activities. The program includes the provision for regular inventory checks. The specific requirements for inventory management are given in the following sections.

5.3.1 Container/Stockpile Inventory

If radioactive material is not immediately transferred to a low-level radioactive waste (LLRW) broker or contractor, a running inventory of radioactive materials in a container will be posted on the container. Documentation of stockpile inventories, e.g., identification number and figures showing the site location, will be maintained on site. Inventories of material in a container or stockpile will be kept on the Stockpile/Container Inventory Log Sheet (Attachment 1), or equivalent. The log sheet will be updated as material is added to containers or stockpiles, or when stockpiled material is removed for disposal. Moving of stockpiled material within an RMA may not require updating of the inventory log sheet, but may require updates to the RCA site figures and/or drawings.

5.3.2 Records

TtEC will maintain reports for RAM waste that contain the following information:

- Point of origin
- Storage location
- Removal date
- Waste description
- Isotope and activity (if known)
- Other hazardous constituents (if known)
- Estimated quantity or volume
- Waste packaging dates
- Any additional comments

TtEC will maintain a master RAM inventory at each project site. The RSOR will ensure that the inventory is updated at least quarterly. Work control documents or client contractual obligations may require more frequent updating. Note that electronic records or alternate forms may be used as replacements for Attachment 1 and Attachment 2 (Radioactive Waste Inventory Log Sheet), provided the record/form contains the same minimum information.

5.4 Disposition of Radioactive Material

Disposition of RAM collected during characterization, remediation, or survey activities, or generated through site activities will consist either of reduction in volume through decontamination, or disposal. These two activities are discussed below.

5.4.1 Decontamination

In some instances, it may be possible to reduce the volume of RAM by decontaminating items contaminated with RAM to levels at which the item no longer needs to be classified as RAM. The guidance for determining whether decontamination is appropriate and for actually performing decontamination is given in SOP 007.

Any former RAM that has been decontaminated to levels below those requiring classification as RAM shall have any RAM labels removed or otherwise defaced such that the wording and radiation symbol are no longer legible. Additionally, the status of any inventoried RAM that has been decontaminated shall be updated on the associated data sheets and in the RWI log to indicate that the item is no longer an actively tracked RWI item.

5.4.2 Disposal

Unwanted RAM will be disposed of as LLRW. Preparation of material for disposal, and actual disposal shall be conducted under the approved procedures of a licensed waste broker or client-approved contractor. The status of RAM waste that has been disposed of and removed from the site shall be updated on inventory data sheets and in the RWI log to indicate that the item is no longer in storage on site.

6.0 RECORDS

Copies of waste inventory reports and transfer documents provided to the LLRW waste broker or contractor will be retained as records.

7.0 REFERENCES

Number	***Title***
AEC Regulatory Guide 1.86	*Termination of Operating Licenses for Nuclear Reactors*
10 CFR 20	*Standards for Protection Against Radiation*
SOP 003	*Release of Materials and Equipment from Radiologically Controlled Areas*
SOP 007	*Decontamination of Equipment and Tools*
SOP 012	Radiologically Controlled Areas – Posting and Access Control

8.0 ATTACHMENTS

Attachment 1, Stockpile/Container Inventory Log Sheet

Attachment 2, Radioactive Waste Inventory Log Sheet

ATTACHMENT 1

STOCKPILE/CONTAINER INVENTORY LOG SHEET

Container ID #				Page of	
Description of Item	Item ID #	Date	Time (24 hr)	Contact Dose Rate - µR/hr	Initials

ATTACHMENT 2

RADIOACTIVE WASTE INVENTORY LOG SHEET

Point of Origin	Storage Location	Collection Date	Target Removal Date	Waste Description	Estimated Radioactive Isotope(s) and Activity Content	Other Hazardous/Regulated Constituents	Estimated Quantity or Volume	Waste Packaging Date(s)	Waste Shipping Date(s)	Additional Information

Standard Operating Procedure

AIR SAMPLING AND SAMPLE ANALYSIS

SOP-009

Revision 2

Approved By:

Steven Adams, CHP, Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

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7/17/15	2	S. Adams	Inserted new sections on roles and responsibilities; placement of airborne monitors; Attachment 3 on calculating need for indoor air monitoring; and Attachment 4 on calculating the need for outdoor air monitoring	3–11, 13, 17–24

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1.0 PURPOSE

This procedure is used by Tetra Tech EC, Inc. (TtEC) personnel and its subcontractors to explain how to identify and control potential sources of airborne radioactive material and to describe the methods used to perform air monitoring. Air monitoring results are used: 1) to verify the effectiveness of process controls in reducing inhalation exposure; 2) as a means of detecting, quantifying, and documenting derived air concentrations (DACs), and 3) to demonstrate that necessary exposures are as low as reasonably achievable (ALARA). Air monitoring results will also be used to determine what respiratory protection, if any, is required for the work area. Air sample analyses will be performed by trained personnel using approved procedures specific to the alpha and beta radiation counting equipment. Further discussion of sample analysis is not within the scope of this procedure.

2.0 SCOPE

This procedure will be used for all TtEC and subcontractor radiological air sampling activities that are performed in support of field projects, regardless of the organization performing the work. Results will be used to determine respiratory protection requirements, and assign DAC value exposures to workers from inhalation.

3.0 DEFINITIONS AND ABBREVIATIONS

Airborne Radioactivity Area – A room, enclosure, or area in which airborne radioactive material is dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases, in concentrations:

- In excess of the DACs specified in Title 10 Code of Federal Regulations (CFR) Part 20, Appendix B; or
- To such a degree that an individual present in the area without respiratory protection could exceed, during the hours that the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours (HRs).

Annual Limit on Intake – The ALI is the derived limit for the quantity of radioactive material taken into the body of a worker by inhalation or ingestion in a year.

Breathing Zone – That region adjacent to the workers' mouths and nostrils from which air is drawn into the lungs while they perform their assigned work. Air taken from this region will represent the air the worker is breathing while he/she works. The samples collected to assess breathing zone concentrations are normally collected from an area within about 12 inches of the head (NRC 1992).

Derived Air Concentration – DAC is the concentration of a given radionuclide (as specified in 10 CFR 20, Appendix B) in air that, if breathed by the "reference man" for a working year (40 hours per week for 50 weeks) under the conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one ALI.

Derived Air Concentration-Hour – The product of the concentration of radioactive material in air (expressed as a multiple of the DAC for each nuclide) and the time of exposure to that nuclide, in hours. Two-thousand DAC-HRs represent one ALI.

Grab Sample – A random, single sample taken over a short period of time (dependent upon flow rate) and based upon the minimum volume required for analysis.

High-Volume Air Sample – Air sample taken at an air flow rate of 5 cubic feet per minute (cfm) to 30 cfm.

Lapel Sampler – A battery-operated portable air sampler with a sample collector fastened in the breathing zone.

Low-Volume Air Sample – Air sample taken at an air flow rate of 1 cfm to 5 cfm.

Particle – An aggregate of molecules forming a solid or liquid ranging in size from a few molecular diameters to some tenths of millimeters (several hundred microns).

Representative – Having the same quality and characteristics of the entire volume from which a sample is drawn.

Sample – A representative portion of an atmosphere of interest, or one or more separated constituents from a representative portion of an atmosphere.

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this SOP are defined below.

4.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this Standard Operating Procedure (SOP). Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

4.2 Radiation Safety Officer Representative

The Radiation Safety Officer Representative (RSOR) is responsible for the following activities:

- Establish workplace air monitoring based on airborne radioactivity, the requirements of this SOP, and authorized work documents. Exceptions to any requirement requires the concurrence of the RSO.
- Evaluate the air monitoring program to ensure that it meets requirements of 10 CFR 20, the Radioactive Material License, this SOP, and authorized work documents.
- Ensure there are a sufficient number of calibrated, functioning airborne radioactivity monitoring instruments and supporting equipment.
- Specify required actions to be taken, if needed, when existing workplace radiological conditions change.
- Use available radiological monitoring information to optimize processes and procedures or controls consistent with maintaining exposure to radiological hazards ALARA.
- Notify the RSO immediately when an air monitoring results show ≥ 10% of a DAC.

4.3 Radiation Control Technician

The Radiation Control Technician (RCT) is responsible for the following activities:

- Perform air monitoring tasks in accordance with the directions in this SOP.
- Communicate monitoring results to personnel and the RSOR.
- Communicate to the RSOR any changes in work, processes, procedures, configurations, or controls that may affect radiological conditions of an operation or area.
- Identify changes in existing workplace airborne radiological conditions and notify the RSOR.
- Report to the RSOR immediately when the air monitoring results show ≥ 10% of a DAC.

5.0 PROCEDURE DETAILS

Air samples will be taken in areas with the potential to exceed 10 percent of the DAC for any radionuclide. It is the responsibility of the RSOR to determine placement of air monitors within an area/facility/room in order to adequately characterize the extent of any airborne radioactivity. When determining the placement and number of air monitors, the RSOR should consider the following factors.

- Size of the area/facility/room
- Type of operations conducted at the facility
- Contamination levels and potential for airborne contamination
- Traffic patterns
- Air flow patterns
- Specific area/facility/room features (location of ventilation intake and exhaust registers)
- Locations having high source-term potential
- Any available historical air monitoring results

Air monitors should be positioned to measure air concentrations to which people are exposed. Place the air sample inlet approximately 2 meters (6 feet) above the floor and either between any workers and the potential point of release or so that the air sample is representative of the air breathed by the workers. If this cannot be achieved, initiate breathing zone air (BZA) monitoring.

Data obtained from air monitoring shall be used to assess the control of airborne radioactivity in the workplace and to evaluate the dose equivalent to radiation workers from internal sources. Process or other engineering controls (e.g., containment or ventilation, misting and water sprays for outdoor activities) shall be used, to the extent practicable, to control the concentration of radioactive material in air. Air samplers shall be operated in accordance with the manufacturers' operation and calibration procedures. Filters of different air samples shall be placed in a separate envelope, polybag, or other suitable container to ensure that there is no possibility of cross-contamination. During collection and handling of air samples, caution must be used to prevent the samples from being contaminated by other sources of radioactive material.

5.1 Precautions

Avoid unnecessary contamination of air sampling equipment through the use of plastic coverings and care in handling. Do not cover the air intakes or exhausts on air samplers. Avoid unnecessary exposure when conducting air monitoring surveys by using ALARA practices. Air samplers used in confined spaces may ignite explosive gases. Extreme care shall be exercised, including prior sampling of the atmosphere for explosive gas and oxygen content.

Samples should be taken in such a manner as to not contaminate the sample filter with materials that are not airborne, or by sucking up loose contamination from surfaces near the sampling head. Caution should be used to minimize generating airborne material by the exhaust of the sampler.

When calculated radionuclide concentrations in the air exceed 10 percent of the DAC value, report this information to the RSOR (or qualified designee) immediately. In addition, consideration should be given to isotopic analysis and area access restriction/posting.

5.2 Types of Air Samples

The types of air samples that should be collected during radiological work activities are described below.

5.2.1 General Area Air Samples

General area air samples provide data representative of the work area that can be used to determine if the area should be controlled as an airborne radioactivity area. Samples are normally taken over a short period of time, ranging from an hour to one or more days. This type of sample:

- Is collected on a routine basis at predetermined times and locations, as specified in the Radiation Work Permit (RWP) or other work documents
- Uses a low-volume air sampler
- Consists of a minimum of 100 cubic feet (ft^3) (2,832 liters) of air passed through the sample filter
- Is collected from between 3 and 6 feet above the floor level, in the vicinity of the workers performing the field work
- Is analyzed for alpha and beta activity

5.2.2 Grab Samples

Grab air samples are collected to evaluate the concentration of airborne radioactive radionuclides during a relatively short sampling period. This type of sample is useful for estimating the instantaneous concentration of airborne contamination. This type of sample:

- Is collected as needed during radiological work coverage at the discretion of the RCT, or as directed by the RSOR
- Uses a high-volume air sampler
- Consists of a minimum of 100 ft3 of air passed through the sample filter
- Is collected in the vicinity of the workers performing the fieldwork
- Is analyzed for alpha and beta activity

5.2.3 Breathing Zone Air Samples

BZA samples provide data representative of the concentration of airborne radioactive material that a worker would be breathing during a particular task. This type of sample:

- Is used during work activities where widely varying airborne contamination concentrations exist across the work area
- Uses a small portable air sampler with a sample head attached to the worker's collar, or similar alternative method (e.g., extended tubing attached to a low volume air sampler).
- Requires that the sample head be positioned within 12 inches of the worker's face
- Consists of a minimum of 50 ft3 (1,416 liters) of air passed through the sample filter
- Is analyzed for alpha and beta activity

5.3 Air Sampling Procedures

The following sections describe the air sampling procedures that are conducted during radiological work activities.

5.3.1 General

Sample types, number, locations, and volumes will be collected as specified in the RWP or other work document.

Sample filters and cartridges will be surveyed with a portable alpha/beta survey meter before being placed in an envelope or baggie. If the survey indicates the presence of contamination in concentrations that exceed background, appropriate steps will be taken to determine the source of contamination and to secure the area.

Samples will be analyzed, at a minimum, for gross alpha and beta-gamma, and for determination (if any) of the DAC. If the sample analysis indicates the presence of airborne contamination at a concentration that exceeds 10 percent of a DAC, appropriate steps will be taken to determine the source of contamination, secure the area, and notify the RSOR. The RSOR will confer with the corporate RSO and the Project Manager, then notify the RASO upon validation of the air sample analysis.

The Air Sample Identification Record (Attachment 1) and Personal Air Monitoring Log (Attachment 2) provide examples of air sampling record sheets. Equivalent or electronic forms that provide, at a minimum, the information on these forms may be used. Air samples will be preserved and archived after analysis.

5.3.2 General Area Air Sampling

The following activities should be performed when conducting general air sampling:

1. Determine the requirements for air sampling prior to initiating any work activities. Attachment 3 describes the method for determining the need for indoor air monitoring. Attachment 4 describes the method for determining the need for outdoor air monitoring. In addition, review the Work Plan and the RWP to ensure air monitoring is being performed in accordance with the strictest requirements stated in the authorized work document.
2. Test the functionality of the air sampling equipment prior to entering the work area. Check for current dates on calibration tags and confirm that the sampler flow meter has recently

been calibrated. Any equipment not functioning properly, or with out-of-date calibrations, will not be used. Notify the RSOR (or designee) of any equipment that does not function properly.

3. Gather essential supplies before entering the work area. These may include:
   - Extension cords
   - Ground-fault circuit interrupter receptacles
   - Air sample filters
   - Tongs (if necessary)
   - Gloves
   - Air sample envelopes
   - Pen or marker
   - Backup air sample equipment
4. Record the following information on the air sample envelope:
   - Sample identification number
   - Date
   - Location
   - Air sampler identification number
   - Start time
5. Place the air sampler on a stable surface 3 to 6 feet from the ground in the vicinity of the workers performing the field activities.
6. Place an unused sample filter into the sample holder, using care not to contaminate the filter with material on the tongs or gloves used to hold the filter while placing it into the holder. If the sampler has been in the contaminated area for some time, it is good practice to clean any visible debris or dust from around the sampler filter holder housing before placing the unused filter into the holder.
7. Operate the air sampler for the predetermined time. Verify the sampler flow rate, if a flow meter is provided on the sampler. Record any deviation from the predetermined flow rate.
8. If not provided with an automatic shut-off timer, turn the air sampler off as soon as practical after the predetermined sampling time has elapsed.
9. Prior to removing the sample from the holder, survey the filter using a hand-held alpha and beta contamination survey meter. Note the activity observed on the outside of the sample envelope.
10. If the survey of the air filter indicates the presence of radioactive contamination and the area is not already controlled as an airborne radiation area, stop work, notify the RSOR (or designee), and implement appropriate controls, including postings. Record sample information on the sample envelope, place the sample in the envelope, and immediately forward the sample to the on-site count room for analysis and determination of the percent DAC.

11. Using caution not to knock debris or dust from the sample filter holder housing onto the air sample, remove the air sample from the holder using clean gloved hands or clean tongs.
12. Place the sample filter into the sample envelope, using caution not to scrape or remove contamination from the surface of the sample.
13. Record the following information on the air sample envelope*:*
    - Stop time
    - Sample volume
    - Sample pump flow rate
14. Analyze and determine the percent DAC.
15. On Attachment 1 (or equivalent), note the sample analysis information provided by the laboratory as soon as the data is available, including:
    - Alpha count results (microCuries per milliliters [µCi/mL])
    - Beta count results (µCi/mL)
    - Percent DAC
16. Complete Attachment 1 by transcribing the information from the sample envelope to Attachment 1 and initialing.
17. Report any higher than normal, higher than expected, greater than 10 percent of the DAC, or trending upward results to the RSOR (or designee) immediately.

5.3.3 Breathing Zone Air Sampling

The following steps will be taken for breathing zone air sampling:

1. Determine the requirements for BZA sampling prior to initiating any work activities. This is accomplished by calculating the hazard index in Attachment 3, reviewing the Work Plan and RWP, and discussing the results with the RSOR. The need for BZA sampling will be determined based on the strictest requirement in the authorized work documents.
2. Assemble the individual BZA sampler sets. Make sure that all hoses are firmly seated in the hose connectors found on the sample head and sample pump. Make sure that the sample head is not cracked or damaged in any way. Set aside any damaged or unusable equipment and notify the RSOR (or designee).
3. Note the relative size of the individual on whom the sampler will be issued. It may be necessary to replace the standard length belt with a longer belt, or chain two belts together to achieve the required length. Make sure that the belt buckle is not damaged and will function properly to restrain the sampler around the worker. Set any damaged or unusable equipment aside and notify the RSOR (or designee).
4. Test the functionality of the air sampling equipment prior to entering the work area. Check for current dates on calibration tags and recent calibration of the sampler flow meter. Any equipment not functioning properly, or with out-of-date calibrations, should not be used. Notify the RSOR (or designee) of any equipment that does not function properly.

   ***Note*:** Only use a sample pump containing a battery that is known to be fully charged.

5. Insert a new, unused sample filter paper into the sample head and tighten the sample head. Take care not to damage the filter paper or the sample head during this operation.
6. Prior to issuing any equipment to a worker, instruct the worker to:
   - Refrain from touching or tampering with the pump or the sample head
   - Leave the work area if the sampler fails and note the stop time
   - Contact the RCT for assistance when leaving the work area, and at completion of work
7. Prior to issuing any equipment to a worker, enter the following information on Attachment 2:
   - Wearers' name
   - Wearers' identification number
   - Sampler identification number
   - Date
8. Attach the personal BZA sampler to the worker. Make sure that the belt is tight, but not uncomfortable.
9. Attach the sample head to the worker. Make sure that the sample head is clipped securely to the worker's lapel or other piece of clothing close to the worker's face. Make sure that opening in the end of the sample head is unobstructed.
10. Check the hose connecting the sample head to the sample pump. Make sure that the hose is not kinked, crimped, or folded. Make sure that the hose is not in a position where it may become kinked, crimped, or folded during work. Make sure that the hose will not interfere with routine work. If any of these conditions are found, reorient the hose. It may be necessary to find alternative places to position the sample head or sample pump so the hose is unobstructed.
11. Upon arrival at the work location, turn the pump ON. Note the START TIME and flow rate on Attachment 2. Make sure to note whether flow rate is in units of cubic feet per minute (cfm) or liters per minute (lpm).
12. Every time a worker leaves the work area, turn the sample pump OFF and note the stop time. Upon re-entering the work area, turn the sample pump back ON and make a notation of the re-start time.
13. At the end of the sampling period (end of the task, or end of the shift), turn the pump OFF and note the stop time on Attachment 2.
14. Calculate the total time that the sample pump was operating by adding together the operating periods of time.
15. Calculate the total sample volume by multiplying the operating time by sampler flow rate. The result may be in units of cfm or lpm.
16. Record the total sample volume and note the appropriate units (cfm or lpm) on Attachment 2.

17. Select a clean, unused sample envelope. Label the envelope with the following information:
    - Sample identification number
    - Date
    - Location
    - Worker name
    - Total sample volume (use the appropriate units – cfm or lpm)
18. Open the sample holder, using caution not to remove or add to the contamination on the sample.
19. Prior to removing the sample from the holder, survey the sample using a hand-held alpha and beta contamination survey meter. Note the activity observed on the outside of the sample envelope.
20. If the sample survey indicates the presence of radioactive contamination, and the area is not already controlled as an airborne radiation area, stop work, notify the RSOR, and implement appropriate controls, including postings.
21. Using caution not to knock debris or dust from the sample filter holder housing onto the air sample, remove the air sample from the holder using clean gloved hands or clean tongs.
22. Place the sample into the sample envelope, using caution not to scrape or remove contamination from the surface of the sample.
23. Confirm that the information on the sample envelope matches the information in Attachment 2.
24. Analyze and determine percent DAC.
25. On Attachment 2, note the sample analysis information provided by the laboratory as soon as the data are available, including:
    - Alpha count results (µCi/ml)
    - Beta count results (µCi/ml)
    - Percent DAC
26. Complete the Attachment 2.
27. Report any higher than normal, higher than expected, or trending upward results to the RSOR (or designee) immediately.

5.3.4 Documentation

Air samples shall be documented using either an Air Sample Identification Record or Personal Air Monitoring Log (or equivalent).

6.0 RECORDS

The records generated as a result of following this procedure should be documented in accordance with the provisions of SOP 003, *Release of Materials and Equipment from Radiologically Controlled Areas*.

7.0 REFERENCES

Reference	***Title***
10 CFR 20	Standards for Protection Against Radiation, Appendix B
NRC, 1992	*Air Sampling in the Workplace*, NRC Regulatory Guide 8.25., U.S. Nuclear Regulatory Commission, Washington, DC.

8.0 ATTACHMENTS

Attachment 1, Air Sample Identification Record

Attachment 2, Personal Air Monitoring Log

Attachment 3, Calculating the Need for Air Monitoring Indoors

Attachment 4, Calculating the Need for Air Monitoring Outdoors

ATTACHMENT 1

AIR SAMPLE IDENTIFICATION RECORD

Project/Location: _____ Page ____ of ____

Sample ID	Date	Location	Start Time	Stop Time	Air Sampler ID	Sample Volume	Count Results α (µCi/ml)	Count Results ☐ (µCi/ml)	%DAC α / β	Counter ID

Abbreviations and ***Acronyms:***

α – alpha
β – beta
µCi/ml – microcurie per milliliter
DAC – derived air concentration
ID – identification number

ATTACHMENT 2

PERSONAL AIR MONITORING LOG

Name of Wearer	SSN#	Sampler ID #	Date	Time On / Time Off	Flow Rate cfm /lpm	Total Volume ft^3 / Liters	Activity α (µCi/ml)	Activity β (µCi/ml)	Percent DAC α / β

Abbreviations and Acronyms:

α alpha
β beta
µCi/ml microcurie per milliliter
cfm cubic feet per minute
DAC derived air concentration
ft^3 cubic feet
ID identification number
lpm liters per minute

ATTACHMENT 3 - CALCULATING THE NEED FOR AIR MONITORING INDOORS

Apply Equation 3-1 to calculate the Hazard Index used to determine the need for air monitoring.

$$HI = (Q \times R \times F) / (10^4 \times ALI \times C) \qquad \text{Eq. (3-1)}$$

where;

- HI = Hazard Index, potential intake as a percent of the ALI
- Q = Amount of unencapsulated radioactive material (in curies) that will be handled by the workers,
- R = Release fraction of the radioactive material as determined from Table 3-1 below,
- 10^4 = Factor for combining units from NUREG 1400 (NRC, 1993).
- ALI = ALI for the isotope of interest (in curies). (Appendix B of 10 CFR 20.1001 - 20.2401).
- C = Confinement factor from Table 3-2 below
- F = Other modifying factors

The parameter value, F, that may be appropriate to consider include dispersibility that comes from adding energy to the system during decontamination and remediation processes such as grinding, scrubbing, cutting, washing, or excavating. Other modifying factors to consider are occupancy of the area and the areal or volumetric distribution of the radioactive material in the building material or in the outside surface.

A dispersibility factor of 10 can be applied to the calculation if cutting or grinding is performed. Evaluations may also be made for short-duration, occasional, or one-time types of operation. A modifying factor of 50 is applied to convert from an annual basis to a short-term basis (taken to be weekly). A modifying factor addressing occupancy may eliminate the need for some short-duration personal sampling or even fixed air sampling in otherwise unoccupied areas. By reducing the need for unnecessary air samples, exposure of radiological control technicians may be reduced.

Compare the HI to the criteria in Table 3-3 for the recommended type of air monitoring. If air-monitoring requirements for an area are uncertain, the RCT shall perform special limited-time studies using portable air samplers to help determine the need for routine monitoring. These studies may be documented on standard air monitoring forms with the same level of documentation and review.

Table 3-1 Release Fraction of the Radioactive Material

Physical Form	Release Fraction (R)
Gases or volatile material	1.0
Volatile powders (e.g., ^{238}Pu, ^{239}Pu, ^{241}Am)	0.1
Nonvolatile powders, beta/gamma	0.01
Nonvolatile powders, alpha	0.001
Solid (e.g., concrete, asphalt, soil, wood, metal)	0.00001
Liquids	0.0001
Surface contamination, beta/gamma	0.001
Surface contamination, alpha	0.0001
Encapsulated material	0

Table 3-2 Confinement Factor for Workplace Locations and Conditions

Type of Confinement	Confinement Factor (C)
Glovebox	10
Well ventilated hood	1
Open Bench, normal ventilation	.01
No confinement	.01

Table 3-3 Air Monitoring Recommended Based on the Hazard Index (HI)

Air Monitoring Recommended	HI
Very low level of hazard from airborne radioactivity. Air sampling generally not necessary. However, monthly or quarterly grab samples may be appropriate in some situations to confirm that airborne levels are indeed low.	< 1
Fairly low level of hazard from airborne radioactivity. General air sampling appropriate. Intermittent or grab samples may be appropriate near the lower end of range. Continuous sampling may be more appropriate near the upper end of range.	1 to 10
Potential for moderate hazard from airborne radioactivity. In addition to general air sampling, evaluate the need to determine intakes by either breathing zone air sampling (recommended) or bioassay measurements	>10
Potential for relatively high level of hazard from airborne radioactivity. In addition to general and breathing zone air sampling, the need for early warning air sampling should be evaluated. (e.g., Continuous Air Monitoring)	>100

Using the Equation and Tables to Determine Recommended Air Monitoring

Example 1

Tetra Tech EC is remediating a laboratory which is located in a military research complex. The laboratory has been used for various projects for the past 10 years. The laboratory has two hoods with a fixed air sampler located in front and center of each hood, each sampler at approximately 2 meters from the floor. A variety of work, such as preparing samples used in bioassay research, particle deposition testing for prototype air monitors, and measurements of hot particles from a former military reactor were conducted in the laboratory in the past year. The laboratory is also used for storage of instrument check sources.

Characterization surveys of the laboratory floor, work benches, and walls demonstrated the gross alpha and beta surface concentrations were not different from background. The interior surfaces of the hoods had an average total beta surface concentration of 5,000 dpm/100 cm^2 and an average removable surface concentration of 1,000 dpm/100 cm^2.

The sources for the bioassay research are identified as ^{58}Co (1.1 E-2 Ci), ^{60}Co (5.4 E-6 Ci), ^{65}Zn (5.4 E-6 Ci), ^{134}Cs (5.4 E-6 Ci), and Cs (5.4 E-6 Ci). These sources are in liquid solution and will be solidified and repackaged occurring in the hoods. These sources have a release fraction (R) of 0.0001 because they are liquids, and are assigned a confinement factor (C) of 1.0 because they are handled in the hoods.

The hot particles that have been studied in the past year are identified as ^{90}Sr/Y (4.4 E-6 Ci) and ^{99}Tc (5.0 E-6 Ci). These hot particles can become airborne if they are not handled carefully. They could be inhaled, or ingested, so a release fraction (R) of 0.01 is assigned. The hot particles are assigned a confinement factor (C) of 0.1 because they are handled both on countertops and in the hoods.

The instrument check sources stored in the laboratory are used in a different facility. Routine leak testing of these sealed sources does not indicate any leakage of radioactivity. Therefore, they are not considered a significant inhalation hazard, and are not necessary for the calculation.

The surface area of the hood is 140 square feet (1.3×10^5 cm^2). The total activity in the hood is calculated to be 1.3×10^5 cm^2 x 50 dpm/cm^2 x 4.505×10^{-13} Ci/dpm = 2.93×10^{-6} Ci. No radioanalytical analysis has been done to define the radionuclide(s) constituting the surface contamination It is assumed that the source term is ^{90}Sr/Y; the radionuclide with the most limiting ALI. The release fraction is 0.001 and the confinement factor is 0.1.

The remediation and final status surveys and sampling of the laboratory is estimated to take 13 weeks. However, solidification and packaging of the liquid sources, packaging of the hot particles, and removal of the hood is estimated to take 10 work days. A modifying factor (F) of 0.04 is assigned. No other modifying factors are considered.

The following table demonstrates how to apply Equation 3-1.

Source	**Curies**	**Release Fraction (R)**	**Confinement Factor (C)**	**ALI (Ci)**
^{58}Co	1.1 E-2	0.0001	0.1	7 E-4
^{60}Co	5.4 E-6	0.0001	0.1	3 E-5
^{65}Zn	5.4 E-6	0.0001	0.1	3 E-4
^{134}Cs	5.4 E-6	0.0001	0.1	1 E-4
^{137}Cs	5.4 E-6	0.0001	0.1	2 E-4
^{90}Sr/Y	4.4 E-6	0.01	0.1	4 E-6
^{90}Sr/Y	2.9E-6	0.001	0.1	4 E-6
^{99}Tc	5.0 E-6	0.01	0.1	7 E-4

Total Curies 1.1 E-2

Method 1 –
The calculation could be made using the activity for each source and then the 'R', 'C', and ALI for each source. With a large number of sources to compare the conservative method would be to calculate HI for each of the sources and then sum all of the HIs.

Method 2 –
Another method would be to choose the source with the majority of the activity and assume its ALI and maximum value for R and minimum value for C of the other radionuclides. Using this second method the ^{58}Co source, >2,000 times more activity than any of the other radionuclides s chosen for the calculation.

$$HI = (Q \times R \times F) / (10^4 \times ALI \times C) = (0.011 \text{ Ci} \times 0.01 \times 0.04) / (10^4 \times 7 \times 10^{-4} \text{ Ci} \times 0.1) = 6.3 \times 10^{-6}$$

Comparing 6.3×10^{-6} to Table 3 the HI is well below any requirement for air sampling.
Example 2

A multi-family housing unit at a former Navy base is to be torn down during the site decommissioning. Surveys have demonstrated that the average radium-226 (^{226}Ra) surface concentration level is 50 dpm/100 cm^2. The total surface area of the floors, walls, ceilings, and stairwells is approximately 33,000 square feet (ft^2). The average ^{226}Ra concentration is 1.14 pCi/g in sample cores collected from the wood, brick, cement, gypsum, insulation, tile, and concrete construction materials. The total mass of the building debris is estimated to be 593.0 tons. The approximate value for Q is calculated as shown below (Equation 3-2).

$$Q = (33{,}000\ ft^2 \times 929.03\ cm^2/ft^2 \times 0.5\ dpm/cm^2 \times 4.505 \times 10^{-7}\ \mu Ci/dpm) + (593\ tons \times 2{,}000\ lb/ton \times 453.5\ g/lb \times 1.14\ pCi/g) \times 10^{-6}\ \mu Ci/pCi$$

$$Q = 6.905\ \mu Ci + 613.2\ \mu Ci = 620.1\ \mu Ci = 6.2 \times 10^{-4}\ Ci$$

The source term is 226Ra and its decay products so it includes alpha and beta surface contamination so R is set conservatively to 0.001. Remediation will require tearing down the structure so the confinement (C) is 0.01. The modifying factor, based on estimated time to tear down the building, separate material according to waste class, perform final surveys, and package waste is 40 work days so F = 0.11.

$$HI = (Q \times R \times F)/(10^4 \times ALI \times C) = (6.2 \times 10^{-4} \times 10^{-3} \times .11)/(10^4 \times 6 \times 10^{-7} \times .01) = 1.1 \times 10^{-3}$$

Comparing 1.1×10^{-3} to Table 3 the HI is well below any requirement for air sampling.

REFERENCES

U. S. Nuclear Regulatory Commission (NRC). 1993. *Air Sampling in the Workplace*, NUREG-1400, U. S. Nuclear Regulatory Commission, Washington, DC.

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ATTACHMENT 4 - CALCULATING THE NEED FOR AIR MONITORING OUTDOORS

Air monitoring of all outdoor jobs for all potential radionuclides of exposure regardless of job location and duration, would be an expensive and technically unjustifiable program design. Attachment 4 defines the criteria for identifying those conditions under which air monitoring should be performed outdoors. The criteria are then applied to nuclides most likely to be of significance to basewide support activities, environmental restoration, and remediation work.

The result is a set of work-site conditions that, if exceeded, would warrant air monitoring. The type of air monitoring that might be considered appropriate is briefly addressed. However, the specifics regarding air monitoring e.g., types of monitoring, frequency of monitoring, and the associated sensitivity of an air monitoring program with regard to minimum detected dose are discussed only briefly. Specific guidance should be developed in the work plans.

The possibility of radionuclide intakes totaling two percent of the ALI (40 DAC-hours) is the starting point for determining the need for air monitoring. An ALI, when determined by the stochastic limit, is the amount of a radionuclide that, if inhaled or ingested in one year, would result in a committed dose equivalent equal to 5,000 mrem, the limiting dose in 10 CFR 20.

NRC require posting as an airborne activity area any area where the airborne concentration exceeds the DAC or can result in an intake of 0.1 ALI or an exposure of 12 DAC-hours in a week (§20.1003 and §20.1902(d) and §835.602(a), respectively. Air monitoring is not required by NRC unless an adult worker is likely to receive in excess of 10 percent of an ALI in one year §20.1502(b)(1).

Radionuclide concentrations in the surface soil that should require air monitoring are calculated for acute and chronic exposure scenario are postulated, and criteria are derived from those analyses to be used with pre-job site characterization data and during-the-job surveillance.

Exposure to airborne dust is considered to result from activities such as heavy equipment operations during excavations or moving dirt, concrete, or asphalt; manual labor such as shoveling, sorting, or filling sample bottles with dirt, demolishing buildings, or well-drilling operations. Inhalation is considered as a possible mode of intake resulting from breathing the respirable particles in the airborne dust.

The magnitude of airborne dust inhalation intake can be calculated as shown in Equation (4-1).

$$I_{dust} = ADL \times BR \times T \qquad \text{Eq. (4-1)}$$

Where,

I_{dust} = Total dust intake (g)
ADL = Airborne dust concentration (gm^{-3})
BR = Breathing rate, ICRP Reference Man for "light activity" (1.2 m^3h^{-1})
T = Exposure time (h)

Two types of exposure conditions are addressed, the single job involving acute (short-term) exposure to very high dust loadings, and the long-term projects involving daily exposure to

moderately high dust loadings. The working conditions associated with the two types of exposures are described in the following paragraphs.

The acute exposure scenario is an 8-hour exposure each day for five days to very high dust loadings of 0.0018 gm^{-3} as might be ass**o**ciated with the maximum mass loading of airborne dust concentrations reported for heavy equipment surface soil excavations (Oztunali et al. 1981). The dust inhalation intake for the acute exposure scenario is calculated using Equation (4-2).

$$I_{dust} = 0.0018\ gm^{-3} \times 1.2\ m^3h^{-1} \times 40\ h = 0.0864\ g \qquad \text{Eq. (4-2)}$$

The chronic exposure scenario is a daily exposure to high dust loadings on a continuing basis. An average daily intake rate of $1.92 \times 10^{-3}\ gd^{-1}$ is calculated, assuming exposure to $2.0 \times 10^{-4}\ gm^{-3}$ (Gilbert et al. 1981) for 8-hd^{-1}. Such a dust loading would not likely be visible to the unaided eye but is recommended as a conservative long term annual average (Yu et al. 1993). This intake rate was assumed for 250 working days per year to give a total annual dust intake of 0.48 g.

As a basis for comparison, the ambient dust loading levels associated with construction activities is $6.0 \times 10^{-4}\ gm^{-3}$ and for exposure to construction traffic on unpaved roads is $4.0 \times 10^{-4}\ gm^{-3}$ (Oztunali et al. 1981). The inhalation ALI established by the NRC assumes the airborne dust to consist of respirable particles (l µm AMAD). The inhalation dose is inversely related to the size of the particles; the larger the particle size distribution the smaller the dose. Assuming a 1µm AMAD particle distribution is a substantially conservative assumption because, for most situations, the dust will consist primarily of resuspended surface soil particles (10 µm to 100 µm) and silt particles (2 µm to 60 µm) and some clay particles (< 2 µm AMAD). Results published in the literature on numerous field studies demonstrate that a 5 µm AMAD particles size distribution is consistent with aerosols in the work place and aerosols generated during decommissioning and demolition activities (MacMillan et al. 2013, Dorian and Bailey 1995, and Kelso and Wraight 1996).The concentration of radioactivity in the airborne dust was assumed to be the same as the concentration in the soil.

The soil contamination levels for establishing air monitoring criteria are calculated using Equation (4-3). For NRC licensees the acute exposure scenario is based on the requirement for posting any area exceeding 12 DAC-hours in a week as an airborne activity area (6% of an ALI) §20.1902(d) and §835.6022(a). The chronic exposure scenario assumes a likely exposure to 10 percent of an ALI for NRC licensees §20.1502(b). Air monitoring should be performed by NRC and Agreement State licensees if the surface soil concentrations exceed the values listed in Table 4-1.

$$C_{i,S}\ (pCig^{-1}) = (ALI_i \times UCF_i)/(ML_S \times BR \times T_S) \qquad \text{Eq. (4-3)}$$

Where,

Ci,S = Concentration of radionuclide (i) in surface soil for scenario (S)
ALI_i = Radionuclide activity intake resulting in 5 rem CEDE
UCF_i = Unit conversion factors for fraction of ALI_i and 10^6 (pCi/µCi)
ML_S = Mass loading for exposure scenario (*S*)
TS = Exposure time for exposure scenario (S)

TABLE 4-1

SOIL CONCENTRATION CRITERIA FOR AIR MONITORING FOR OUTDOOR WORK INVOLVING EXPOSURE TO CONTAMINATED SURFACE SOIL (pCi/g)

			Soil Concentration (pCi/g)	
Isotope	**Class**	**ALI (µCi)**	**Acute Scenario**	**Chronic Scenario**
Co-60	W	200	1.39E+07	4.17E+07
	Y	30	2.08E+06	6.25E+06
Sr-90	D	20	1.39E+06	4.17E+06
	Y	4	2.78E+05	8.33E+05
Cs-137	D	200	1.39E+07	4.17E+07
Ra-226	W	0.6	4.17E+04	1.25E+05
Th-228	W	0.02	1.39E+03	4.17E+03
	Y	0.02	1.39E+03	4.17E+03
Th-232	W	0.003	2.08E+02	6.25E+02
	Y	0.004	2.78E+02	8.33E+02
U-natural	D	1	6.94E+04	2.08E+05
	W	0.8	5.56E+04	1.67E+05
	Y	0.05	3.47E+03	1.04E+04
U-234	D	2	1.39E+05	4.17E+05
	W	0.7	4.86E+04	1.46E+05
	Y	0.04	2.78E+03	8.33E+03
U-238	D	2	1.39E+05	4.17E+05
	W	0.8	5.56E+04	1.67E+05
	Y	0.04	2.78E+03	8.33E+03

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Yu, C., C. Loureiro, J.J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, E. Faillace. 1993. Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil, Argonne National Laboratory, Argonne, IL.

Standard Operating Procedure

ISSUANCE AND USE OF RADIATION WORK PERMITS

SOP-010

Revision 2

Approved By:

Steven Adams, CHP Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/15/12	0	E. Abkemeier	Original	All
2/6/14	1	E. Abkemeier	Corrected typos; documented training on changes.	4, 8, 9
7/17/15	2	S. Adams	Added section on roles and responsibilities; clarified text.	3–8

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1.0 PURPOSE

This procedure is used to specify the general requirements for preparing, issuing, and using radiation work permits at field locations. The procedures presented below may be supplemented by Tetra Tech EC, Inc. (TtEC)-approved subcontractor procedures, and specific work documents.

2.0 SCOPE

This procedure is used by TtEC personnel and its subcontractors for preparation and issuance of radiation work permits used on site. In certain instances, the requirements of this procedure may need to be added to or modified for specific field operations. In these cases, additional requirements and guidance will be provided in work-specific documents. The work-specific documents will be subject to the same review process as this document, and will take precedence over the guidelines in this document, as appropriate.

A Radiation Work Permit (RWP) will be required:

- For personnel entry into a radiologically controlled area (RCA)
- For personnel entry into an area where air concentrations could exceed 10 percent of the derived air concentration (DAC) for a specific radionuclide
- At the discretion of the Radiation Safety Officer Representative (RSOR)

This procedure describes the radiological surveys required to generate a RWP and provides guidelines for specific protective measures required based on the radiological conditions in the work area.

In addition to RWPs written to cover specific work tasks, general RWPs (GRWPs) may be created for tasks, such as tours or survey/remediation activities, in areas in which a worker is not expected to receive an annual total effective dose equivalent of 100 millirem (mrem). In such cases, the GRWP should not span a time period greater than six months. GRWPs do not require an Access Log (Attachment 1).

3.0 DEFINITIONS AND ABBREVIATIONS

Airborne Radioactivity Area – A room, enclosure, or area in which radioactive material is dispersed in the air in the form of dusts, fumes, particulates, mists, vapors or gases, and where the concentration of the dispersed radioactive materials is in excess of:

- The DACs specified in Table 1, Column 3 of Appendix B, Title 10 CFR Part 20.
- Concentrations such that an individual present in the area with no respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent of the annual limit on intake.

Contaminated Area – Any area accessible to individuals where removable surface contamination levels exceed or are likely to exceed 20 percent of the contamination limits provided in Attachment 2 (Contamination Limits Table).

General Radiation Work Permit – A permit created for tasks, such as tours or surveys/remediation activities, in areas in which a worker is not expected to receive an annual total effective dose equivalent in excess of 100 mrem. These tasks are typically ongoing routine tasks, and require minimal anti-contamination personal protective equipment (PPE).

Non-Workers – Any persons entering an area covered by a work-specific RWP or a GRWP whose sole purpose is for observation or other tasks not directly related to the work outlined in the RWP. Individuals that are escorted inside an area covered by a job-specific RWP are exempt

from the requirements of this procedure. The RSOR has sole discretion in determining who qualifies as a non-worker.

Radiation Area – Any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent (DDE) in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.

Radiologically Controlled Area – An area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials and/or to prevent the release of radioactive materials to the uncontrolled areas.

Specific Radiation Work Permit – A permit created for tasks in areas in which a worker could reasonably receive an annual total effective dose equivalent in excess of 100 mrem (based on current radiological surveys), and/or contamination areas and/or airborne radioactivity areas. Tasks performed under these permits are typically finite in duration (less than one month) for non-routine tasks, and require additional anti-contamination PPE and/or monitoring.

Total Effective Dose Equivalent – The sum of the DDE (external dose) and the committed effective dose equivalent (internal dose).

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this Standard Operating Procedure (SOP) are defined below.

4.1 Radiation Safety Officer

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

4.2 Radiation Safety Officer Representative

The RSOR is responsible for creating, modifying, terminating, and performing the post-job radiological conditions and closeout review of RWPs. The RSOR is responsible for ensuring the radiological conditions stated in the RWP are correct, the PPE requirements, if any, are sufficiently protective of workers, and the controls and monitoring of radioactive materials described in the RWP will ensure the worker exposure and dose will be as low as reasonably achievable (ALARA).

4.3 Radiation Control Technician

The Radiation Control Technician (RCT) is responsible for ensuring he/she and the workers working under an RWP comply with all conditions stipulated in the RWP.

5.0 PROCEDURE DETAILS

The procedures to follow in conducting activities under this SOP are provided below.

5.1 General

The general procedures to follow in conducting activities under this SOP are provided below.

5.1.1 Criteria for Initiating Radiation Work Permit

An RWP is required when entering radiologically impacted areas (i.e., RCAs, radioactive materials areas, radiation areas, contaminated areas, or airborne radioactivity areas).

5.1.2 Planning and Prerequisites

Planning and prerequisite activities are described below.

5.1.2.1 Planning the Remediation Work Plan

The RSOR, or designee, initiates the RWP process by filling in the General Information section of the RWP. The accepted form to use for an RWP is included as Attachment 3 of this document. The RSOR enters the effective date (date the RWP was initiated) and the expiration date that will correspond to the estimated completion date for the project.

The RSOR, or designee, completes the Task section of the RWP. This includes an estimate of the number of personnel required for each task and the number of personnel-hours that will be spent inside a radiologically impacted area. A detailed description is encouraged but not required, and can be attached to the RWP. Work performed in areas with different radiological conditions should be listed as different tasks. These tasks may not become apparent until after the surveys performed to support preparing the RWP are completed.

The RSOR, or designee:

- Obtains and reviews any previous surveys performed in the work area.
- Obtains all information available on the identity, form, and quantities of radionuclides present in the work area.
- Reviews facility drawings, if available, to determine ventilation flows, component and equipment layouts, and building structures that can be used for contamination barriers.

The Site Superintendent meets with the RSOR, or designee, to discuss the nature of the work to be performed, the specific components or equipment to be worked on, the positions the personnel may take to perform the work, the possibility of releasing radioactive contamination during the work activities, and the potential for changing radiation exposure rates as work progresses.

The RSOR, or designee, selects the necessary instrumentation, equipment and protective clothing to perform surveys in the work area. If contamination is expected in the work area, equipment to be taken into the work area may be wrapped to prevent contamination of equipment. If anticipated contamination levels are above the limits given in Table 1 (Attachment 2) for classification of an area as a contaminated area, contamination controls will be established before entry into the area to prevent the spread of contamination upon exiting.

5.1.2.2 The Remediation Work Plan Pre-job Survey

Safety hazards that may be encountered during the work activities are evaluated (e.g., confined space entry, electric equipment or mechanical equipment requiring lock-out tags, falling objects, bumping hazards, slippery surfaces, fire hazards). An analysis of each hazard and precautions to be taken shall be documented and provided to personnel prior to entry into the area.

RCTs obtain radiation exposure rates in the area where the personnel will be positioned during work activities as required. The adjacent area is surveyed to identify any locations where elevated readings are observed, and a route to the work area is established. Readings are recorded on survey forms, as specified in procedure SOP 001, *Radiation and Contamination Surveys*.

Swipe samples are obtained from the work area, adjacent areas, and along the route to the work area in sufficient quantity to adequately design work controls to maintain exposures ALARA. RCTs will rely on their professional experience or consultation with the RSOR, or designee, to determine what constitutes “sufficient quantity.” Swipe samples and air samples collected in the area are then processed and recorded on survey forms, as specified in procedure SOP 001.

The issuance of an RWP for work in an area will require air sampling to be performed as part of the RWP. Air sampling is conducted in accordance with SOP 009, *Air Sampling*. The RCT who surveyed the work area and obtained information from prior surveys, when available, records the exposure rates measured during the survey of work area on survey forms, as specified in procedure SOP 001.

5.2 Procedure Process

The procedures for working in areas requiring an RWP are described below.

5.2.1 Worker and Work Site Requirements

Based on the data obtained from the pre-job survey, and factoring in anticipated contamination conditions in the area, the RSOR, or designee, identifies the dose limits in the Radiological Limits section of the RWP. Limits should be specified as an order of magnitude bound (i.e., whole-body exposure < 10 mrem/ hour) that would not be expected to be exceeded under normal working conditions. Space is provided for clarifying remarks or including other specific points of note. The radiological limits will govern the work to be performed under the RWP. If at any point during the work, the limits are known to be exceeded, then work must cease and the RWP must be modified or a new RWP must be issued to reflect the current radiological conditions. A well-selected limit will be one general enough to avoid unnecessary stoppages of work, while still protecting worker safety per the ALARA philosophy.

Next, the RSOR, or designee, determines the types of protective clothing required to be used by personnel performing prescribed tasks, the respiratory protection requirements, dosimetry requirements, and monitoring requirements, and lists them under the Protection Requirements section of the RWP. Finally, any additional training requirements for personnel and the need for ALARA briefings or reviews are noted on the RWP.

Determinations of protection requirements are to be performed by the RSOR, or designee, using his/her professional judgment and in accordance with industry standard practices and appropriate regulatory guidelines. Air monitoring is required if it is likely that airborne contamination may be present or created during work activities (i.e., during excavation and demolition activities). If air contaminants exceed 10 percent of the DAC, work activities will be stopped. Work will not resume unless engineering or other controls are established that will reduce the air contaminant concentration to less than 10 percent of the DAC.

5.2.2 Special Instructions

Special instructions associated with personal protective clothing, dosimetry, monitoring and inspection, respiratory protection, training or ALARA are indicated in this section of the RWP.

5.2.3 Review and Approvals

The RSOR and Site Health and Safety Specialist (SHSS), or designees, as a minimum, shall approve the RWP prior to work. The SHSS shall verify that relevant non-radiological safety considerations are addressed. When the non-radiological concerns of the SHSS have been adequately addressed, the RSOR will approve the RWP.

The RSOR shall contact the RSO immediately if monitoring indicates any of the following events occurred. Once the events are confirmed, the RSO shall notify the Radiological Affairs Support Office.

- An individual total effective dose equivalent (TEDE) exceeding 500 mrem
- The collective TEDE for the job exceeding 1 rem
- Individual airborne exposures exceeding 10 DAC-hours in a 7-day period
- General area exposure rates exceeding 200 mrem/hour
- Contamination levels exceeding 10 times the limits requiring classification of an area as a controlled area.

The check boxes in the approval section will be marked to indicate which of the approvers is required for each particular RWP. Any mandatory approver may prescribe changes to the draft RWP prior to final approval.

5.2.4 Using the Radiation Work Permit

A pre-job briefing is held with the individuals performing the work described in the RWP. The following topics are discussed in the pre-job briefing:

- Complete descriptions of the work tasks to be performed, and methods to minimize exposures to radiation and contamination while performing the work tasks.
- Discussions of the radiation, contamination, and airborne radioactive materials in the work area, and situations that could result in increased levels of these components.
- Health and safety issues that could be encountered during work activities.
- Emergency procedures and responsibilities.
- Discussions of the protective equipment requirements and monitoring requirements.

The RSOR, or designee, compiles the current year dose for the individuals performing RWP work to verify that the radiation exposure received during the work activities will not result in the individuals' dose exceeding administrative limits. The individuals' current radiation exposures will be listed on the Radiation Work Permit Authorization Log (Attachment 4).

Each individual entering the RWP work area is required to understand the RWP and to sign the Radiation Work Permit Authorization Log, indicating that the individual understands the provisions of the RWP, is aware of his/her current year dose, and will comply with the RWP requirements.

An RWP that covers work to be performed at a field site or in a building shall have an Access Log (Attachment 1) appended to the RWP. RWPs that cover general work areas are not required to have an access log, but an access log may be appended to the RWP if desired.

In cases where an Access Log is used, the RCT (or individual) logs the time the individual entered the work area, along with the reading on the individuals Pocket Ion Chamber or Direct Reading Dosimeter (DRD), if worn. The RCT (or individual) also indicates whether the individual wore a respirator during the work activities.

When an individual who signed in on a Radiation Work Permit Access Log exits the work area, the RCT (or individual) logs the time the individual leaves the area, and the individual's DRD reading, if worn. If the individual returns to the work area, another signature entry (and corresponding line entries) must be made on the Radiation Work Permit Access Log.

As previously noted, if the radiological limits listed on the RWP are exceeded at any point during a prescribed work task, then all work shall be stopped until the RWP can be modified to address the over-limit condition, or a new RWP is issued.

5.2.5 Modifying the Radiation Work Permit

In the event of changes occurring to the conditions or scope of the work that do not justify the generation of a new RWP, modifications to the RWP may be made by the RSOR. No more than two modifications can be made to an RWP before a new RWP must be issued. Modifications to the RWPs will be reviewed and approved in accordance with the initial requirements, as specified in Section 4.2.3 above.

To modify the RWP, each change is made with a single line cross-out of the text or item. The RSOR, or designee, must initial and date adjacent to each change. The RSOR, or designee, must communicate all changes to the individuals working under the RWP, and document the changes with a new RWP authorization log signed by all individuals who perform work covered by the RWP.

5.2.6 Terminating the Radiation Work Permit

The RWP is terminated when the end date of the RWP is reached, or can be terminated for one of the following reasons:

- The job has been completed.
- There is a significant change in the scope of work.
- There is a significant change in the radiological conditions.
- The RWP is revised.

When the RWP is terminated before the end date, a single line is drawn through the end date and a new end date recorded in its place. The person terminating the RWP provides his/her initials adjacent to the change. If the end date is extended, the extension must be managed in accordance with the change procedure noted in the previous section. The RWP can be terminated by the RSOR or designee. As part of the termination of an RWP, the Post-job Radiological Conditions and Closeout Review sections of the RWP shall be completed.

To complete the Post-job Radiological Conditions section, the RCT shall conduct a survey of the work site governed by the RWP. This survey should be conducted in a manner similar to the pre-job survey and should include determination of the current measurements for all quantities obtained in the pre-job survey. In addition, if personnel monitoring was in effect during work under the RWP and/or an individual was found to be exposed to contamination above the monitoring limits, the appropriate checkbox should be marked.

At a minimum, the closeout review will be conducted by the RSOR. As part of the closeout review, the reviewer(s) shall verify that associated records for the RWP are noted on the RWP form and that they are present in the project files. Reviewers shall also determine if there were any lessons learned that might be of value to personnel during future work performed on site. If so, then lessons learned synopsis shall be written and communicated/incorporated to project personnel.

6.0 RECORDS

The following records were referenced in this SOP.

- Radiation Work Permit Access Log
- Radiation Work Permit Authorization Log

- Radiation Work Permit

7.0 REFERENCES

Number	***Title***
AEC Regulatory Guide 1.86	*Termination of Operating Licenses for Nuclear Reactors*
10 CFR 20	*Standards for Protection Against Radiation, Appendix B*
SOP 001	*Radiation and Contamination Surveys*
SOP 009	*Air Sampling and Sample Analysis*

8.0 ATTACHMENTS

Forms provided in this section illustrate the minimum requirements for the respective subject matter. Alternative documents may be used, providing the information is presented in a clear and concise manner and the content meets or exceeds the information required to complete these documents.

Attachment 1, Radiation Work Permit Access Log

Attachment 2, Contamination Limits Table

Attachment 3, Radiation Work Permit

Attachment 4, Radiation Work Permit Authorization Log

ATTACHMENT 1 – RADIATION WORK PERMIT ACCESS LOG

RWP NUMBER: _____ **REVISION:** _____ **DATE:** _____

WORK LOCATION:
(Field Area or Bldg #) _____ **START DATE:** _____ **END DATE:** _____

Date In	Time In	Worker Name	Signature	Employee ID Number	PIC/DRD Number	DRD Reading		Date Out	Time Out	Resp (√)
						In	Out			

ATTACHMENT 2

TABLE 1
CONTAMINATION LIMITS TABLE

Radiation Type	Release Limits[1] (Fixed) (dpm per 100 cm^2)	Release Limits[1] (Removable) (dpm per 100 cm^2)
Alpha (α) Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	20
Beta (β-) Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	200
Beta-Gamma (β-γ) Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	1,000

Notes:
[1] These limits are based on AEC Regulatory Guide 1.86 (AEC, 1974)
Abbreviations and Acronyms:
AEC – Atomic Energy Commission
cm^2 – square centimeter
dpm – disintegrations per minute

ATTACHMENT 3 – RADIATION WORK PERMIT

Tetra Tech EC, Inc.

RSOR USE ONLY	
Permit Number	
Effective Date	Expiration Date

RADIOLOGICAL WORK PERMIT

GENERAL INFORMATION (to be completed by the Requestor)				
Requested by (Name & Project)	Date	Phone No.	Site Mailing Address	
Work Location	Work Area	Building/Site	Extent	Room No.

Work Plan	Health & Safety Plan	Contract Number	Expected Start Date	Expected End Date

Tasks to be performed inside an RCA *(add attachment if necessary)*	Estimated No. Personnel	Estimated No. Personnel-hours

RADIOLOGICAL LIMITS (to be completed by the RCT)

☐ Anticipated radiological conditions ☐ See Attached Map

Surface Contamination (dpm/100 cm sq)

	Direct	Swipe	LAS (Large Area Swipe)
Alpha			
Beta/gamma			
Tritium			

External Dose Rate (mrem/hr in work area)

Beta + gamma _____
Neutron _____
Total (b + g + n) _____

Airborne Radioactivity

Radionuclide(s) DAC ☐ Anticipated or ☐ Measured

Completed by	Name	Signature	ID Number	Date

ALARA/RADIOLOGICAL PROTECTION REQUIREMENTS (to be completed by RCT)

Protective Clothing Requirements
☐ None ☐ Rubber Overshoes ☐ Double Coveralls
☐ Lab Coat ☐ Skull Cap ☐ Hood ☐ Double Gloves ☐ Plastic Coverall
☐ Gloves ☐ Booties ☐ Single Coverall ☐ Double Booties ☐ Tape Openings
☐ Other: _____

Respiratory Requirements
☐ None ☐ Combination cartridge* ☐ Chemical cartridge*
☐ Powered Air Purifying Respirator ☐ Ventilation ☐ Air Line Respirator* ☐ SCBA*
☐ Negative Pressure Respirator ☐ Supplied air suit* ☐ Bubble Hood* **** Requires Health & Safety approval***
☐ Other: _____

Dosimetry Requirements
☐ None ☐ WB dosimeter ☐ Supplemental dosimeter
☐ TLD finger rings ☐ Special neutron dosimetry ☐ Pu access list ☐ Alarming dosimeter
☐ Bioassay sample ☐ Whole-body count ☐ Accident dosimeter ☐ Nasal swipes
☐ Other: _____

Monitoring Requirements
☐ None ☐ Notify RCT before job starts
☐ Intermittent coverage ☐ Personnel before leaving job ☐ Equipment and tools before removal
☐ Continuous coverage ☐ RCT monitor doffing of PCs ☐ Air monitoring
☐ Self-frisking ☐ Other: _____

Additional Training Requirements _____

☐ ALARA Pre-job briefing ☐ ALARA review (see attachments)

Completed by RCT Name Signature Employee ID Number Date
☐ Completed

SPECIAL INSTRUCTIONS (to be completed by the RCT)

Special Instructions:

Completed by RCT Name Signature ID Number Date
☐ Completed

APPROVALS

1. ***RSOR*** ☐	Name	Signature	ID Number	Date
2. ***SHSS*** ☐	Name	Signature	ID Number	Date
3. ☐	Names	Signatures	ID Numbers	Date
☐				

POST-JOB RADIOLOGICAL CONDITIONS (to be completed by the RCT/HPT)

Measured Radiological Conditions *(Record all readings as highest / general area)* ☐ See attached map

	Surface Contamination (dpm 100 sq cm) Direct	Swipe	LAS (large area swipe)	External Dose Rate (mrem/hr in work area)	
Alpha				Beta + gamma	
Beta/gamma				Neutron	
Tritium				Total (b + g + n)	

Airborne Radioactivity
DAC _____ ☐ Estimated or
Isotope ☐ Measured

Survey of Personnel Leaving Job Site
☐ Personnel contaminated above applicable limits
(If yes, attach the Radiological Incident Report)

Completed by RCT Name Signature ID Number Date
☐ Completed

REVIEW

Associated reports for this job *(indicate the ones that apply):*

☐ CAM Results	☐ Nasal swipe data	☐ RWP acknowledgement log
☐ Job-specific air monitoring	☐ Bioassay sample(s)	☐ Dose tracking report
☐ Pre-job survey data	☐ Whole Body Count(s)	☐ Radiological occurrence/incident report
☐ Post-job survey data	☐ Wound count	☐ ALARA Pre-job briefing
☐ Finger ring data	☐ Skin contamination	☐ Formal ALARA review
☐ Special dosimetry results	☐ Personal clothing survey	☐
☐ Other:		

☐ Lessons Learned (If Yes, then briefly explain. Add attachment(s) if necessary)

Reviewed by RCT Name Signature ID Number Date
☐ Reviewed

Reviewed by RSOR (or designee) Name Signature ID Number Date

ATTACHMENT 4 – RADIATION WORK PERMIT AUTHORIZATION LOG

RWP NUMBER: _____ **REVISION:** _____ **DATE:** _____

WORK LOCATION: _____ **START DATE:** _____ **END DATE:** _____

Worker Name	Employee ID Number	Current year TEDE (mrem)	*Signature	RCT Authorization	Date

* By my signature, I indicate that I have read, understand, and will comply with all requirements of this RWP.

Standard Operating Procedure

GAMMA SCREENING OF TRUCKLOADS USING THE STATIONARY PORTAL MONITOR AND USING PORTABLE SURVEY INSTRUMENTATION

SOP-011

Revision 2

Approved By:

Steven Adams, CHP Corporate Radiation Safety Officer	7/17/2015 Date

REVISION HISTORY

Revision (Date)	*Rev. No*	*Prepared By*	*Description of Changes*	*Affected Pages*
11/15/12	0	E. Abkemeier	Original	All
8/19/14	1	E. Abkemeier	Added procedural clarifications; updated definitions and abbreviations	4, 6–9
7/17/15	2	S. Adams	Inserted section on roles and responsibilities, strengthened precaution section, included new documentation requirement on concurrence for unconditional release of truckloads of dispersible material from TtEC control	All

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1.0 PURPOSE

The purpose of this procedure is to provide guidelines for performing gamma radiation screening of trucks loaded with non-contaminated soils and debris leaving Tetra Tech, EC, Inc. (TtEC) control using a Ludlum Model 3500-1000RMW portal monitor or equivalent. The purpose of the portal scan is to protect against the inadvertent shipment of materials exhibiting elevated radiation levels. The scan serves only to release the contents of the truck and not the truck itself. This procedure also covers hand screening of trucks using portable survey instruments.

2.0 SCOPE

This procedure describes the appropriate methods for using a portal monitor and portable survey instruments to perform gamma radiation screening of trucks loaded with non-radioactive soils and debris that will be transported to recycling centers, landfills, and other licensed disposal facilities.

3.0 DEFINITIONS AND ABBREVIATIONS

Client Agency – Organization given the authority to approve or reject a decision to allow free release of truckloads of non-radioactive dispersible material, e.g., state or federal regulatory agency, or Navy Radiological Affairs Support Office.

Client Representative – Client decision maker given the authority to approve or reject a decision to allow free release of a truckload of dispersible material. The client representative is defined in the appropriate work control document, e.g., client Radiation Safety Officer (RSO), Project Manager, or Program Manager. The client representative may be an individual in the client agency.

Radiation Control Technician – Individual possessing appropriate training and skills and the responsibility to ensure radiation safety for workers and the general public in the course of performing his/her specific duties.

Radiation Safety Officer Representative – Individual designated by the Corporate RSO with the site-specific responsibility to ensure that all conditions of the applicable Nuclear Regulatory Commission radioactive materials license (RML) or Agreement State RML are followed. Additionally, he/she is charged with keeping all worker and general public exposures as low as reasonably achievable.

Work Control Document – Authorized document that defines the criteria and data quality objectives (DQOs) for allowing unconditional release of a truckload of dispersible material from TtEC control. The criteria and DQOs may be more stringent than the requirements in this Standard Operating Procedure (SOP). The work control documents also define the client representative and client agency. Examples of work control documents include the Task-Specific Plan, Sampling and Analysis Plan, Radiation Protection Plan, Characterization and Remediation Plan, and Final Status Survey Plan.

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this SOP are defined below.

4.1 Radiation Safety Officer

The RSO is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the

RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision.

Work control documents may require the RSO to notify an appropriate client representative whenever a truck or its load fails the unconditional release surveys using the portal monitor and the hand survey

4.2 Radiation Safety Officer Representative

The responsibilities of the Radiation Safety Officer Representative (RSOR) are described below.

- Provides training on the truck portal monitor.
- Notifies the RSO immediately that a truck and its load have failed portal monitor and hand surveys.
- Prior to allowing material/waste to leave an RCA for off-site release or disposal as non-low-level radioactive waste, confirms that documentation exists from the appropriate client representative, as defined in an authorized work control document, that states the material/waste can be unconditionally released.

4.3 Radiation Control Technician

The Radiation Control Technician (RCT) performs truck surveys using the portal monitor, and performs hand-held surveys in conformance with this SOP. The RCT also is responsible for notifying the RSOR, or his/her designee, if the portal monitor is inoperable, and if a truck fails the portal monitor and hand monitor surveys.

5.0 PROCEDURE DETAILS

The procedures to be followed in performing activities associated with this SOP are described below.

5.1 General

General procedures to follow in screening truckloads are described below.

5.1.1 Precautions

The following precautions will be used:

- Prior to removing any material, the RSOR will confirm that documentation has been signed by an approved client representative, as defined in a Work Control document, that the material has been cleared for disposal as clean waste.
- The RSOR will accompany the contractor loading the material to ensure the proper stockpiled material is being removed.
- The detector alarm set point will be set as directed by the site RSOR with the concurrence of an approved client representative as defined in a Work Control document.
- Trucks should adhere to the required pauses and speed indicated in Section 5.2 of this procedure when passing through the detectors. Failure to carefully follow these requirements will result in invalid or incomplete screenings and will result in the screening having to be repeated.

5.1.2 Limitations

The following limitations will be in place:

- Calibration shall be performed annually, after maintenance is performed, if the instrument fails the performance test, or if proper operation is in question. Calibration is to be conducted by the manufacturer per the manufacturer's instruction manual.
- Setup and daily performance tests will be conducted in accordance with the operating manual for the Ludlum Model 3500-1000 portal monitor. Only one performance test need be performed per day even if the monitor is turned on and off throughout the day.

5.2 Portal Monitoring Screening

When using the Ludlum Model 3500-1000RMW for gamma screening surveys of trucks loaded with soil and/or debris, an RCT trained in the operation of the Model 3500-1000RMW will be present to monitor the instrumentation. The RCT's training on the portal monitor must be officially documented, and said documentation must be verified by the RSOR before assigning an individual to operate the portal monitor.

The following steps will be used for portal monitor screening:

1. Turn the instrument to the "on" position if not already on.
2. Ensure that the green lights on the "Power OK" and "System OK" are illuminated. If both lights are not illuminated, contact the RSOR.
3. Record the date, time, type of material, material location (origin of material) and license plate of the vehicle on the Truck Survey Log (Attachment 1).
4. Have the truck advance toward the detector slowly until the occupancy sensor is tripped.
5. Inform the truck driver to proceed slowly through the detectors. The rate of travel should be as slow as possible (not to exceed 3 miles per hour). If the truck is traveling too fast, a red over-speed light will illuminate on the instrument panel.
6. If the over-speed light illuminates, request that the truck driver proceed forward and turn around to restart the screening process. Wait for the instrument to be manually reset before proceeding.
7. While the truck is passing through the detectors, a green "checking" light will illuminate to tell the operator that the infrared motion detectors are operating properly. When the truck completes its pass (indicated by the checking light going off), it is necessary for the driver to pause the truck until cleared by the RCT to proceed or to return for a rescreen. If the checking light repeatedly does not illuminate while a truck is passing through, have the truck stop in a convenient location nearby. Notify the RSOR that the unit is not operational. At this point, the load contents have not been released and the portal monitor will have to be repaired and the truck re-scanned or a hand survey conducted. If a hand survey is to be used, proceed to Step 1 of Section 5.3 below.
8. If the checking light illuminates and the red alarm light does not illuminate when the truck has completed a pass, record the results (clean) under the Pass 1 column on Attachment 1 and proceed to Step 14. In the event that the red alarm light illuminates, let the truck continue through the detectors and record results (alarm) under the Pass 1 column on Attachment 1 and proceed to Step 9.

9. Inform the truck driver that it will be necessary to pass through the detectors again to confirm the alarm. Direct the truck driver to reposition the truck for another pass through the detector.
10. Push the reset button (if necessary). If the checking light illuminates and the red alarm light illuminates, let the truck continue through the detectors, record the results (alarm) under the Pass 2 column on Attachment 1, and proceed to Step 13. In the event that the red alarm light does not illuminate, let the truck continue through the detectors, record the results (clean) under the Pass 2 column on Attachment 1, and proceed to Step 11.
11. Inform the truck driver that it will be necessary to pass through the detectors again to confirm the portal monitor did not alarm. Direct the truck driver to reposition the truck for another pass through the detector.
12. Push the reset button (if necessary). If the checking light illuminates and the red alarm light does not illuminate when the truck passes through, record the results (clean) under the Pass 3 column on Attachment 1, and proceed to Step 14. In the event that the red alarm light illuminates, let the truck continue through the detectors, record the results (alarm) under the Pass 3 column on Attachment 1, and proceed to Step 13.
13. Inform the truck driver that the load is not releasable and follow the steps in Section 5.4 below. Indicate “Ret.” under the Disposition header of the Truck Survey Log to indicate the load has been returned, and initial the appropriate line on the Truck Survey Log. Have the truck driver initial the log as well. Subsequent truck surveys can now be conducted beginning at Step 1 above.
14. The truck load can be released. Indicate “Rel.” under the Disposition heading on the Truck Survey Log and initial next to the appropriate row. Have the truck driver initial the log as well. Subsequent truck surveys can now be conducted beginning at Step 1 above.

NOTE: The system continuously monitors radiation when the portal is occupied and compares the readings to the alarm level determined by using an average of the background levels. If the alarm threshold is breached, the audible and visual alarms will be activated.

5.3 Hand Screening

In instances where the portal monitor malfunctions while a truck is being surveyed, or if the portal monitor is inoperable, or if a truck fails two out of three passes, a hand survey will be required. Hand-held gamma instruments (Ludlum Model 2350-1 with Ludlum Model 44-10 2-inch by 2-inch sodium iodide (NaI) detector or equivalent) are used to survey trucks. The survey instruments are set up in accordance with the requirements of SOP 002, *Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use,* and performed in accordance with SOP 001, *Radiation and Contamination Surveys* and any applicable requirements from work control documents. Surveys should be performed in an area that is convenient to the workplace traffic flow. The area should be sufficiently isolated from any potential sources of radiation, and should allow the technician to obtain easy access to all sides of the vehicle. It is anticipated that when hand surveys are necessary, they will be conducted adjacent to the location where the portal monitor has been installed; however, an alternative location may be used. The following steps will be performed when performing a hand survey:

1. In an area adjacent to where the trucks are being screened and known to be free of radioactive material, establish a background count rate and record it on the Radiological Truck Survey Form for Portable Instruments (Attachment 2). If multiple surveys are to

be performed in a single area, then the background only needs to be established once for that area.

2. The end of the detector should be held approximately 4 inches from the surface of the truck containing the load when performing surveys.

3. Move the detector over the surface of the truck or containers in a serpentine pattern at a rate of < 0.5 meter per second covering 100 percent of the surface of the sides, the undercarriage, and the rear portion of the truck where the load is contained. Extra scrutiny should be used for any areas that result in significant increase in the audible signal of the meter. For maximum readings, as specified on Attachment 2, the technician performing the survey will use experience and judgment to take a meter level reading at the point of greatest audio response for the given side/area being surveyed.

4. When taking a reading for a maximum count rate on a given side/area, read the meter after sufficient response time has elapsed (i.e., the meter needle is relatively stable and the audible count rate is relatively stable) typically 8–10 seconds at near background count rates.

5. If the hand screening survey results in readings greater than 10,000 counts per minute (cpm) (or otherwise determined in conjunction with the client representative defined in the Work Control document based on the typical background gamma rates for that area), the RSOR and RSO will be notified immediately. Upon confirmation that the count rate exceeds the criterion for release, the appropriate client representative will be notified. Document the survey results on the appropriate survey form (Attachment 2). Inform the truck driver that the load is not releasable, and follow the steps in Section 5.4 below.

6. If the hand screening survey results are below 10,000 cpm (or otherwise determined in conjunction with the client representative defined in the work control document) based on the typical background gamma rates for that area), the truck may be released.

5.4 Protocol for Trucks Failing to Receive Portal Monitor or Hand Survey Clearance

When a truck causes two or three portal monitor alarms to trigger in three passes, or fails a hand screening using portable survey instrumentation, the truck will not be released off site. The RSOR shall be contacted immediately and apprised of the situation. The following steps shall be taken in response to a truckload that does not receive portal monitor clearance:

1. Copies of the portal monitor output for all passes resulting in an alarm shall be retained by the operators for inclusion with the truck survey log.

2. The offending truck, with load in place, shall initially be subjected to a hand survey per the procedures in Section 5.3. If a hand survey has already been completed and documented per the procedures in Section 5.3, proceed to step 4 below.

3. A hand survey log shall be completed and also appended to the truck survey log. The purpose of the hand survey is to identify whether elevated areas of radiation exist that may indicate the presence of radioactive material. Particular attention should be given to the area of the truck that caused the alarm according the portal monitor (e.g., alarm in back).

   NOTE: If an area of elevated activity is not identified using a hand survey, immediate notification should be given to the RSOR, who will inform the RSO, who will inform the appropriate client representative.

4. All rejected trucks shall be directed to an appropriate rejected truck pile pad and the material dumped for further characterization and survey activities. Material should be placed on a visqueen liner or other surface to prevent the spread of potential contamination.

   NOTE: If multiple contractors are present at an installation, the truck will be sent to an area controlled by the contractor from which the load originated. More than one rejected truck pile pad may exist at each installation. If the originator does not have a designated controlled area, the truck will be temporarily placed in a TtEC RCA.

5. Rejected truckload piles must be kept segregated until the pile has been surveyed, sampled, and the results have been reviewed by the RSOR, the RSO, and with concurrence from the appropriate client representative identified in the Work Control document.

6. After the materials are offloaded, trucks shall be scanned upon exiting the impacted area, and the empty truck will be rerun through the portal monitor. If the truck does not alarm the portal monitor, it is free to return to service. If the empty truck alarms the portal monitor, the RSOR and RSO shall be notified and all portal monitor operations shall be temporarily halted pending resolution by the RSOR, RSO, and concurrence from the appropriate client representative.

   NOTE: Trucks that have material removed due to elevated measurements obtained during portal monitor or portable instrument surveys shall have the tires surveyed for contamination in accordance with SOP 001.

7. The truckload pile will be rescanned using a vehicle-towed array or by hand using a Ludlum 2350-1 datalogger (or equivalent) with a Model 44-10 detector (or equivalent). The pile shall be spread into a ≤ 6-inch laydown area and a hand survey shall be conducted. Any sources located during the rescan of a rejected truckload pile require that notification be given to the RSOR, who will notify the RSO. Upon confirmation of the nature of the radioactive source, the RSO will notify the appropriate client representative identified in the Work Control document. The disposition of the pile will be determined by the RSOR or designee with concurrence from the appropriate client representative. If no sources are found, a minimum of two samples shall be taken from the pile and sent for radioanalysis for the potential radionuclides of concern. Samples will be collected at areas exhibiting radiation levels equal to or greater than 3 sigma plus mean background (or other radiation level, as agreed upon by the client representative). If radiation measurements do not exceed 3 sigma plus background (or other radiation level, as agreed upon by the client representative), the samples will be selected from two areas exhibiting the largest gamma readings. All areas exhibiting a gamma radiation count rate exceeding 10,000 cpm (or otherwise determined in conjunction with the client representative based on the typical background gamma rates for that area) will be sampled.

8. If the sample results do not indicate the presence of any of the radionuclides of concern above the release limits, then the stockpile can be either reloaded and run through the portal monitor again or aggregated with an existing clean stockpile. If the sample results indicate the presence of one or more radionuclides above the release criteria, the entire load shall be placed into a waste bin for further characterization and off-site disposal.

6.0 RECORDS

When following this SOP, a Truck Survey Log, provided as Attachment 1, will be generated and retained in the permanent project file. Multiple entries can be made on the same survey form for trucks that do not set off the alarm on the detector. If a hand survey is performed, a separate survey form (Attachment 2) will be used.

The RSOR will attach a copy of the documentation authorizing clearance of the material to the Truck Survey Log.

7.0 REFERENCES

Number	***Title***
SOP 001	*Radiation and Contamination Surveys*
SOP 002	*Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use*

8.0 ATTACHMENTS

Forms provided in this section illustrate the minimum requirements for their respective subject matter. Alternative documents may be used, providing the information is presented in a clear and concise manner and the content meets or exceeds the information required to complete these documents.

Attachment 1, Truck Survey Log

Attachment 2, Radiological Truck Survey Form for Portable Instruments

ATTACHMENT 1

TRUCK SURVEY LOG

Date	Time	Note	Type of Material	Material Location	License Plate No.	Pass 1		Pass 2[a]		Pass 3[b]		Hand Survey[c]		Disposition[d]		Technician Initials	Driver Initials
						Alarm	Clean	Alarm	Clean	Alarm	Clean	Reqd.	Comp.	Rel.	Ret.		

[a] Pass 2 and 3 not necessary if Pass 1 is clean

[b] Pass 3 not necessary if Pass 1 and Pass 2 are both alarm

[c] Indicate if hand survey required, if so initial upon completion

[d] Indicate release or return

Notes: 1 = Alarm 2 = Heavy Load 3 = Light Load 4 = Empty

Attachment 2

Radiological Truck Survey Form for Portable Instruments

Date:	Time:	Truck Identification (i.e. tag number):
Purpose of Survey: (include load origin)		

INSTRUMENTS USED

Model Number	Serial Number	Calibration Due Date	Background
1.			
2.			
3.			

Item Or Location	Count Rate Gross CPM	Distance or location from the surface of the vehicle
1. Max Reading on the sides of the vehicle		4”
2. Max Reading on the underside of the vehicle		4”
3. Max Reading on the rear of the vehicle		4”
4.		
5.		
6.		
7.		
8.		

Sketch/Diagram (optional):

Remarks:

Disposition (Released/Returned):

Surveyor (initials):	Reviewed by (signature):	Date:

Standard Operating Procedure

POSTING AND ACCESS CONTROL IN RADIOLOGICALLY CONTROLLED AREAS

SOP-012

Revision 2

Approved By:

Steven Adams, CHP
Corporate Radiation Safety Officer

7/17/2015
Date

REVISION HISTORY

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8/19/14	1	E. Abkemeier	Corrected typographical errors and fonts	6, 8, 9
7/17/15	2	S. Adams	Inserted Roles and Responsibilities section	5, 6

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1.0 PURPOSE

The purpose of this procedure is to specify methods and requirements to achieve consistent posting and control of radiologically controlled areas. This procedure is intended to satisfy the posting requirements of 10 Code of Federal Regulations (CFR) 20 (1-92), Standards for Protection Against Radiation.

2.0 SCOPE

This procedure identifies the requirements and types of postings necessary to clearly identify radiological conditions in a specific area or location within an area. It also specifies the requirements for access into and egress from radiologically controlled areas. This procedure will be used by Tetra Tech EC, Inc. (TtEC) personnel and its subcontractors to control entry and egress from radiologically controlled areas (RCAs).

3.0 DEFINITIONS AND ABBREVIATIONS

Airborne Radioactivity Area – A room, enclosure or area in which radioactive material is dispersed in air in the form of dusts, fumes, particulates, mists, vapors, or gases, and the concentration of the dispersed radioactive materials is in excess of:

- The derived air concentrations (DACs) specified in Table 1, Column 3 of Appendix B, 10 CFR 20.
- Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI).

Annual Limit on Intake – The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a 1-year period. ALI is the smaller value of intake of a given radionuclide by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 sievert [Sv]) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2 of Appendix B of 10 CFR 20.) One ALI is equivalent to 2,000 DAC-hours (hrs).

As Low As Reasonably Achievable – An approach to radiation protection for the control and management of exposure to the workforce and the general public (both individual and collective); thus ensuring a level of exposure as low as social, technical, economic, practical, and public policy considerations permit. The ALARA program is structured to increase worker awareness of exposure reduction techniques and the associated benefits of that reduction.

Contamination Area – Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* in Table 1 (Attachment 1), but do not exceed 100 times those values.

Derived Air Concentration – The concentration of a given radionuclide in air which, if breathed for a working year of 2,000 hours under conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of Appendix B of 10 CFR 20 (1-92).

Fixed Contamination – Surface contamination exceeding the contamination limits provided in Table 1 (Attachment 1) that cannot be readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk swipe, or masslinn.

High contamination area – Any area, accessible to individuals where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in Regulatory Guide 1.86 (Table 1, Attachment 1).

Radiation Area – Any area accessible to personnel in which there exists ionizing radiation at exposure rates such that an individual could receive a deep dose equivalent in excess of 5 millirem (mrem) in 1 hour at 30 centimeters (cm) from the radiation source or from any surface that the radiation penetrates.

Radiation Work Permit – A document generated, in accordance with SOP-010, *Issue and Use of Radiation Work Permits*, to provide specific requirements for radiological activities.

Radioactive Materials Area – Any area or room in which an amount of licensed material is used or stored that exceeds 10 times the quantity of such material specified in Appendix C, 10 CFR 20.

Radiologically Controlled Area – An area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials and/or to prevent the release of radioactive materials to the uncontrolled areas.

Underground Radioactive Materials – An underground area that is known to contain radioactive materials, such as pipelines, tanks, cribs, covered ponds, covered ditches, catch basins, inactive burial grounds and sites of known, covered spills.

4.0 ROLES AND RESPONSIBILITIES

The roles and responsibilities of individuals described in this Standard Operating Procedure (SOP) are defined below.

4.1 Corporate Radiation Safety Officer

The Radiation Safety Officer (RSO) is the manager responsible for maintaining, revising, reviewing, and approving changes to this SOP. Directly or through a subject matter expert, line management may request that the RSO make an exemption to or variance from portions of this SOP. The request must be in writing, clearly identifying the exemption or variance sought, and providing justification for why an exemption would be in the best interest of TtEC, not simply of the requesting organization. The RSO will provide the requestor a written notice of his/her decision. In addition, the RSO reviews and approves technical basis decisions addressing posting and access control.

4.2 Radiation Safety Officer Representative

The Radiation Safety Officer Representative (RSOR) is responsible for the following activities:

- Reports the loss, damage, or unexpected exposure of dosimetry to the RSO.
- Prepares a radiation exposure investigation report if a dosimeter is lost or if an unexpected exposure occurs.
- Contacts the RSO or designee immediately if the airborne concentrations exceed 10 percent of the levels listed in Table 1, Column 3 of Appendix B of 10 CFR 20.

- Assesses the condition of the site/facility to ensure all postings and signage are appropriate, correctly placed, and comply with the requirements of this SOP, on a weekly basis, or on a frequency established in approved work documents.

4.3 Radiation Control Technicians

The Radiation Control Technician (RCT) is responsible for the following activities:

- Reports to the RSOR, as soon as possible, any non-compliance with the posting requirements established in this SOP.
- Reports to the RSOR immediately if anyone loses or damages a dosimeter.

5.0 PROCEDURE DETAILS

The procedures to follow in conducting activities under this SOP are provided below.

5.1 General

This SOP will address establishing and posting:

- RCAs
- Radioactive Materials Areas (RMAs)
- Radiation areas
- Contamination areas
- Airborne radioactivity areas
- Underground RMAs

5.1.1 Precautions

Personnel working in a RCA shall:

- Comply with all radiation protection instructions and postings.
- Refrain from eating, drinking, smoking, chewing, or applying makeup while in a RCA.
- Perform jobs or tasks in such a manner that minimizes the creation or spread of contamination.
- Ensure that tools and equipment are surveyed prior to removing the items from a RCA.
- Refrain from loitering in radiation areas.
- Wear dosimetry in a manner required by the Radiation Work Permit (RWP).
- Perform a personal contamination survey upon exit from a RCA.
- Immediately report the loss, damage, or unexpected exposure of dosimetry to the RSOR.
- Notify the RCT of any wounds, sores or rashes before entering any area where contamination exists.
- Exit immediately if a wound occurs in a RCA, notify the RCT and seek first aid.
- Follow any additional requirements dictated by the RSOR or RCT.

5.1.2 Signage

All radiologically controlled areas will be designated an RCA. Additional restricted areas (such as a controlled area, radiation area, RMA, and Airborne Radioactivity Areas [ARAs]) may be posted within an RCA, as necessary, to identify additional precautions that may be required.

Signs identifying radiological hazards shall be posted on all entrances and accessible sides of the barrier surrounding the identified RCA. Signs identifying radiological hazards shall be firmly attached to the barrier or entrances with materials that will withstand the effects of adverse weather and normal use conditions. If signs with the exact wording are not readily available, alternative phrases may be used as long as the same requirements are clearly communicated in the posting. Signs must be identified in English. Additional languages secondary to English may be used in tandem.

5.1.3 Surveys

Radiation and contamination surveys for establishing and maintaining RCAs shall be performed in accordance with SOP 001, *Radiation and Contamination Surveys*.

5.2 Procedure Process

The procedures to follow while working in RCAs are described below.

5.2.1 Establishing and Posting Radiologically Controlled Areas

RCAs shall be designated by clearly and conspicuously posting all entrances and all other accessible sides of the area with a sign bearing the following:

The sign will also list requirements for entering the RCA. To enter a RCA, a person must meet all posted requirements or be escorted by a trained individual.

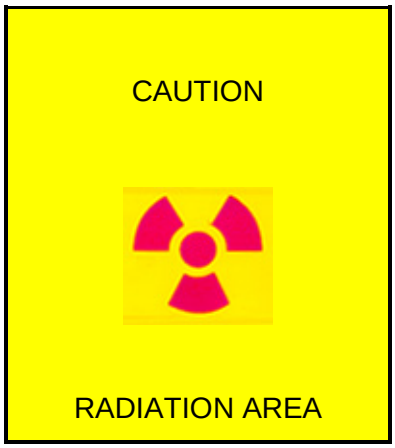
5.2.2 Posting Requirements for Radioactive Materials Areas

Radiation protection personnel shall post any area or room in which radioactive materials are stored or used with a sign or signs bearing the radiation symbol and the words “CAUTION, RADIOACTIVE MATERIALS AREA.”

When posting signage in a room, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the radioactive material shall be bounded by signs fastened to stanchions, posts, or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction. If signs with these exact words are not readily available, alternative phrases may be used as long as the same requirements are clearly communicated in the posting.

5.2.3 Establishing and Posting Radiation Areas

Radiation protection personnel shall post signs in radiation areas that bear the radiation symbol and the words “CAUTION, RADIATION AREA.”



If an entire room or most of a room is at or above the 5 mrem per hour (mrem/hr) level, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area at or above the 5 mrem/hr level shall be bounded by signs fastened to stanchions, posts, or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction. If a posting is placed on a door in a manner

that would prevent the posting from being observed if the door is propped open, an additional posting shall be placed in the doorway.

A single entry/exit point shall be established to access the radiation area. Access into radiation areas shall be limited to radiation workers wearing dosimetry that are signed in on an approved RWP.

5.2.4 Establishing and Posting Contamination Areas

The procedures for establishing and posting signs in contamination areas are describe below.

5.2.4.1 Removable Surface Contamination

Radiation protection personnel shall post any contamination area or high contamination area with a sign or signs bearing the radiation symbol and the words “CAUTION, CONTAMINATION AREA”, or “CAUTION, HIGH CONTAMINATION AREA” as appropriate.

When posting a room, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the contamination shall be bounded by signs fastened to stanchions, posts, or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction.

A single entry/exit point shall be established to access the contamination area. A step-off pad that provides a defined boundary between contaminated and non-contaminated areas shall be placed at the entry/exit point. Each contamination area that is to be entered shall have a step-off pad maintained in an uncontaminated condition located at the access/egress point.

Contamination areas that require access by personnel on a daily basis, should have a frisking station located as close to the access/egress point as is reasonably possible, taking background radiation levels and work processes into consideration. All personnel exiting a contamination area shall perform personnel contamination monitoring in accordance with the applicable RWP.

5.2.4.2 Fixed Contamination

If the area of contamination is within a RCA, the boundaries of the contamination area will be delineated in such a way to identify it for future characterization. If the area of contamination is not within a RCA, then the area will be posted as a contamination area, as described in Section 5.2.4.1.

5.2.5 Establishing and Posting Airborne Radioactivity Areas

TtEC policy is to minimize the amount of radioactive materials taken into a worker's body. In order to accomplish this, Airborne Radioactivity Areas are posted at 10 percent DAC, as specified in Table 1, Column 3 of Appendix B of 10 CFR 20. Maintaining the airborne activity below these limits will eliminate any posting requirements.

To verify that the limits for airborne radioactivity are not exceeded, air sampling will be performed continuously during each work activity. The results of the air samples are compared with the limits above to verify that the limits are not exceeded. If the limits are exceeded, immediately contact the RSOR or designee.

Radiation protection personnel shall post any ARA or room with a sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA."

When posting a room, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the airborne radioactivity shall be bounded by signs fastened to stanchions, posts, or other sturdy structures. The signs will be positioned such that they are conspicuous when the area is approached from any accessible direction.

5.2.6 Establishing and Posting Underground Radioactive Materials Areas

The entrance to any area (normally outside areas) shall be posted to indicate the presence of identified underground items that are known to contain radioactive materials, such as pipelines, tanks, cribs, covered ponds, covered ditches, catch basins, inactive burial grounds, and sites of known, covered, spills.

The entrances to the areas shall be clearly and conspicuously posted as follows:

Underground radioactive material areas shall also be posted “Authorized Personnel, RWP Required for Entry.” If signs with these exact words are not readily available, alternative phrases may be used as long as the same requirements are clearly communicated in the posting.

6.0 RECORDS

Documentation generated during the procedures identified in this SOP shall consist of recording the date and location of any radiologically controlled, radioactive material, radiation, contaminated or airborne radioactivity areas established in the project logbook. A sketch of the area and area boundary should be included on the survey forms.

7.0 REFERENCES

Number	***Title***
Atomic Energy Commission Regulatory Guide 1.86	Termination of Operating Licenses for Nuclear Reactors
10 CFR 20	Standards for Protection Against Radiation
SOP 001	Radiation and Contamination Surveys
SOP 010	Issuance and Use of Radiation Work Permits

8.0 ATTACHMENTS

Attachment 1, Table 1, Contamination Limits

ATTACHMENT 1

TABLE 1

CONTAMINATION LIMITS

Radiation Type	Release Limits[1] (Fixed plus Removable) (dpm per 100 cm^2)	Release Limits[1] (Removable) (dpm per 100 cm^2)
Alpha (α) Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	20
Beta (β-) Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	200
Beta-Gamma (β-γ) Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	1,000

Notes:

[1] These limits are based on AEC Regulatory Guide 1.86 (AEC 1974)

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm^2 – square centimeter
dpm – disintegrations per minute

ATTACHMENT 5

WORK INSTRUCTIONS

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ATTACHMENT 5

INDEX

Work Instructions

FCR #	SUBJECT	RASO APPROVAL DATE	STATUS
N/A	Radiological Work Instruction for Hunters Point Parcel C Petroleum Hydrocarbon Investigation	6/5/2014	Open
N/A	Radiological Work Instruction for the Keller Canyon Returned Soils	4/2/2015	Open
N/A	Radiological Work Instruction for the CH2M Hill Parcel F Pilot Study (for survey of dry equipment and material)	4/8/2015	Open
N/A	Radiological Work Instruction for the CH2M Hill Parcel F Pilot Study (for survey of wet sediment)	6/15/2015	Open

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Radiological Work Instruction for Hunters Point Parcel C Petroleum Hydrocarbon Investigation

E-mail Approval Date: Matt Slack June 5, 2014

ITSI Gilbane (Gilbane) personnel will be performing soil boring work within radiologically controlled areas at Hunters Point Naval Shipyard in San Francisco, California.

This effort will involve advancing soil borings, collecting soil samples, and collecting groundwater samples. Work will be performed per Gilbane's Final Petroleum Hydrocarbon Project Work Plan Parcel C, Hunters Point Naval Shipyard, November 2013, Section 3.2.

Work will be performed in the current radiologically controlled areas of Building 211, adjacent to Berth 2, south end of Lockwood Street between Berths 3 and 4, and west of Berth 5. Trieco is working to down post areas as possible to reduce the radiologically controlled area that Gilbane will have to access. Field work is schedule to start the week of July 7, and Trieco anticipates that the petroleum hydrocarbon sites remaining within radiologically controlled areas in Parcel C will be limited to Building 211 and the area adjacent to Berth 2.

Building 211 and Berth 2 areas are designated as radiologically-impacted sites and it is possible that portions of the structure and areas below these areas may contain elevated levels of radioactive material. Therefore, the following information applies to Building 211 and the area adjacent to Berth 2 as identified in the Historical Radiological Assessment, Volume II (NAVSEA 2004). Subsequent radionuclides of concern which could be encountered during this work include radium-226, cesium-137, thorium-232, plutonium-239 strontium-90. As a result, basic radiation survey protocols will be implemented during planned work activities inside the impacted areas. Activities to be performed by Gilbane personnel inside the radiologically-impacted areas include:

- Advancing soil borings
- Collecting soil samples
- Collecting groundwater samples
    - Note that any waste generated (e.g., during soil boring advancement) will be stored in Building 211 until disposal method is approved based on radioanalytical results. Sample collection and analysis will be performed by Trieco personnel under the Trieco contract. Release criteria are listed in Table 1. Trieco will maintain custody of waste drums under TtEC's Nuclear Regulatory Commission radioactive material license #29-31396-01 pending analytical results. If radioanalytical results indicate no release criteria exceedances, the waste drums will be transferred to Gilbane for disposal. If radioanalytical results indicate one or more exceedances, Trieco will maintain control of the applicable waste drum(s), pending further direction from the Navy.

Using governing criteria as defined in Nuclear Regulatory Commission radioactive material license # 29-31396-01 and RWP 2014-001 or equivalent, Trieco will provide basic radiation protection protocols when Gilbane requires access to radiologically-impacted areas referenced above by:

* Providing a radiation safety brief to field staff assigned to the project
* Providing project field staff with dosimetry
* Performing incoming equipment and material surveys.
* Providing surveillance during water sampling activities
* Performing radiological surveys of equipment and materials prior to decontamination of equipment and materials.
* Performing personnel surveys as needed while the work is being performed.
* Performing radiological release surveys at the conclusion of the project on outgoing equipment and material, including temporary probe materials used for sampling purposes.

The survey activities performed under this work instruction will be conducted in accordance with the general approach and methodologies that are outlined in the Base wide Radiological Management Plan (DCN: EMAC-8823-0003-0104) and associated Standard Operating Procedures (SOPs). The survey activities will comply with the requirements of the Base-wide Health and Safety Plan. If elevated levels of radioactivity are identified during the performance of the work, temporary suspension of activities in the affected area will be required followed by immediate notification of the site Radiation Safety Officer Representative (RSOR). No site-specific air monitoring is required as the material handled will not likely become airborne; however, general air monitoring within Building 211 will continue as the result of adjacent activities.

Incoming equipment and materials will be surveyed for radioactivity prior to being placed into service within the jobsite. All alpha, beta and gamma surveys will be conducted in accordance with SOP HPO-Tt-006, Radiation and Contamination Surveys.

Radiological surface screening with a Ludlum Model 2350-1 data logger and 44-10 2" by 2" NaI detector, as well as a Ludlum Model 2360 Model data logger and a 43-68/43-89/43-93 detector will be conducted in the immediate area where soil boring and water sample collection activities will be performed to ensure that existing radiation levels are not elevated prior to initiating work. If previous documented surveys have been conducted as a part of the current Building 253/211 characterization survey, these surveys may serve as documentation of existing radiation levels. If elevated levels of contamination are detected during any survey (i.e., any detectable exceedance shown in Table 1) work will be suspended and the Radiological Affairs Support Office (RASO) and the RSOR will be notified prior to resuming work activities.

Containers used to collect water samples or soil samples will be surveyed for surface contamination, as well as for gamma exposure rate in accordance with SOP HPO-Tt-006, Radiation and Contamination Surveys. (Note: Gamma exposure rates greater than twice background on contact will require immediate notification of the site RSOR. In conjunction with the RSO and RASO representative, a determination will be made as to whether implementation of additional radiological controls is warranted.)

Prior to release or relocation, tool, material, and equipment surveys will be conducted in accordance with SOP HPO-Tt-006, Radiation and Contamination Surveys. If contaminants are identified that exceed the release criteria in Table 1, temporary suspension of work in the affected area will be required followed by immediate notification of the site RSOR.

TABLE 1
RELEASE CRITERIA

Radionuclide	Radiation	Half-life (years)	Surfaces[a] (dpm/100 cm^2)		Water	Soil (pCi/g)
			Removable	Total	(pCi/L)	
Cesium-137	Beta, gamma	30.1	1,000	5,000	119	0.113[b]
Plutonium-239	Alpha, gamma	24,100	20	100	15	2.59
Radium-226	Alpha, gamma	1,599	20	100	5	1.0[c]
Strontium-90	Beta	28.78	200	1,000	8	0.331[d]
Thorium-232	Alpha, gamma	14E9	20	100	15	1.69

Notes:

[a] Total limits are based on AEC *Regulatory Guide 1.86*. Limits for removable surface activity are 20 percent of the Total limit values.

[b] Limit adopted from the *Final Basewide Radiological Removal Action Memorandum – Revision 2006*.

[c] Limit is 1 picocurie per gram (pCi/g) above background per agreement with U.S. Environmental Protection Agency.

[d] State of California residential value for non-radiological landfill disposal.

Montgomery, Shanti

From: Slack, Matthew L CIV SEA 04 04N <matthew.slack@navy.mil>
Sent: Thursday, April 02, 2015 10:38 AM
To: Leslie Howard
Cc: Brooks, George P CIV NAVFAC SW, PACO; Haran, Catherine M CIV NAVFAC SW; Edwards, Zachary L CIV SEA 04 04N; Joyce, Greg; Kaastrup, Ellen; Montgomery, Shanti; Berry, Adam; Adams, Steven
Subject: RE: Keller Canyon Work Instructions

Importance: High

Leslie,
I have reviewed the revised Keller Canyon Work Instruction and have no further comment and concur with implementation of the work instruction.

Matt

-----Original Message-----
From: Adams, Steven [mailto:Steven.Adams@tetratech.com]
Sent: Wednesday, April 01, 2015 7:32 PM
To: Slack, Matthew L CIV SEA 04 04N
Cc: Leslie Howard; Brooks, George P CIV NAVFAC SW, PACO; Haran, Catherine M CIV NAVFAC SW; Edwards, Zachary L CIV SEA 04 04N; Joyce, Greg; Kaastrup, Ellen; Montgomery, Shanti; Berry, Adam
Subject: Keller Canyon Work Instructions

Matt,

Please replace the Keller Canyon Work Instructions sent to you last night with the attached version. The work instructions have been upgraded with the additional specificity per our discussion this afternoon. Please review and concur that TtEC may implement these work instructions.

If you have any questions or require any additional information please contact me at (702) 521-4549 or via email.

Steven Adams, CHP | Corporate Radiation Safety Officer Certified Health Physicist Telecommuting |

Cell: 702.521.4549 Steven.Adams@tetratech.com <mailto:Steven.Adams@tetratech.com>
<mailto:Steven.Adams@tetratech.com>

Tetra Tech EC | Environmental Safety and Quality

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Radiological Work Instruction for the Keller Canyon Returned Soils

Tetra Tech ECI and subcontracted radiological control personnel will be performing the radiological release of the potentially impacted soils/materials at former Hunters Point Naval Shipyard (HPNS) in San Francisco, California. The Keller Canyon returned soils/materials originated from a Hunter's Point Naval Shipyard Radiologically Controlled Area (RCA) and were inadvertently transported for disposal at Keller Canyon Landfill without proper radiological screening.

All Keller Canyon returned soil/materials are designated as radiologically-impacted and it is possible that the soil, asphalt, concrete and household trash may contain concentrations of radionuclides that are elevated in comparison to undisturbed background locations at the HPNS. Radionuclides of concern which could be encountered at concentrations exceeding background during this work include strontium-90 (Sr-90), cesium-137 (Cs-137), and radium-226 (Ra-226). Therefore, Tetra Tech ECI Radiological Work Permit #2015-002 will be followed during the characterization and remediation of Keller Canyon soils. Requirements for this RWP are shown in Figure 1.

The returned materials will be spread out in lifts no greater than 6 inches in height and up to 1,000 square meters (m^2) in surface area within Radiological Screening Yard (RSY) 4. As necessary, the material will be allowed to dewater prior to the performance of radiological surveys. All items (asphalt, concrete, garbage, etc.) with any dimension larger than 6 inches will be removed from the soils and placed at the perimeter of the pad for future removal and radiologic survey on pad used exclusively for oversized materials.

Once the soil screening pad with the spread material is cleared of oversized objects, vehicular towed array will be used to perform a high-density gamma scan supported by GPS hardware. This survey will result in a 100% surface scan as detailed in the *Final Execution Plan, Revision 1 dated December 20, 2011 (DCN: RMAC-0809-0004-0003.R1).* Systematic sampling will be performed in accordance with the *Final Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan Revision 1, July 2011) provided as Attachment 1 to the Final Execution Plan, Revision 1.* Areas showing gamma radiation levels greater than the established investigation level of 3 sigma greater than the mean background area will be investigated further for the presence of radioactive material. A static gamma measurement will be acquired at locations exceeding the investigation level. If the static gamma radiation level exceeds the investigation level a biased sample will be collected from that location. These samples will be screened at an off-site radiological laboratory by gamma spectroscopy and Sr-90 analysis, if required. The radionuclides of concern (Sr-90, Cs-137 and Ra-226) will be analyzed by Test America – St. Louis. Test America – St. Louis, accredited by the Department of Defense Environmental Laboratory Accreditation Program and the California Department of Public Health, will be providing the definitive data results.

Once the definitive data are received and TtEC has determined that the soil meets the off-site disposal criteria (i.e., the radionuclides of concern do not exceed the release criteria specified in Table 1), the data will be forwarded to the Radiological Affairs Support Office (RASO) for concurrence to stage as non-low level radioactive waste (LLRW) for transfer to the Navy's Basewide non-LLRW transport and disposal contractor. Upon receiving RASO concurrence, TtEC will stage the radiologically cleared material in a Navy-designated non-impacted area. Following staging of the material, the RPM for the Navy's Basewide non-LLRW transport and disposal contractor will be notified that the associated soils have been radiologically cleared and may be disposed of as non-LLRW at which time the staged material becomes the responsibility of the Navy's Basewide non-LLRW transport and disposal contractor.

If soils/materials exceeding the activity concentrations shown in Table 1 are identified in the systematic or biased soil samples, the RASO will be notified. Upon notification and RASO concurrence to proceed, remediation will be performed. The extent of the remediation area will be bound by those samples that do not exceed the release criteria. Additional characterization samples may be taken to reduce the volume of soil placed in LLRW bins for off-site disposal.

Materials greater than 6 inches in length, height, or width will be sorted from soils and placed at the edge of the pad boundary. Once all pad soils have been placed, but prior to vehicular towed array, these larger items will be moved to an adjacent pad and laid out in lanes. All items with any dimension greater than 6 inches will receive alpha/beta/gamma surveys in accordance with SOP-003. Survey groups will be used to expedite the survey of smaller items. Groups will be formed by consolidation of smaller items to form a square meter of exposed surfaces. This square meter of surface will be surveyed, then flipped, and surveyed on the other side. Each group will have a photograph taken that will be included with the generated release survey. Each group will be represented by two surveys, one for each side. All items will be subject to a 100% alpha/beta/gamma scan. This materials survey for free release will be conducted in accordance with *The Final Basewide Radiological Management Plan.* Radiation Safety Officer Representative (RSOR) approved release surveys of these items will be forwarded to the RASO for concurrence prior to transfer to the Navy's non-LLRW transport and disposal contractor for disposal. Release criteria for large objects can be found in Table 1. Items that cannot be surveyed due to inaccessible survey areas, material type, configuration or other physical property will be segregated and disposed based on the results of the gamma scans and soil samples from the RSY pads. If the gamma scans and analysis of soil samples demonstrate there is contamination the items will be controlled and released as LLRW. Otherwise the items will be staged as non-LLRW.

All survey activities performed under this work instruction will be conducted in accordance with the general approach and methodologies that are outlined in the *Basewide Radiological Management Plan* and associated Standard Operating Procedures (SOPs). The survey activities will comply with the requirements of the *Accident Prevention Plan/Site Safety and Health Plan dated December 2014 (DCN: ECSD-4808-0003-0004).* If elevated levels of radioactivity are identified during the performance of the work, temporary suspension of activities in the affected area will be required followed by immediate notification of the site RSOR.

TABLE 1
RELEASE CRITERIA

Radionuclide	Radiation	Half-life (years)	Surfaces[a] (dpm/100 cm^2)		Water[e]	Soil (pCi/g)
			Loose	Total	(pCi/L)	
Cesium-137	Beta, gamma	30.1	1,000	5,000	119	0.113[b]
Radium-226	Alpha, gamma	1,599	20	100	5	1.0[c]
Strontium-90	Beta	28.78	200	1,000	8	0.331[d]

Notes:

[a] These limits are based on AEC Regulatory Guide 1.86 (AEC, 1974)

[b] Limit adopted from the *Final Basewide Radiological Removal Action Memorandum – Revision 2006.*

[c] Limit is 1 picocurie per gram (pCi/g) above background per agreement with U.S. Environmental Protection Agency.

[d] State of California residential value for non-radiological landfill disposal.

[e] Limit based on EPA drinking water standards.

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND DETACHMENT
RADIOLOGICAL AFFAIRS SUPPORT OFFICE
160 MAIN ROAD
YORKTOWN, VA 23691

IN REPLY REFER TO:
5104
Ser PAO/0179
08 Apr 15

From: Officer in Charge, Naval Sea Systems Command Detachment, Radiological Affairs Support Office
To: Director, Base Realignment and Closure Program Management Office West

Subj: RADIOLOGICAL WORK INSTRUCTION FOR THE CH2M HILL PARCEL F PILOT STUDY HUNTERS POINT NAVAL SHIPYARD SAN FRANCISCO, CALIFORNIA

1. The subject document was emailed from Steven Adams to Naval Sea Systems Command Detachment, Radiological Affairs Support Office (NAVSEA DET RASO) on 24 Mar 15 for review and approval.

2. NAVSEA DET RASO has completed a review of the subject document and has "no comments." NAVSEA DET RASO concurs that a draft version of the document be provided to the Concord Base Closure Team for their review and approval.

3. NAVSEA DET RASO point of contact is Mr. Patrick Owens at DSN 953-7644 or commercial (757) 887-7644.

/s/
B. J. DABNEY
Acting

Copy to:
COMNAVSEASYSCOM WASHINGTON DC (SEA 04N)

Radiological Work Instruction for the CH2M Hill Parcel F Pilot Study

CH2M Hill personnel will be performing a Pilot Study within Parcel F at Hunters Point Naval Shipyard in San Francisco, California.

This effort will involve the operation of watercraft along the Parcel F shoreline in order to collect samples, deploy monitoring equipment, and place a carbon amendment on the bay floor. The work is described in detail in Attachment 1, *Summary of Construction and Sampling Techniques for the Demonstration of Activated Carbon Amendments at Hunters Point Naval Shipyard, San Francisco, California.*

All Parcel F underwater areas are designated as radiologically-impacted and it is possible that the sediment may contain concentrations of radionuclides that are elevated in comparison to undisturbed background locations at the former Hunters Point Navy Station (HPNS). Therefore, the following information applies to Parcel F as identified in the Historical Radiological Assessment, Volume II (NAVSEA 2004). Radionuclides of concern which could be encountered at concentrations exceeding background during this work include radium-226, cesium-137, uranium-235, plutonium-239, and strontium-90. As a result, basic radiation survey protocols will be implemented during planned work activities bringing equipment and/or personnel in contact with potentially contaminated sediment within Parcel F. Activities to be performed by CH2M Hill personnel inside the radiologically-impacted areas include:

- Sediment and filter feeder sample collection
- Deployment and retrieval of hydrodynamic monitoring equipment near the test pilot area
- Carbon amendment placement
- Post application monitoring immediately following the initial placement of activated carbon and 6-, 12-, and 18 months post-placement

Using governing criteria as defined in Nuclear Regulatory Commission radioactive material license # 29-31396-01, California radioactive material license #7909-01, and RWP 2015-001 or equivalent, Tetra Tech EC, Inc. (TtEC) will provide basic radiation protection protocols when CH2M Hill requires access to radiologically-impacted areas referenced above by:

* Providing a radiation safety brief to field staff assigned to the project
* Providing project field staff with dosimetry
* Performing incoming equipment and material surveys.
* Providing surveillance during activities in which personnel come in contact with potentially contaminated sediment, including the retrieval of potentially contaminated equipment
* Performing radiological surveys of dry equipment and materials prior to decontamination of equipment and materials.
* Performing radiological surveys on dry sampling containers prior to being shipped for non-radiological characterization.
* Performing radiological release surveys on dry equipment and material, including temporary probe materials used for sampling purposes that are leaving the Parcel F radiological control area (RCA)

The survey activities performed under this work instruction will be conducted in accordance with the general approach and methodologies that are outlined in the Basewide Radiological Management Plan (DCN: EMAC-8823-0003-0104) and associated Standard Operating Procedures (SOPs). The survey activities will comply with the requirements of the Accident Prevention Plan/Site Safety and Health Plan

(DCN: ECSD-4808-0003-0004). If elevated levels of radioactivity are identified during the performance of the work, temporary suspension of activities in the affected area will be required followed by immediate notification of the site Radiation Safety Officer Representative (RSOR). No site-specific air monitoring is required as the material and equipment being handled will not result in airborne concentrations exceeding 10 percent of the limits established in Table 1, column 3 of Appendix B of 10 CFR §§20.1001 – 20.2401.

Incoming equipment and materials will be surveyed for radioactivity prior to being placed into service within the jobsite. All alpha, beta, and gamma surveys will be conducted in accordance with SOP-001, Radiation and Contamination Surveys. The radiological surveys will be performed using a Ludlum Model 2350-1 data logger and 44-10 2" by 2" NaI detector, as well as a Ludlum Model 2360 Model data logger and a 43-68/43-89/43-93 detector, or equivalent or superior radiation instrument system.

A radiological control technician (RCT) will be present whenever potentially contaminated equipment or materials will be brought on board a vessel. The RCT will conduct radiological surveys as needed on the surfaces of any equipment or clothing which have come in contact with potentially contaminated sediment. Anchors, spuds, or other gear that contacted the sediment will require an M&E free release survey prior to the vessel leaving Parcel F. If the radiation surface concentrations exceeds the limiting Table 1 surface levels, work will be suspended temporarily and the RSOR will be notified immediately. The RSOR, in conjunction with the TtEC Radiation Safety Officer (RSO) and the Radiological Affairs Support Office (RASO) representative, will make a determination as to whether to resume work, and if implementation of additional radiological controls is warranted.

TABLE 1
RELEASE CRITERIA

Radionuclide	Radiation	Half-life (years)	Surfaces[a] (dpm/100 cm^2)		Water	Soil (pCi/g)
			Loose	Total	(pCi/L)	
Cesium-137	Beta, gamma	30.1	1,000	5,000	119	0.113[b]
Plutonium-239	Alpha, gamma	24,100	20	100	15	2.59
Radium-226	Alpha, gamma	1,599	20	100	5	1.0[c]
Strontium-90	Beta	28.78	200	1,000	8	0.331[d]
Uranium-235	Alpha, gamma	7E8	1,000	5,000	30 µg/L[e]	0.195

Notes:

[a] These limits are based on AEC *Regulatory Guide 1.86*. Limits for removable surface activity are 20 percent of these values.

[b] Limit adopted from the *Final Basewide Radiological Removal Action Memorandum – Revision 2006*.

[c] Limit is 1 picocurie per gram (pCi/g) above background per agreement with U.S. Environmental Protection Agency.

[d] State of California residential value for non-radiological landfill disposal.

[e] Limit based on EPA drinking water standards.

Radiological Work Instruction for the CH2M Hill Parcel F Pilot Study

Background

CH2M Hill personnel are performing a Pilot Study within Parcel F at the former Hunters Point Naval Shipyard (HPNS) in San Francisco, California. All Parcel F underwater areas are designated as radiologically-impacted and it is possible that the sediment may contain concentrations of radionuclides that are elevated in comparison to undisturbed background locations at the former Hunters Point Navy Station (HPNS). Therefore, the following information applies to Parcel F as identified in the Historical Radiological Assessment, Volume II (NAVSEA 2004). Radionuclides of concern which could be encountered at concentrations exceeding background during this work include radium-226 (^{226}Ra), cesium-137 (^{137}Cs), uranium-235, plutonium-239 (^{239}Pu), and strontium-90 (^{90}Sr). As a result, basic radiation survey protocols will be implemented during planned work activities bringing equipment and/or personnel in contact with potentially contaminated sediment within Parcel F.

The CH2M Hill pilot study involves the operation of watercraft along the Parcel F shoreline in order to collect samples, deploy monitoring equipment, and place a carbon amendment on the bay floor. The work is described in detail in Attachment 1, *Summary of Construction and Sampling Techniques for the Demonstration of Activated Carbon Amendments at Hunters Point Naval Shipyard, San Francisco, California.*

Activities planned to be performed by CH2M Hill personnel inside the radiologically-impacted areas as described in Attachment 1 include the following.

- Sediment and filter feeder sample collection in 20 cm long metal tubes
- Deployment and retrieval of hydrodynamic monitoring equipment near the test pilot area
- Carbon amendment placement
- Post application monitoring immediately following the initial placement of activated carbon and 6-, 12-, and 18 months post-placement

Tetra Tech EC, Inc. (TtEC) is to provide basic radiation protection protocols when CH2M Hill requires access to radiologically-impacted areas referenced above by:

- Providing a radiation safety brief to field staff assigned to the project
- Providing project field staff with dosimetry
- Performing incoming equipment and material surveys.
- Providing surveillance during activities in which personnel come in contact with potentially contaminated sediment, including the retrieval of potentially contaminated equipment
- Performing radiological surveys <u>of dry equipment and materials</u> prior to decontamination of equipment and materials.
- Performing radiological surveys <u>on dry sampling containers</u> prior to being shipped for non-radiological characterization.
- Performing radiological release surveys <u>on dry equipment and material, including</u>

temporary probe materials used for sampling purposes that are leaving the Parcel F radiological control area (RCA)

Revised Work Instructions

CH2M Hill had to revise their Pilot Study. The revision resulted in the need to release seven 1-gallon containers of sediment collected from Parcel F from CH2M Hill to Pacific Eco Laboratory. This revision requires changes in the TtEC basic radiation protection protocols listed above by performing additional surveys. These surveys are necessary because the radiation emitted from potential radiological contaminants of concern (^{226}Ra, ^{235}U, ^{239}Pu, and ^{90}Sr) may be absorbed by the sediment and container walls. The original survey methods are not designed to detect the potential RCOC at concentrations exceeding background.

A free release survey of the containers is conducted in accordance with the requirements established in TtEC SOP-003 *Release of Material and Equipment from Radiologically Controlled Areas*. The free release surveys include radiation exposure rate, total alpha/beta surface contamination, removable alpha/beta surface contamination, and field gamma spectra. In addition, the exposure rate, alpha/beta surface concentration, and a field gamma spectra will be measured on a composite sample from the containers.

The survey activities performed under this work instruction will be conducted in accordance with the general approach and methodologies that are outlined in the HPNS Basewide Radiological Management Plan (DCN: EMAC-8823-0003-0104) and associated Standard Operating Procedures (SOPs).

Because uncontained potentially radioactive contaminated sediment is being handled a Radiation Work Permit (RWP) will be needed for preparing and surveying the uncontained sediment. The RWP will be prepared, reviewed, approved, and used in accordance with TtEC SOP-010 *Issue and Use of Radiation Work Permits*.

1. The exposure rate at one foot and near contact for each container will be measured using a Ludlum Model-19, Bicron MicroREM, or equivalent meter. A background exposure rate should be established prior to performing the container exposure rates. The background and container exposure rates shall be conducted in accordance with Section 5.2.1 of TtEC SOP-001 *Radiation and Contamination Surveys*. If the exposure rate of a container exceeds twice background the container cannot be released for unrestricted use and will be relinquished to CH2M Hill.
2. All accessible surfaces of each container will be surveyed for total alpha/beta surface contamination using a Ludlum Model-2360 ratemeter/scaler/data logger with a 43-68 gas flow proportional detector or 43-89 scintillation detector, or equivalent in accordance with Section 5.2.3 of TtEC SOP-001. If the alpha or beta total surface concentration on a container exceeds the levels listed in Table 4-1 of TtEC SOP-001, 100 dpm/100 cm^2 alpha or 1,000 dpm/100 cm^2 beta, a static measurement will be performed to confirm the scan survey results. If the static survey measurement confirms that the total surface contamination exceeds the aforementioned limits the container may not be released for unrestricted use. The container will be evaluated for decontamination in accordance with TtEC SOP-007, *Decontamination of Equipment and Tools*, or relinquished to CH2M Hill. If the TtEC HPNS

Radiation Safety Officer Representative (RSOR), or his designee, determines that decontamination is feasible, the decontamination is conducted in compliance with the precautions, limitations, preparations, and performance of Section 5.0 of SOP-007. If a post decontamination survey results in total alpha/beta surface concentration less than the Table 4-1 limits the container may be released for unrestricted use. Otherwise the container will be relinquished to CH2M Hill.

3. Removable surface contamination survey will be conducted in accordance with Section 5.2.2 of TtEC SOP-001. Ensure the outside of the containers is not wet prior to collecting swipes. Swipes collected for removable surface contamination shall be analyzed in accordance with Section 5.2.2.3 of TtEC SOP-001 using a Ludlum Model 2929 scaler with a Model 43-10-1 ZnS(Ag) scintillation probe (or equivalent) or Protean Alpha/Beta Gas Flow Proportional Counter (or equivalent). If the alpha or beta removable surface concentration on a container exceeds the levels listed in Table 4-1of TtEC SOP-001, 20 dpm/100 cm^2 alpha or 200 dpm/100 cm^2 beta, the container cannot be released for unrestricted use. The container will be evaluated for decontamination in accordance with TtEC SOP-007 or relinquished to CH2M Hill. If the TtEC HPNS RSOR, or his designee, determines that decontamination is feasible, the decontamination is conducted in compliance with the precautions, limitations, preparations, and performance of Section 5.0 of SOP-007. If a post decontamination survey results in alpha/beta removable surface concentrations less than the Table 4-1 limits the container may be released for unrestricted use. Otherwise the container will be relinquished to CH2M Hill.

4. The Berkeley Nucleonics Corporation (BNC) SAM-940-3G (SAM) radioisotope identifier connected to a Model 6998, 3-inch by 3-inch sodium iodide scintillation detector is used to acquire a gamma spectra from each individual container and to acquire a gamma spectra of all containers grouped together. The SAM shall be operated in accordance with TtEC SOP-015 *Use of the Berkeley Nucleonics Corporation SAM-940-3G Radioisotope Identifier*. If the only gamma emitting radionuclides identified are categorized as NORM the container may be released for unrestricted use. Otherwise the container will be relinquished to CH2M Hill.

5. A composite sample from the containers is prepared and receives an exposure rate measurement, total alpha/beta surface survey, and a gamma spectra measurement. The survey processes are described in steps #6 through #9.

6. The composite sample consists of three subsamples from each container. A sub-sample should be collected from near the top, middle, and bottom of each container. If sub-sampling from the top, middle, and bottom is not practical then carefully stir the container prior to collecting each subsamples should be placed in a large container with a bottom surface area ≥ 2,580 cm^2 (400 square inches [$in.^2$]). The RWP defines the PPE to be worn by worker preparing and surveying the uncontained sediment. Care should be taken to ensure no cross contamination of personnel, material, and equipment occurs during the preparation and surveys of the uncontained sediment.

7. First, acquire an exposure rate at 30 cm (1-foot) from the surface and at the near surface of the composite sample using a Ludlum Model-19, Bicron MicroREM, or equivalent meter. If the exposure rate exceeds twice background at 30 cm or the near surface the containerized sediment cannot be released for unrestricted use and is relinquished to CH2M Hill. If the exposure rate does not exceed twice background go to step #8.

8. Acquire a gamma spectra of the composite sample using the SAM-940-3G in accordance with SOP-015. If a RCOC is identified the containerized sediment cannot be released for unrestricted use and is relinquished to CH2M Hill. If no gamma emitter is identified or the only gamma emitting radionuclides identified are NORM go to step #10.

9. Survey the surface of the composite sample for total surface activity using a Ludlum Model-2360 ratemeter/scaler/data logger with a 43-68 gas flow proportional detector or 43-89 scintillation detector, or equivalent in accordance with Section 5.2.3 of TtEC SOP-001. If the maximum alpha surface measurement exceeds 600 dpm/100cm^2 or the maximum beta surface measurement exceeds 6,000 dpm/100 cm^2 verify the surface concentration with a static survey measurement (ANSI/HPS, 2013). If a static survey measurement exceeds the aforementioned limits the contained sediments cannot be unconditionally released and the sediment is relinquished to CH2M Hill. If the alpha/beta measurements criteria are not exceeded then slowly and carefully stir the composite sample with a small spatula or equivalent tool and repeat the alpha/beta surface survey four more times. If during the five surface surveys the maximum alpha surface measurement does not exceed 600 dpm/100cm^2 and the maximum beta surface measurement does not exceed 6,000 dpm/100 cm^2 the sediment may be released for unrestricted use (ANSI/HPS, 2013). When the surface scans are completed carefully transfer the composite sample back into the containers.

10. If the TtEC HPNS RSOR, or their designee, determines the results of scan, swipe, static, exposure rate, and gamma spectra survey measurements meet their respective unrestricted release criteria then the containerized sediment may be released for unrestricted use. Otherwise relinquish the sediment to CH2M Hill.

11. Results of the scan, swipe, static, and exposure rate surveys are documented in accordance with Attachments 1 and 2 of TtEC SOP-001. The gamma spectra measurements are documented in accordance with Attachment 1 of SOP-015.

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Zachary Edwards, Radiological Affairs Support Office

References

American National Standards Institute and Health Physics Society (ANSI/HPS), 2013. *Surface and Volume Radioactivity Standards for Clearance*. ANSI/HPS N13.12-2013, Health Physics Society. McLean, VA

TtEC, 2014. *Basewide Radiological Management Plan* (DCN: EMAC-8823-0003-0104)

TtEC, 2015. *Radiation and Contamination Surveys*. SOP-001

TtEC, 2015. *Release of Material and Equipment from Radiologically Controlled Areas*. SOP-003

TtEC, 2015. *Decontamination of Equipment and Tools*, SOP-007.

TtEC, 2015. *Issue and Use of Radiation Work Permits*, SOP-010

TtEC, 2015 *Use of the Berkeley Nucleonics Corporation SAM-940-3G Radioisotope Identifier*. SOP-015.

TABLE 4-1

RELEASE LIMITS FOR MATERIALS AND EQUIPMENT

Radiation Type	Release Limits[1] (Total) (dpm per 100 cm^2)	Release Limits[1] (Removable) (dpm per 100 cm^2)
Alpha (α) Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	20
Beta (β-) Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	200
Beta-Gamma (β-γ) Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	1,000

Notes:

[1] These limits are based on AEC Regulatory Guide 1.86 (AEC 1974)

Abbreviations and Acronyms:

AEC – Atomic Energy Commission

cm^2 – square centimeters

dpm – disintegrations per minute

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