Sediment Remedy Design Investigation Work Plan
Middle River Complex
2323 Eastern Boulevard
Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ANS	Applied NanoStructured Solutions, LLC
ASTM	ASTM International, Inc.
AVS	acid-volatile sulfides
bgs	below ground surface
Cd	cadmium
COC	chemicals of concern
COPC	chemicals of potential concern
Cr	chromium
Cu	copper
EESH	Energy, Environment, Safety, and Health (Lockheed Martin Corporation)
EGIS	electronic geographic information system
EROP	Enterprise Operation
FCV	final chronic value
FS	feasibility study
GAC	granular activated carbon
GC	gas chromatography
GPS	global positioning system
HASL	Health and Safety Laboratory
HASP	health and safety plan
Hg	Mercury
IDW	investigation derived waste
LMCPI	LMC Properties, Inc.
Lockheed Martin	Lockheed Martin Corporation
MDE	Maryland Department of the Environment
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MRAS	Middle River Aircraft Systems
MRC	Middle River Complex

MSA	Martin State Airport
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PAC	powdered activated carbon
PAHs	polycyclic aromatic hydrocarbons
PARCC	precision, accuracy, representativeness, comparability, and completeness
Pb	lead
PCBs	polychlorinated biphenyls
PDF	portable file document
PM	project manager
PPE	personal protective equipment
PPW	passive pore water
PRGs	preliminary remediation goals
QA	quality assurance
QC	quality control
RD	remedial design
REC	recognized environmental condition
SEM	simultaneously extracted metals
SIM	selective ion monitoring
SOP	standard operating procedures
Tetra Tech	Tetra Tech, Inc.
Th	Thorium
TOC	total organic carbon
U	Uranium
UMBC	University of Maryland Baltimore County
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
Zn	Zinc

Section 1
Introduction

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. has prepared this work plan to further characterize sediments of the waterways adjacent to the Middle River Complex (MRC) at 2323 Eastern Boulevard in Middle River, Maryland (see Figure 1-1). The objective of this proposed sampling program is to provide additional data to further characterize sediment stratigraphy, contaminant distribution, bioavailability, treatability, and radiological properties in support of the feasibility study (FS) and a remedial design (RD) for sediment adjacent to the Middle River Complex site. Furthermore, the collected data will assist in the evaluation of bio-toxicity and treatability to evaluate/support rationale for not removing all sediment impacted with elevated levels of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), cadmium (Cd), and other metals.

Work performed under this investigation will supplement and enhance existing sediment data collected during the 2005, 2008, 2010, and 2012 sediment investigations for Cow Pen Creek and Dark Head Cove. The objectives will be met by collecting and measuring an array of chemical and environmental parameters, and conducting bench-scale testing of sediment samples. This work plan is organized as follows:

Section 2 – Site Background: Briefly describes the site history and previous investigations

Section 3 – Investigation Approach and Methodology: Presents the technical approach to the investigation and describes the field methodology for sampling and chemical analyses

Section 4 – Bench-Scale Treatability Testing: Summarizes the objectives, methodology, and technical approach for conducting bench-scale treatability tests for creek bottom sediments

Section 5 – Project Deliverables: Describes the reporting that will summarize the findings of the investigation program and bench-scale testing

Section 6 – References: Cites references used in compiling this planning document

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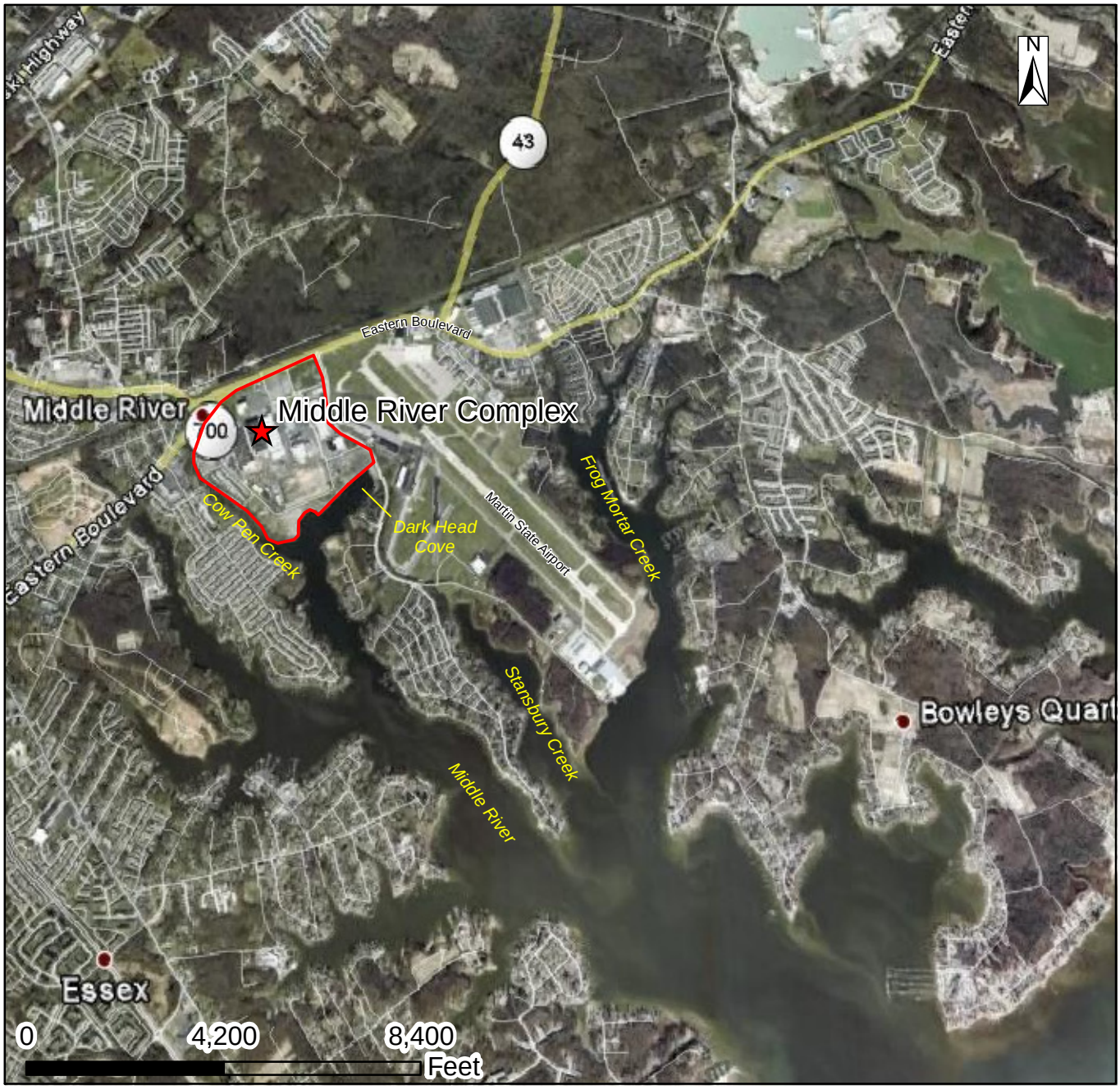

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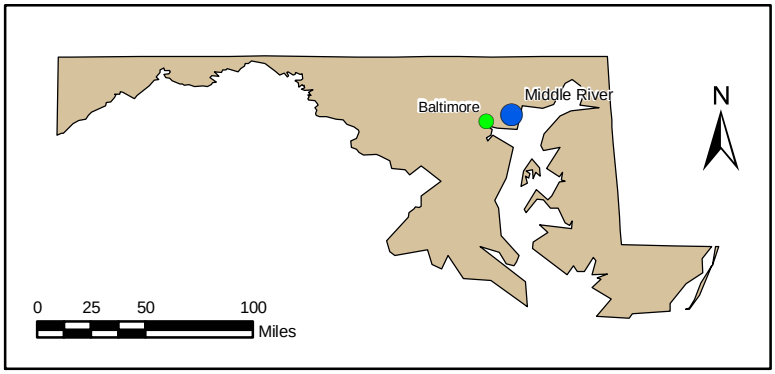

FIGURE 1-1

MIDDLE RIVER COMPLEX LOCATION MAP

Lockheed Martin Middle River Complex
Middle River, Maryland

DATE MODIFIED:	CREATED BY:
4/28/11	MP

TETRA TECH

Section 2
Site Background

2.1 SITE DESCRIPTION

The Lockheed Martin Corporation (Lockheed Martin) Middle River Complex (MRC) is located at 2323 Eastern Boulevard in Middle River, Maryland. A facility layout map is provided as Figure 2-1. The site is comprised of approximately 180 acres with 12 main buildings. The property includes an active industrial area and yard, perimeter parking lots, an athletic field, a vacant concrete covered lot, a trailer and parts storage lot, and numerous grassy areas along the facility perimeter. Locked chain-link fences surround all exterior lots and the main industrial area. The site is bounded by Eastern Boulevard (Route 150) to the north, Dark Head Cove to the south, Cow Pen Creek to the west, and Martin State Airport (MSA) to the east.

MRC is owned by LMC Properties, Inc., (LMCPI) a subsidiary of Lockheed Martin. LMCPI activities at the site are limited to facility and building management and maintenance. Two main tenants occupy the site: MRA Systems, Inc., (MRAS), a subsidiary of General Electric Company, and the Mission Systems & Training (MST) business area of Lockheed Martin. MRAS designs, manufactures, fabricates, tests, overhauls, repairs, and maintains aeronautical structures, parts, and components for military and commercial applications. MST fabricates, assembles, tests, and otherwise supports vertical-launch systems. Historically, the property has been used for aircraft and missile-launching-systems design, development, and sales. Applied NanoStructured Solutions, LLC (ANS), a Lockheed Martin company, occupies a smaller portion of the site than the other tenants. ANS is involved in the development and commercialization of nanotechnology.

2.1.1 Physical Setting

2.1.1.1 Land Use

The MRC is an industrial facility within the broader Chesapeake Industrial Park. The area surrounding the property primarily consists of commercial, industrial, and residential establishments. Six other facilities, comprising the remainder of the Chesapeake Industrial Park,

lie adjacent to the Lockheed Martin MRC. These include Tilley Chemical Company, Inc. (a distributor of food- and pharmaceutical-chemicals for the personal care and other industries), North American Electric (an industrial and commercial electrical-contractor), Johnson and Towers (a heavy-duty diesel equipment, truck, and boat repair and maintenance company), Poly-Seal Corp. (a producer of flexible packaging for various items), Exxon (a gasoline filling-station and convenience store), and the Middle River Post Office. Residential developments lie north of Eastern Boulevard (Route 150), and on the opposite shores of Cow Pen Creek, Dark Head Cove, and Dark Head Creek. (Dark Head Creek is not shown in the figures but flows from Dark Head Cove to Middle River, which is a tributary to Chesapeake Bay.)

2.1.1.2 Physiography

The site lies within the Western Shore of the Coastal Plain Physiographic Province. The Coastal Plain topography is generally characterized by low relief. The topography of the MRC is gently sloping, ranging from sea level to approximately 32-feet above mean sea level (Cassell, 1977). The topography slopes from Eastern Boulevard to the southwest and south, towards Cow Pen Creek and Dark Head Cove.

2.1.1.3 Hydrology

The Lockheed Martin MRC lies at the junction of Cow Pen Creek and Dark Head Cove (Figure 2-1). Both are tidal surface water bodies that feed into Dark Head Creek, a tributary to Middle River, which is a tributary to Chesapeake Bay. The facility lies approximately 3.2 miles upstream of Chesapeake Bay. No surface water bodies lie within or cross the Lockheed Martin MRC.

Excluding areas immediately adjacent to Cow Pen Creek and Dark Head Creek, surface water runoff discharges from the facility via storm drains, soil infiltration, and evaporation. Nine stormwater drainage systems at the facility discharge to Cow Pen Creek and Dark Head Cove; these drainage systems were mapped by TAI Consulting Engineers in 2001 (see Figure 2-2). Other outfalls may have been used historically but are no longer in service. Stormwater runoff from the Chesapeake Industrial Park and a portion of the Martin State Airport (across Wilson Point Road), as well as from some of the area along Eastern Avenue, is collected through a stormwater-conveyance system and discharged to Cow Pen Creek and Dark Head Cove.

Lockheed Martin MRC maintains a State of Maryland National Pollutant Discharge Elimination System (NPDES) permit (State discharge permit No.: 00-DP-0298, NPDES permit No.: MD0002852) issued by Maryland Department of the Environment (MDE) Industrial Discharge Permits Division, Water Management Administration (Earth Tech, 2003). MRAS generates sanitary wastewater and process wastewater. The facility pre-treats and discharges its wastewater under an Industrial User Discharge Permit (permit No.: WWDP#1390), issued to MRAS by the Baltimore County Department of Public Works, Bureau of Utilities (Earth Tech, 2003). The permit authorizes the facility to discharge its processed and sanitary wastewater from seven permitted discharge points (i.e., outfalls).

2.1.2 Subsurface Conditions

2.1.2.1 Soils

Soils underlying the Lockheed Martin MRC have been mapped as Mattapex-Urban Land Complex and Sassafras-Urban Land Complex by the United States Department of Agriculture (USDA) Soil Conservation Service. Mattapex-Urban Land soils consist of deep, well-drained, silty soils, the original texture of which has been disturbed, graded over, or otherwise altered before construction. Sassafras-Urban Land soils consist of deep, well-drained, sandy soils, the original texture of which has been disturbed, graded over, or otherwise altered before construction (USDA, 1993). MRC site-assessment activities, however, indicate that a high percentage of these soils contain a very high clay and silt content, with poor surface drainage.

2.1.2.2 Geology

Geologic maps of Baltimore County show that the Lockheed Martin MRC is underlain by the Potomac Group, a Cretaceous-age interbedded gravel, sand, silt, and clay unit ranging in thickness from 0–800 feet. In the Baltimore area, the Potomac Group is comprised of the Patapsco Formation, the Arundel Formation, and the Patuxent Formation (Chapelle, 1985; Vroblesky and Fleck, 1991).

The Patapsco Formation ranges up to 400 feet thick and is composed of a gray, brown, and red variegated silt and clay unit with lenticular lenses of sand and few gravels. The Arundel Clay Formation is composed of dark gray and maroon lignitic-clays ranging from 25–200 feet thick.

The Patuxent Formation is described as a white or light-gray to orange-brown, moderately sorted sand unit with quartz gravels, silts, and clays ranging up to 250-feet thick (Reinhardt, 1977).

The entire survey area is mapped as clay or sand facies of the Patapsco Formation (Reinhart, 1977). Sands are more concentrated on the peninsulas east of Martin State Airport and in areas north of Eastern Boulevard; all peninsulas (except for the Wilson Point Road area) west of the airport are mapped as clay facies. Arundel Clay is mapped as outcropping northwest of the MRC facility (Reinhardt, 1977).

Lithologic logging of soils beneath the MRC (conducted during extensive site-characterization activities) identifies a very heterogeneous substrate. Underlying soils are composed primarily of silty sands, fine-grained to medium-grained sands, silty clays, clayey silts, and plastic clay, with the primary lithology being clay to silty clay. Sand lenses are encountered but do not appear to be continuous beneath the facility. Shallow groundwater tends to flow in the more sandy lenses toward the surface-water bodies, and the water table is generally a subdued representation of the surface topography.

2.2 PREVIOUS SEDIMENT INVESTIGATIONS

Various MRC site investigations have identified surface water and sediment contamination resulting from historical land filling and plant activities. Surface water and sediment impacts include elevated concentrations of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals. Three sampling investigations were performed between 2005 and 2008: in March and October 2005, and in November 2008. Seven surface water samples and 12 sediment samples were collected in March 2005, and 10 surface water samples and 50 sediment samples were collected in October 2005. In November 2008, 146 sediment samples from four depth intervals were collected. Sampled depth intervals were from zero to six inches below ground surface (bgs), six to 18 inches bgs, 18 to 30 inches bgs, and 30 to 54 inches bgs. Samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compound, PCBs, and priority pollutant metals.

Sediment sampling results indicated potentially unacceptable risks to local fauna, including benthic invertebrates, fish, and piscivorous (fish–eating) birds. Risk drivers included PCBs and, to a lesser extent, PAHs, present in the top 30 inches (i.e., within the top three depth intervals

mentioned previously) of the sediment bed. Specifically, PCBs and PAHs were identified in shallow sediments near the bulkhead; however, only PAHs were identified near MSA. In addition, cadmium (Cd) and chromium (Cr), metals potentially toxic to benthic macroinvertebrates were found in sediment at deeper intervals. Both metals have also been identified in Cow Pen Creek and Dark Head Cove sediments.

Because available data were insufficient to meet project objectives, an additional sediment investigation was performed in 2010 (Tetra Tech, 2011) that focused on areas previously not sampled. Sediment samples were collected from 24 site locations, and from three locations that were located away from possible MRC influences, in order to determine background conditions reflecting an urbanized coastal area. Sediment samples were collected from zero to six, six to 18, 18 to 30, and 30 to 52 inches below the surface water/sediment interface. Sediment samples were analyzed for PAHs, PCBs, and metals. Several samples were also analyzed for acid–volatile sulfides (AVS)/simultaneously extracted metals (SEM).

PAHs were detected at concentrations ranging from 1.2 micrograms per kilogram (µg/kg) to 457,300 µg/kg. The highest concentrations of total PAHs were found in samples collected along the shoreline of MRC and in Dark Head Cove. The highest PAH concentrations in surface sediments were detected in samples from the eastern portion of Dark Head Cove (near MSA) and from the middle of the cove adjacent to the MRC property. PAH concentrations tended to be higher in the middle two depth intervals (six to 18 inches and 18 to 30 inches) than in surface sediment. However, sediment samples collected from the upper reaches of Cow Pen Creek had elevated PAH concentrations from the surface to 30-inches in depth. PAH exceedances were also detected in a few samples collected from the middle two intervals near Outfall 09. Overall, PAH results were consistent with previous findings.

Detected concentrations of total Aroclors (PCBs) range from 11 µg/kg to 54,000 µg/kg. Total Aroclor concentrations were highest in surface sediments and decreased with increasing depth. Surface sediment PCB concentrations were highest in the middle of Dark Head Cove and adjacent to the shoreline of the MRC complex. The areas with the most elevated concentrations were well bounded by other samples. These findings were similar to the conclusions of the previous investigation.

Several metals were detected in sediment at concentrations in excess of screening values. Metals of particular interest included Cd, Cr, copper (Cu), lead (Pb), mercury (Hg), and zinc (Zn). Cd and Cr generally had the highest concentrations (with respect to their sediment guidelines) as compared to the other metals. The highest metals concentrations in Dark Head Cove were generally found in sample intervals between six to 18 inches and 18 to 30 inches, which indicate that sediments with higher concentrations are being buried by cleaner sediments. Some exceptions were observed in Cow Pen Creek, which was expected, because the deposition rate (as estimated from the age-dating analysis) is probably lower in the creek, and the scour there appears to be greater than in the cove.

Various samples were collected and analyses performed to evaluate whether the chemicals in the sediment might be bioavailable to ecological receptors, including comparison of sediment AVS/SEM, sediment pore water chemistry analyses, and a benthic macroinvertebrate community study. Sediment samples from seven locations were collected from each depth interval and analyzed for AVS/SEM. Metals included in the SEM analysis were Cd, Cr, Cu, Pb, nickel, silver, and Zn. In general, AVS concentrations were higher than SEM in most samples, indicating that the SEM metals are not expected to be bioavailable or directly toxic to benthic invertebrates.

One sample in the shallowest depth interval, and two in the 18-to-30 inch depth interval, had AVS/SEM ratios within a range the United States Environmental Protection Agency (USEPA) considers “uncertain” for potential toxicity to benthic invertebrates (USEPA, 2005). These were the only sampled locations where a potential for toxicity was indicated throughout the vertical sediment column. Note that the AVS/SEM samples do not correspond to samples with the highest sediment concentrations of these metals.

Sediment pore water was extracted (via centrifugation) at the laboratory from core depths corresponding to the top three intervals sampled for sediments (depths of zero to six inches, six to 18 inches, and 18 to 30 inches) to determine the equilibrium concentrations of chemicals of potential concern (COPC) in pore water (both horizontally and vertically) near the MRC. Pore water concentrations of various metals (arsenic, Cd, and selenium) and PAHs exceed surface water ecological-screening values at all three intervals in one or more samples. Pore water concentrations of Pb exceed surface water ecological screening values in one interval. Aroclor-1260 (PCB) concentrations exceed surface water ecological screening values in all pore

water samples in which it was detected. Aroclor-1260 was reported as not detected in the 18 to 30 inch interval; however, the detection limit for Aroclor-1260 in that depth's sample(s) was higher than its screening level. Although this may introduce uncertainty, biological activity is typically minimal below depths of 18 inches in sediment environments such as those found at the MRC.

Benthic macroinvertebrate samples were collected to evaluate the status of benthic communities residing in sediment at the site. Benthic invertebrate samples were also collected from two background/reference locations (i.e., locations hydraulically remote from the MRC) and used for comparison to site samples. One reference site (Marshy Point), representing the most (comparatively) pristine local-area environmental conditions, had relatively good benthic conditions. The other two local reference sites (Bowleys Quarters, and a remote downstream reference site in Middle River) both showed some indications of conditions stressful for benthic macroinvertebrates, even in locations remote from the MRC. Some indications of stress to benthic organisms were found at all sites local to the MRC. However, some sites local to the MRC have a higher density of benthic organisms than the reference sites.

Fish samples were collected from five site locations and three reference locations to measure chemical concentrations in their tissue. The site–associated fish collection locations included one in Cow Pen Creek, two in Dark Head Cove, and two at the confluence of the two water bodies. To compare these locations with similar environments in the Middle River area, samples of the same fish species were also collected from reference areas at Marshy Point, Bowleys Quarters, and Middle River.

Concentrations of detected chemicals in fish tissue samples collected in the immediate vicinity of the MRC study area were similar to reference or regional concentrations. Average total PCB concentrations in channel catfish (the species most frequently collected in this study) were less than average concentrations reported for regional samples collected from the Back River and Middle River (which most likely represent the region from which the site data were collected). Metals concentrations in channel catfish from the site were generally similar to reference concentrations, based on a comparison of site versus reference area average concentrations. The PCB concentrations detected in fish tissue did not appear to correlate with the lipid content and size of fish collected at a given location (i.e., from the site, from reference locations, and compiled from

regional data). Several metals detected in sediment were not detected in fish tissue, including cadmium, which had elevated concentrations in sediment samples collected from the site.

The conclusions of the 2010 investigation (Tetra Tech, 2011) indicated that sediments adjacent to the MRC pose potential risks to human health and the environment that warrant action, and that additional data were needed to support the feasibility study (FS), including the following:

- additional geotechnical data to provide for FS evaluations and, eventually, remedial design
- additional data to evaluate treatment requirements for sediment dewatering elutriate
- bulk sediment for potential bench-scale treatability studies

Additional sediment investigation completed in 2012 included collecting geotechnical, column settling, sediment dewatering elutriate, and dredge elutriate data to support proposed remediation and treatment alternatives (e.g. capping, removal, *in situ* treatment, enhanced natural recovery) to be evaluated as part of the FS (Tetra Tech 2012a).

Visual classification of MRC sediment cores and laboratory tests on selected 2012 sediment-core samples indicate that the top three to five feet typically consist of elastic silt underlain by fat clay intermixed with lean clay, sandy lean clay, and sandy elastic silt. The field and laboratory shear strength and consolidation test results indicate that the top 10 feet are considered very soft to soft and prone to consolidation under typical loading such as capping (Tetra Tech, 2012a).

A column settling test defines the anticipated settling behavior of sediments that may be dredged, and predicts the distance that suspended solids may travel. The column settling test results from Cow Pen Creek samples demonstrate faster zone-settling during the first few hours of the test as compared to the Dark Head Cove test results, probably due to the sand content of the Cow Pen Creek sediments. Dewatering elutriate tests and a dredge elutriate test were conducted to identify potential treatment requirements for dewatering (ensuring that elutriates meet ambient water quality criteria before discharge), and to evaluate parameters that will affect potential dredging design. Data suggest that Aroclor-1260 was the only PCB released into elutriate generated during the dewatering elutriate test, at a concentration of 0.3 micrograms per liter (µg/L). Filtration with a five-micrometer filter reduced the concentration of Aroclor-1260 to below detection limits (0.2 µg/L). No PCBs were released to the water column during the dredge elutriate tests, but limited concentrations of PAHs (i.e., fluoranthene,

pyrene) and metals were released. The metals and PAHs detected in unfiltered samples appear to have been removed to below ambient water quality criteria effluent limitations after filtration through a 0.45-micrometer filter (Tetra Tech, 2012a).

2.3 RADIOLOGICAL HISTORY AND PREVIOUS RADIOLOGICAL INVESTIGATIONS

2.3.1 Radiological History

Aircraft equipment fabrication and testing for the United States government and commercial clients have comprised the primary operating history at MRC since 1929. Former Building D, located on Tax Block E north of Dark Head Cove (Figure 2-2), is the only area of the MRC that has a documented use of radiological materials at the MRC (Tetra Tech, 2012b). Building D was built in the early 1940s for final assembly of aircraft frames, and was demolished in 1972. The building had an assembly floor (first floor), and a basement (current concrete slab), and occupied approximately 400,000 square feet. Currently, only the concrete basement floor of former Building D remains at Block E.

The former basement areas were used for welding, extrusion milling, engine preparation, and assembly. The northwestern and southwestern portions of the basement housed several offices and laboratories used for radiological research and operations. Cleaning, plating, and finishing work areas were located along the southern interior wall near the building's center. After the building was demolished, the concrete was used for storage, including the storage of airplane carcasses from the Martin State Airport air museum at the eastern end of the slab.

After aircraft production ended in Building D, research activities were performed in the western portions of the basement during the 1950's and 1960's. These activities included:

- research, development, fabrication and testing of fuel assemblies for nuclear reactors using varying enrichments of uranium–235 (U-235)
- fabrication of aircraft components, including thermo-electric generators known as Systems for Nuclear Auxiliary Power generators, using magnesium-thorium alloy (4% thorium as thorium 232 [Th-232])
- possession of sealed or plated sources, including a cobalt-60 source, thought to have been used for instrument quality checks and radiography operations

An Atomic Energy Commission license (AEC), SNM-1192, was issued in May 1970 for the decontamination of the Building D. Nuclear Regulatory Commission (NRC) records show that the pre-decontamination and post-decontamination surveys of the building were performed in 1970 to support the facility decontamination license application, making the building ready for demolition (Tetra Tech, 2012b,c). In 1970, approximately 36,500 cubic feet of radioactively contaminated equipment and wastes were removed from the facility and disposed of at an off-site disposal facility.

In 1982, the NRC reviewed the post-decontamination survey and concluded that the site met current (1982) NRC criteria for unrestricted use and that no site survey is necessary. The NRC report stated that no determination could be made on whether the drains containing residual U-235 activity were sealed with cement, but that this activity is unlikely to present a hazard because the building was demolished and the site covered with grass (Tetra Tech, 2012b). The understanding is that unrestricted use applies if the concrete basement floor remains in place.

In 1995, NRC and Maryland state personnel performed an inspection and activity survey of former Building D as part of closeout verification for the AEC. Gamma walkover surveys of the former Building D concrete pad were performed along parallel lines five meters apart; surface contact readings were taken at approximately 10 meter intervals, paying attention to drains, clean-outs, and holes in the pad. After the inspection and field survey were completed, the NRC concluded that the facility was suitable for unrestricted use and all licenses were terminated (Tetra Tech, 2012b).

2.3.2 Previous Radiological Investigations

Several investigations have been conducted since the 1995 NRC and state inspection to evaluate whether radiological activities conducted in Building D had affected environmental media (e.g., soil, sediment, etc.). The investigations included: a radiological survey (alpha, beta, and gamma radiations) of the former Building D foundation slab, soil sampling, and laboratory analyses (Tetra Tech, 2004); radiological screening of sediment removed from storm drains upstream of outfalls 005, 006, and 008 as part of an interim remedial measure in 2010 (Tetra Tech, 2012d); a records review of reasonably available AEC, NRC and Lockheed Martin documents (Tetra Tech, 2012b); work area exposure surveys, radiological field screening, and

laboratory radiological analyses of concrete and soil samples collected in the area of the former nuclear laboratory (Tetra Tech, 2012c).

The 2004 survey of the former Building D concrete slab (former basement) revealed no areas with activity readings significantly above background. However, three areas had gamma readings slightly above background that were unlikely to present an exposure risk for a full-time worker. Six soil samples were collected to evaluate these areas with elevated gamma activity; metal nuclides such as cesium-137 (0.145 picocuries per gram in one sample) and actinium-228 (concentrations of 0.95 and 1.02 picocuries per gram in two samples) were detected.

The 2012 survey and concrete/soil sampling results did not indicate radiological hazards (Tetra Tech, 2012c). Although the majority of concrete and soil samples contained at least one isotope that exceeded background concentrations, laboratory results for the concrete samples indicated that thorium and uranium isotope concentrations were less than USEPA preliminary remediation goals (PRGs). PRGs are risk-based concentrations that are considered by USEPA to be protective of human residential exposures over a lifetime. The concentrations of two uranium isotopes (uranium-234 and uranium-235) in three soil samples exceeded PRGs. These samples were collected in shallow soil (four feet or less), and are limited to two soil borings (E-SB-976 and E-SB-984) in the southwestern portion of former Building D, near the former nuclear laboratory and former waste disposal areas.

2.4 CURRENT INVESTIGATION

The previous sediment sample investigation results and Block E radiological soil results indicate that additional data are required to further characterize the distribution of COPCs in Cow Pen Creek sediment, and to determine if radiological constituents are present in sediment near Block E outfalls. Additionally, bench-scale treatability testing is needed to evaluate possible technologies for remediation of PAHs, PCBs, and metals in sediment. This work plan details the scope-of-work that will be performed to address these objectives.

Town of Middle River

Martin State Airport

AMTRAK RAILROAD

EASTERN BOULEVARD

MARTIN BLVD.

CHESAPEAKE PLAZA

WILSON POINT ROAD

DARK HEAD COVE ROAD

DARK HEAD COVE

COW PEN CREEK

BLOCK 'A'

BLOCK 'A'

BLOCK 'B'

BLOCK 'D'

BLOCK 'E'

BLOCK 'F'

BLOCK 'G'

BLOCK 'H'

BLOCK 'I'

ATHLETIC FIELD

PARKING LOT NO. 4

EXXON GAS STATION

PARKING LOT NO. 5

BUILDING "G"

POST OFFICE

ANNEX BUILDING

ENG. DEV. LAB BLDG.

PARKING LOT NO. 1

BUILDING "M"

BUILDING "P"

GATE "A"

BUILDING "L"

BUILDING "C"

BUILDING "B"

PROGRAM BUILDING

JOHNSON AND TOWERS

VERTICAL ASSEMBLY BUILDING

PARKING LOT NO. 2

MAINTENANCE OFFICE AND SHOP

BUILDING "A"

FIRECOAT BUILDING

FOUR #2 FUEL OIL USTs ABANDONED IN-PLACE

DROP HAMMER BUILDING ACTIVE FIRING RANGE

MAINTENANCE GARAGE

POWER HOUSE

DRUM STORAGE FACILITY

FLAME CUT

DIE STORAGE

HAZARDOUS WASTE STORAGE BUILDING

PARKING LOT NO. 6

PARKING LOT NO. 3

CONSERVATION BUILDING

500,000-GAL. WATER TANK

TRANSFER SHED

FORMER BUILDING "D"

FIRE PUMP BUILDING WITH 275-GAL DIESEL FUEL AST

FORMER 500-GAL. UST

FORMER 500,000-GAL. DIESEL FUEL AST

TILLEY CHEMICAL COMPANY

FORMER SEWAGE TREATMENT PLANT

NORTH AMERICAN ELECTRIC

WATERFRONT LOT

FORMER AERO PYHSICS LAB./WIND TUNNEL TEST BUILDING

FORMER HYDRAULIC AND FIELD TEST BUILDING

SEVEN 1,000-GAL. AVIATION FUEL USTs ABANDONED IN-PLACE

FORMER TRAINING SCHOOL

FORMER RAMP STORAGE BUILDING

FORMER BOAT HOUSE

FIGURE 2-1

MIDDLE RIVER COMPLEX
SITE LAYOUT AND TAX BLOCKS

LEGEND

MIDDLE RIVER COMPLEX TAX BLOCK BOUNDARY

STRUCTURE

RAILROAD TRACKS

Lockheed Martin Middle River Complex
Middle River, Maryland

0 150 300 600 Feet

N

DATE MODIFIED: 11/30/11

CREATED BY: MP

TETRA TECH

Map Document: (K:\GProject\middle_river\Maps\Tax Blocks_30Nov11.mxd)
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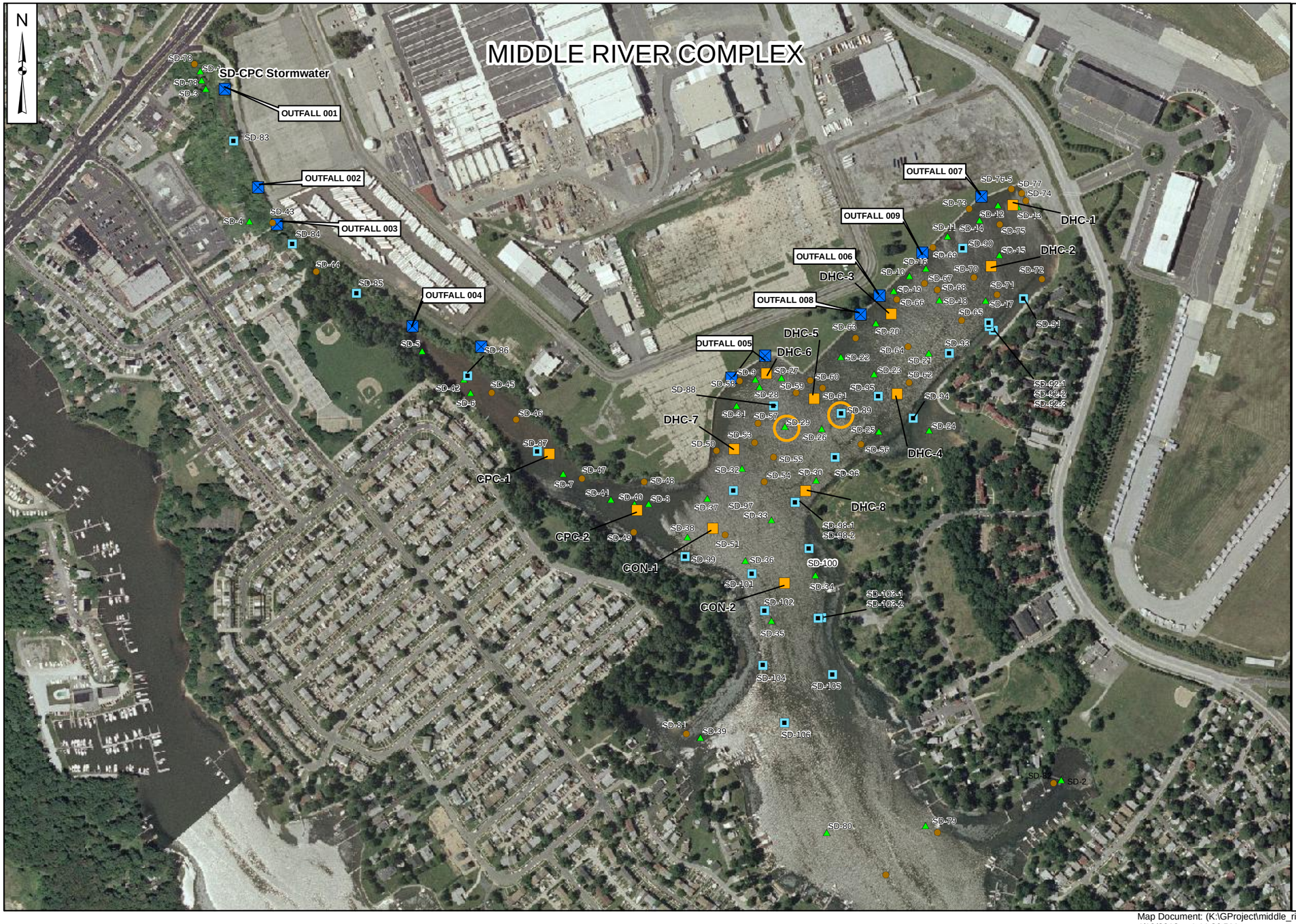

TETRA TECH

Figure 2-2
Historical Sediment Sample Locations
Lockheed Martin Middle River Complex
Middle River, Maryland

Legend

- Sediment Sample Locations- 2011
- Sediment Sample Locations- 2005
- Sediment Sample Locations- Nov 2008
- Delineation Sample - 2010
- Treatability Testing Sample Location- 2011
- Storm Drain Outfall

500 250 0 500
Feet

Drawn By: MP 04/19/13
Checked By:
Approved By:

Contract Number: 112IC02903

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Section 3
Investigation Approach and Methodology

Sediment samples will be collected from selected locations in Cow Pen Creek and Dark Head Cove to further characterize sediment stratigraphy, contaminant distribution, bioavailability, treatability, and radiological properties. The activities proposed for this investigation follow:

- mobilize/demobilize for sampling staff and equipment
- collect sediment samples from areas of Cow Pen Creek for bulk chemistry analyses
- collect sediment samples from areas of Dark Head Cove for radiological analyses and polychlorinated biphenyls (PCBs) analyses
- collect bulk sediment samples and a surface water sample from Dark Head Cove for bench-scale treatability tests to evaluate potential remedial technologies for sediment contaminants
- collect and chemically analyze sediment pore water concentrations using passive pore water samplers
- collect, store, and characterize investigation derived waste (IDW), and dispose of the waste at an off-site Lockheed Martin Corporation (Lockheed Martin)-approved treatment or disposal facility
- perform laboratory chemical analyses and chemical data validation on sediment samples
- evaluate environmental sampling data
- perform bench-scale treatability tests to evaluate the effectiveness of possible treatment technologies for remediation of contaminated sediment
- report results

3.1 MOBILIZATION/DEMOBILIZATION

Following approval of this work plan, the Tetra Tech, Inc. (Tetra Tech) field operations leader will coordinate mobilization activities, which include procuring the required subcontractors and

mobilizing personnel and materials to the field. Mobilization will also include locating the appropriate equipment required for the field tasks, purchasing and leasing necessary equipment as required, and staging equipment for efficient loading and transportation to the site. Mobilization is likely to begin in the summer 2013, and will include the following:

- coordinate with Lockheed Martin to obtain digging/excavation permits
- use Miss Utility and a private utility locating firm to locate and mark utilities
- mobilize subcontractors, equipment, and materials to the site
- implement the following:
    - site-specific health and safety plan (HASP)-Appendix A
    - emergency response plan
    - sampling and analysis plan
    - waste management plan conforming to Lockheed Martin's *Energy, Environment, Safety, and Health (EESH) Remediation Waste Management Procedure No: EROP-03, Revision 4* (effective April 17, 2009) [Lockheed Martin. 2009b] -Appendix B
    - quality assurance/quality control (QA/QC) plan
    - data management plan
- arrange a decontamination area

To meet project schedule requirements two mobilizations may be necessary: one to collect bulk sediment that will be used in treatability tests and to deploy the passive samplers; and a second to complete the remaining field activities. A barge with spuds (posts) is recommended to complete the sampling tasks. A barge will be less affected by wind and wake from other boats, and spuds will keep the barge on-station. Additionally, a barge will provide the platform and winch necessary to deploy the large Ponar grab samplers needed to collect bulk sediment samples.

Demobilization activities will include the following:

- demobilize equipment and materials from the site (at work completion)
- perform general site cleanup and removing trash (at work completion)
- perform surface restoration/landscaping repair as necessary (at work completion)

- manage IDW

Before beginning field operations and after obtaining excavation/digging permits, appropriate Tetra Tech personnel will review the site–specific HASP and the respective Safe Work permits included therein. Tetra Tech will conduct a daily mandatory health and safety tailgate meeting before all fieldwork. All Tetra Tech and subcontractor personnel will sign work permits as specified in the HASP. Subcontractors present for the day's field activities will be included in these meetings. The Tetra Tech field operations leader will document the topics covered, personnel in attendance, and conduct the safety audit, in accordance with the Lockheed Martin *Remediation Contractor EESH Handbook, Revision 1* (Lockheed Martin, 2009a). Safety requirements are addressed in detail in the site-specific Tetra Tech HASP included as Appendix A.

Field activities planned for the locations identified in this investigation will be coordinated with Lockheed Martin. Utility clearance work and documentation will conform to the provisions of Lockheed Martin's *Remediation Contractor's EESH Handbook* (Lockheed Martin, 2009a) or the latest update. All required utility clearance activities will be completed, including screening for and identifying possible subsurface utilities. Before beginning any intrusive field activities related to the investigation, Tetra Tech will obtain required clearances and permits, which include performing the following steps:

- notify the underground utility-location center Miss Utility (1-800-257-7777; www.missutility.net)
- review facility and site utility maps
- follow Enterprise Operation (EO)-28 (Lockheed Martin, 2009b) and Lockheed Martin "Minimum Requirements for Intrusive Fieldwork Work Plans," completing the digging authorization form, and obtaining all required signatures

Previous experience indicates utility clearance from Miss Utility is not possible in waters of the state of Maryland. However, Miss Utility representatives will be consulted to locate and identify utilities that run toward and along creek shorelines, and if such utilities may possibly be present beneath the creek bed. The sample from the east end of each transect is anticipated to be on shore above the high water line, and as such, utility clearance for these locations will be required.

A private utility locating service (Enviroscan) will also be used to screen for and identify subsurface or underwater utilities and obstructions. Enviroscan will use typical utility-locating

equipment representing the best available technology, including a Fisher TW-6 electromagnetic pipe and cable locator/tracer, a RadioDetection® C.A.T. and genny pipe and cable locator/tracer, a RadioDetection® model RD4000 multi-frequency pipe and cable tracer, and a GSSI SIR-2000 ground penetrating radar system.

Copies of permits, Miss Utility tickets, and the clearance report will be included in the final project report. Tetra Tech will arrange a meeting with LMC Properties Inc. (LMCPI) to gain site access and obtain the signed permit. Utility clearance will be performed before each phase of the work. Tetra Tech will communicate with the LMCPI and tenants to ensure facility personnel are kept informed of the project scope and schedule.

3.2 SEDIMENT SAMPLING AND ANALYSES

Sediment samples will be collected to further delineate constituents in Cow Pen Creek, to characterize the occurrence and distribution of radiological parameters and PCBs in sediment, and to perform bench-scale tests that will assess potential remedial alternatives at the MRC. These three tasks are described in more detail in the following sections.

3.2.1 Cow Pen Creek Sediment Delineation Sampling

Cow Pen Creek sampling will further delineate the extent of contamination in the creek bed and the adjacent banks, floodplain, and wetland areas, to assist remedial design. Recent topographic survey maps and previous sampling locations in Cow Pen Creek were used to determine proposed sampling locations. Previous sampling locations were used to identify potential data gaps and locations that would help determine the extent of the remediation needed. Most of the previous samples were taken in the middle of the creek. New sample locations were selected to determine if the extent of contamination requires bank to bank removal, or if contamination extends to the floodplain and wetland areas adjacent to the creek. Tentative coordinates for the sediment sampling locations are listed in Table 3-2; these proposed locations may need to be adjusted depending on field conditions.

Tetra Tech will collect sediment samples for chemical analyses from an area in Cow Pen Creek (SD-84) at which previous anomalous results were detected, and in approximate east-west transects across Cow Pen Creek to evaluate the cross-creek distribution of site contaminants. For this task, 31 sediment cores (SD-107 through SD-137) will be advanced in and adjacent to Cow

Pen Creek. Sample locations are shown in Figure 3-1, and details of sampling and chemical analyses are provided in Table 3-1.

Tetra Tech will collect a sediment core (SD-135) as close as possible to the location of SD-84, and one core at each of two locations (SD-136 and SD-137) approximately 10 feet upstream and downstream from SD-84 (total of three cores). Twenty-eight sediment cores will also be collected along seven transects located across the upper, middle, and lower portions of Cow Pen Creek (Figure 3-1). Each transect across Cow Pen Creek will consist of two to five evenly spaced sampling locations (SD-107 through SD-134).

The sampling locations selected for upper portions of the Cow Pen Creek are above the open channel area where there are data gaps or confirmation of previous data is required (i.e., locations SD-124 to SD-134). The creek channel is more sinuous in this area, so additional samples will be placed outside the main channel to determine extent of contamination within the floodplain, overbank, or wetland areas. The samples located the farthest upstream will help delineate the remediation boundary of Cow Pen Creek.

Samples will also be collected close to the mouth of the creek, between the Polygons 40 and 41 (i.e., locations SD-107 to SD-111), to delineate the downstream extent of contamination and the removal boundary in the creek. Five locations along the first transect will determine the bank to bank extent of the remediation. The first sample (SD-107) is within the 100-year flood plain along the side of Hawthorne neighborhood. Three more transects further upstream will be located about 300 feet apart (i.e., locations SD-112 to SD-123); these transects are located within the well-defined banks. The samples will be collected within 5 to 10 feet of the banks to determine the areal width of chemical of concern (COC) distribution and the potential boundary of removal. Other samples will be collected along transects at approximately 50 feet to 100 feet intervals. The tentative coordinates of selected sampling points, based on the recent Cow Pen Creek topographic survey maps, are listed in Table 3-2.

Sub-surface samples from each core will be collected below the mud line at depth intervals of 0-6 inches, 6-18 inches, 18-30 inches, and 30-52 inches. Two to four samples per core will be analyzed for polycyclic aromatic hydrocarbons (PAHs), PCBs, total priority pollutant metals (13 metals), and total organic carbon (TOC) using the analytical methods listed in Table 3-1. An

expected two or three samples will be collected for chemical analyses in the upper reach of Cow Pen Creek where sediment thickness is less as compared to the depositional environment of the tidal lower reach. Previous sediment sampling results indicate that target constituents are limited to shallow depths in the upper portion of Cow Pen Creek.

Tetra Tech anticipates that the first four transects (17 samples) in Cow Pen Creek moving upstream from Dark Head Cove will be accessible by water using a barge-mounted vibracore sampler, hand corers (e.g. Ogeechee sampler, Wildco© corer), hand augers, or similar coring devices. In the past, sampling tubes have also been advanced by hand at shallower locations. The remaining 11 sediment core locations will be advanced by land and during low tide (as necessary) because of the shallow water depth and narrow width of Cow Pen Creek in its upper reaches. Tetra Tech will use a portable vibracore or similar coring device (e.g., hand augers) to collect the eight creek-side (within 5 to 10 feet of the banks) sediment samples. The selected upstream sample locations are tentative; this area is restricted by heavy vegetation and debris, and sample locations may need to be moved to areas clear of debris or vegetation. Samples locations may also be adjusted to cover any specific features (e.g., a sand bar or secondary channel bed) that may help delineate the extent of contamination. Finally, sample locations may be moved in the field due to the presence of cobbles and debris on the creek bottom and bank, and if core refusal is encountered and sediment cannot be obtained for the planned core depth of 30-52 inches. If core refusal is encountered before reaching the depth of 30-52 inches, the sample location will be offset; however, no more than three attempts will be made after refusal. After three failed attempts, the sediment sample will be collected from the upper refusal interval at that location. Site-specific conditions and observations will dictate the final sample locations and depths.

Two to four samples from each of 31 cores will be submitted for laboratory analyses. QA/QC samples consisting of duplicate samples will be collected at a frequency of 10 percent. As, the anticipated number of samples to be submitted for laboratory analyses is 100, 10 duplicate samples will be collected for a total of 110 samples.

3.2.2 Sediment Sampling for Radiological and Polychlorinated Biphenyl Analyses

Tetra Tech will collect sediment samples for bulk radiochemistry analyses near three Block F outfall locations in Dark Head Cove to identify possible elevated radiological readings. These

outfalls are associated with drainage from Block E to the north where Building D was formerly located. Additionally, Tetra Tech will collect sediment samples to confirm previously detected PCB concentrations above 50 micrograms per kilogram (µg/kg). Sample locations are shown in Figure 3-2, and details about sampling and chemical analyses are provided in Table 3-1.

For radiological analyses, Tetra Tech will advance three sediment cores at distances of approximately 5, 25, and 50 feet along transects from each of three MRC outfall locations, for a total of nine cores (see SD-138 through SD-146 in Figure 3-2). Sediment collected in each core will be screened for radiation using methods and instruments specified in Appendix C. Background samples for screening and laboratory analyses will also be collected as discussed in Appendix C. Tetra Tech will collect two samples per sediment core based on field screening or sedimentation rate (assumes 1 centimeter per year [cm/yr], targeting the years between 1955 and 1970; 42-57 centimeters (cm) or 16-22 inches below mud line). In the absence of field screening data for guidance, Tetra Tech will select one sample location based on the assumed deposition rate of one cm/yr, and one of younger sediment that may have been transported since radioactive materials began being used at the MRC. Work areas will also be monitored for gamma radiation using a hand-held dose rate meter. Radiological field screening will be performed by a trained and experienced Tetra Tech health physicist using the procedures described in Appendix C. Eighteen samples and two duplicate samples (collected at a rate of 10%) will be submitted for laboratory analysis of thorium-228, thorium-230, thorium-232, uranium-233/234, uranium-235/236, and uranium-238 using the analytical method listed in Table 3-1.

Tetra Tech will also advance five sediment cores (SD-147 through SD-151) to collect sediment samples in the vicinity of previous sampling location SD-9 near MRC outfall 005 for PCB analysis. Sediment core SD-147 will be advanced as close as possible to SD-9, and cores SD-148 through SD-151 will be arranged in a diamond pattern, with each core spaced approximately 10 feet from SD-9/SD-147. All sediment cores will be advanced using vibracore equipment. Sub-surface samples from each core will be collected below the mud line at depth intervals of 0-6 inches, 6-18 inches, 18-30 inches, and 30-52 inches for an average of four samples per core. Twenty environmental samples and two duplicate samples (collected at a rate of 10%) will be collected in the SD-9 area and submitted for PCB analysis using the method listed in Table 3-1.

3.2.3 Sediment Sampling for Bench-Scale Treatability Testing

Tetra Tech will collect sufficient bulk sediment to perform bench-scale testing of *in situ* technologies aimed at reducing the bioavailability of PCBs, PAHs. Cadmium (Cd) will be included in the bench-scale testing if it is detected in pore water at concentrations above applicable regulatory criteria. Sediment will be obtained from locations (selected based on the historic data set) where PCB concentrations are suspected to range from 1-10 milligrams per kilogram (mg/kg) and from where Cd concentrations are suspected to range from 5-30 mg/kg. Global positioning system (GPS) coordinates were recorded when these locations were previously sampled. Tetra Tech will attempt to directly sample the previous locations; however, due to GPS limitations and the maneuverability of the sampling barge, samples will most likely be collected in proximity of the previous locations.

Tetra Tech will collect three 5-gallon buckets of sediment for PCB treatability testing (SD-152 through SD-154) and one 5-gallon bucket of sediment for Cd treatability testing (SD-155). One of the three PCB bulk samples (SD-152) will be collected from an area identified in feasibility study Alternative G, a location where *in situ* treatment is proposed (i.e., near SD-98), to assess the effectiveness of treatment at sediment concentrations at which actual treatment will be performed.

The sediment in each bucket will be homogenized using a spiral blade or paddle mounted on an electric drill, and one sample per bucket will be analyzed for PAHs, PCBs, and total priority pollutant metals (13 metals) using the methods listed in Table 3-1. Sampling locations are based on historical data distribution and, although attempted, the desired concentration ranges may not be met.

A plastic carboy of water will also be collected from the cove for potential use in the treatability tests. No analyses of this water will be performed. The sediment samples and surface water will be properly stored for up to one year in case additional treatability testing is requested.

3.2.4 Dark Head Cove Sediment Passive Pore Water Sampling

Passive pore water sampling in Dark Head Cove is briefly summarized here, with full details provided in Appendix E. Passive samplers will be deployed at five locations across Dark Head Cove. Five individual samplers will be placed in the top 6 inches of sediment at each location. Two sampling locations will be at the same location bulk sediment samples are collected for the

laboratory treatability study. The remaining three locations will be across the area proposed for *in situ* remediation. Each passive sampler will be comprised of a clean and inoculated sheet of polyethylene. Passive samplers will be allowed to equilibrate with pore water for two months before retrieval. Samplers will be placed in the sediment and submerged with no visible location markers at the water surface so as not to attract curious observers; GPS coordinates will be recorded at each sample location. Each sampling apparatus will be tethered to the MRC shoreline via weighted lines so they can be readily retrieved at the end of the two month sampling period.

3.3 SEDIMENT SAMPLING PROCEDURES AND WASTE MANAGEMENT

3.3.1 Sediment Sampling

Sediment samples will be collected using a four-inch diameter stainless-steel vibracore sampling-tube fitted with a polyethylene acetate liner. A subcontractor will be procured and a barge or boat will be used to collect the sediment samples; the actual vessel used will depend on accessibility of the sample location. All reusable equipment contacting sediments will be decontaminated between sampling locations, as described in Section 3.3.3.

Sampling tubes will be advanced by either manual or mechanical (i.e., vibrating head) means, depending on actual geology and sediment resistance. Sample descriptions such as color, grain size, sorting, texture, and any other pertinent soil characteristics will be recorded on the coring log. The sediment's textural properties will be evaluated in the field using tables specified in ASTM International, Inc. (ASTM) method D2488-00. Grain size will be determined by comparing sediment grains to a grain size chart. The field information will be documented on a Tetra Tech sediment-sampling form.

Each location will be surveyed using GPS with sub-meter accuracy such as a portable Trimble Pro XRS GPS unit or equivalent. The GPS unit will use the Maryland State plane-coordinate Universal Transverse Mercator Zone 18. Tide stage at the time of the survey will be recorded, and the depth to the top of the surface-water/sediment interface will be measured using a weighted tape. Sampling intervals and the terminal depth of each vibracore boring will also be recorded.

Sediment cores will likely be processed onshore. Care will be taken to avoid disturbing the sediment during transport. Sediment from each specific sampling interval will be homogenized in

disposable aluminum pans using disposable plastic spatulas. After the sample is homogenized, the sediment will be placed into sampling containers supplied by the analytical laboratory.

3.3.2 Sample Nomenclature and Handling

Sediment samples submitted to the laboratory will be labeled with an "SD" prefix, identifying the sampled medium as sediment, followed by a three-digit numeral to identify the sampling location, followed by an indication of the depth interval: "SS" for surface sediment (0–6 inches), "01" for the 6–18-inch depth sample, "02" for the 18–30-inch depth sample, and "03" for the 30–52-inch depth sample. For example, SD-117-SS designates a surface sediment sample collected at location SD-117, and SD-117-02 designates a sample collected from an 18–30-inch depth at location SD-117. A "PPW" prefix will be used for passive pore water samples.

Proper custody procedures will be followed throughout all phases of sample collection and handling. Sample containers will be released under signature from the laboratory and will be accepted under signature by the sampler(s) or responsible individual, who will maintain custody until the containers are transferred to the sampler(s). Transport containers will be sealed with strapping tape and a tamper-proof custody seal. The custody seal will contain the signature of the individual releasing the transport container, along with the date and time. Chain of custody protocols will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will demonstrate that the samples have been handled and transferred in a manner that would prevent tampering.

3.3.3 Equipment Decontamination

Reusable sampling equipment will be decontaminated between sampling locations before each use, and decontamination solutions will be collected for appropriate disposal. Decontamination will consist of the following steps:

- Alconox® and potable-water wash
- Potable-water rinse
- Reagent grade isopropanol rinse (achieved by thoroughly wetting the equipment with isopropanol)
- Analyte-free water rinse

- Air drying

Equipment used to collect samples for radiological analyses (at MRC outfalls and SD-9 sampling locations) will be surveyed prior to use, before decontamination, and after decontamination. Radiological decontamination, if required, will be performed in accordance with Tetra Tech Radiological Protection Operating Procedures (Appendix C).

3.3.4 Waste Management

A waste management plan, conforming to *Lockheed Martin EESH Remediation Waste Management Procedure EROP-03, Revision 4* (Lockheed Martin, 2009b) and *Remediation ESH Contractor Handbook,* (Lockheed Martin, 2009a), is included as Appendix B of this work plan. IDW, consisting of equipment rinse water, non-radiological residual sample cores, and personal protective equipment (PPE), will be generated during this sampling event. PPE will be dry brushed to remove any gross soil/sediment, placed in trash bags, and disposed of in a Lockheed Martin–designated trash container. Residual sample cores and equipment rinse water will be collected in 55-gallon drums and stored at a Lockheed Martin–designated central staging area. All drums will be appropriately labeled and logged on a drum inventory form. IDW will be characterized and disposed of in accordance with applicable state and federal regulations. IDW generated during this investigation is expected to be disposed of as non-hazardous waste. Radioactive waste is not expected; however, if it is encountered, it will be packaged and staged under the direction of the health physicist until proper disposal arrangements can be made.

3.4 DATA MANAGEMENT

Data handling procedures followed by the laboratory will meet the requirements set forth in the laboratory subcontract. All analytical and field data will be maintained in Tetra Tech project files. The project files will contain copies of the chain of custody forms, sampling log forms, sampling location maps, and QA/QC documentation.

3.4.1 Data Tracking and Control

A cradle–to–grave sample tracking system will be used for samples throughout the investigation. Before field mobilization, the field operations leader will coordinate and initiate sample tracking. Sample labels will be handwritten in the field or preprinted before entering the field. Labels will

be reviewed for accuracy and for adherence to work plan requirements. The project manager (PM) will coordinate with the analytical laboratory personnel to ensure that they are aware of the number and type of samples and analyses they will receive. When field sampling is underway, the field operations leader forwards the chain of custody forms to the PM/designee and the laboratory at the end of each day sampling occurs. The PM/designee will confirm that the chain of custody forms provide the information required by the work plan.

This data management system will ensure early detection of possible errors made in the field so adjustments can be made while the field team is mobilized. After successful completion of all requested analyses, the laboratory will submit an electronic deliverable for every sample delivery group. When all electronic deliverables have been received from the laboratory, the PM/designee will ensure that the laboratory has performed all requested analyses. Ideally, discrepancies can be noted early enough so that all samples can be analyzed within the prescribed holding times.

3.4.2 Sample Information

Data from field measurements will be recorded using the appropriate log sheets. Reduction of field data entails summarizing and presenting these data in tabular form. Reducing laboratory data entails manipulating raw data instrument output into reportable results. Laboratory data will be verified by the group supervisor and then by the laboratory's quality control/documentation department.

3.4.3 Project Data Compilation

The analytical laboratory will generate an Adobe *Acrobat*® portable document format (PDF) file of the analytical data packages, as well as electronic database deliverables. The electronic database will be checked against the PDF file provided by the laboratory and updated based on data-qualifier flags applied during data validation, as required. Sediment and surface water data will be incorporated into the electronic geographic information system (EGIS) database. All data, such as units of measure and chemical nomenclature, will be reviewed and corrected, if necessary, to maintain consistency with the project database.

3.4.4 Geographical Information System

Data management systems now in use consist of a relational database and EGIS used to manage environmental information pertaining to MRC. The relational database stores chemical,

geological, hydrogeologic, and other environmental data collected during environmental investigations. The EGIS is built from the relational database and contains subsets of the larger data pool. Using EGIS, environmental data can be posted on base mapping to provide a graphical representation of the information. Upon compilation of sample, chemical, and positional data, the data will be incorporated into the MRC EGIS. The EGIS system will then be used to generate various maps from this data, including site and sampling location maps and contaminant tag maps, as needed.

3.4.5 Data Quality Objective and Data Review

The overall data-quality objective of this project is to obtain reliable data meeting or exceeding project requirements. This objective can be further expressed in terms of data precision, accuracy, representativeness, comparability, and completeness (PARCC). For this project, data quality objectives will be addressed as follows:

- *Precision* is the ability to reproduce analytical results within an established acceptable range when performing analyses. Testing facilities will use standard methods and standard operating procedures (SOPs) so that the same methodology is consistently applied to all analyses performed during this project. Laboratory duplicate samples will be analyzed to confirm that data precision is within the established limits for a specific analysis.

- *Accuracy* is a measure of how close the results agree with the "true" (i.e., an accepted reference value). For this project, accuracy will be assessed by evaluating matrix-spike and laboratory-control samples.

- *Representativeness* is the measure of how well the sample represents the system being measured. Sample representativeness will be assessed by evaluating duplicate samples.

- *Comparability* is the confidence with which one data set can be compared to another. Comparability will be established through the use of SOPs and by comparing sediment chemical analytical data to previous studies.

- *Completeness* is the amount of valid data obtained from a measurement system, as compared to the expected amount of data. This factor is of limited relevance to this project; however, a goal of 85% will be established based on the data completeness generated for similar projects.

Sediment pore water quality assurance is addressed in the *Work plan for Passive Pore Water Sampling and Analysis* (Tetra Tech, 2013), included as Appendix E.

Definitive data from this investigation will consist of chemical and radiological results for sediment and sediment pore water samples. These data will further delineate the nature and extent of sediment contamination, and will be used to evaluate potential treatment technologies. These data may also be used in human health and ecological screening. Upon receipt of chemical data from the laboratory, it will be entered into a sample database and evaluated against risk-based criteria or standards.

Data validation consisting of assessing data completeness, holding times, calibrations, laboratory and field blank contamination, field duplicate precision, and detection limits will be completed concurrent with the data evaluation. This review will be based on the United States Environmental Protection Agency (USEPA) Region 3 *Modifications to the National Functional Guidelines for Data Review* (USEPA, 1993 and 1994), and the specifics of the analytical method used.

The samples for this project will be analyzed by a state-accredited laboratory for the compounds described in this work plan, using the methodologies prescribed in the sampling and analysis plan and the quality assurance (QA) plan. All analytical results will be thoroughly checked for quality and usability by qualified chemists. Data usability review results (data validation) will be transmitted to project personnel as they are received. All laboratory data provided will be validated for PARCC in accordance with USEPA Region 3 Level M2 protocols. Oversight of the laboratory QA/QC will be as proactive as possible to ensure valid data are produced during the sampling event. An evaluation of the methodology, method compliance, and any corrective actions will also be performed. Data usability review results will be provided to Lockheed Martin and the managing contractor as they are received.

Table 3-1

Summary of Sediment and Pore Water Sampling and Chemical Analyses-Cow Pen Creek and Dark Head Cove, 2013
Lockheed Martin Middle River Complex, Middle River, Maryland
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Sample number	Location	Sample depth	Sample analyses and methods	Rationale/purpose
SD-107 through SD-137 (31 core locations)	Cow Pen Creek-three cores at and around SD-84 and 28 cores at multiple transects	Two to four samples (depending on site conditions) at each of 31 core locations; sediment samples will be collected from depth intervals of 0-6 inches, 6-18 inches, 18-30 inches, and 30-52 inches. One hundred environmental samples plus ten duplicate samples (duplicate rate of 10%) will be collected.	**Laboratory Analyses**: Polycyclic aromatic hydrocarbons (PAHs) by SW846 Method 8270 (GC/SIM); polychlorinated biphenyls (PCBs) by SW846 Method 8082; total priority pollutant metals (13 metals) by SW846 Method 6010C, 6020, and 7471A (mercury); and total organic carbon (TOC) by United States Environmental Protection Agency (USEPA) Lloyd Khan method	Sediment samples will be collected from three cores at and around previous sample SD-84 (SD-135 through SD-137) and from two to five core locations arranged along seven transects in Cow Pen Creek (SD-107 through SD-134). Samples will further characterize sediment stratigraphy, contaminant distribution, bioavailability, treatability, and radiological properties in support of a feasibility study and remedial design for sediment adjacent to the Middle River Complex site. The data will also assist in the evaluation of bio-toxicity and treatability to evaluate/support rationale for not removing all sediment impacted with elevated levels of cadmium and other metals.
SD-138 through SD-146 (nine boring locations)	Three Tax Block F stormwater outfalls (two outfall areas for 005 and outfall 008)	Three sediment cores will be advanced approximately 5 feet, 25 feet, and 50 feet from each of three Block F outfalls (005 and 008), for a total of nine sediment cores. Two sediment samples will be collected per core (total 18 samples) plus two duplicate samples (10% rate). Samples are will be selected based on field screening results or at a depth of 16-22 inches in the absence of elevated readings.	**Field Measurements**: Radiological screening of work area and sediment using methods and instruments listed in Appendix C. **Laboratory Analyses**: thorium-228, thorium-230, thorium-232, uranium-233/234, uranium-235/236, and uranium-238 using Department of Energy Health and Safety Laboratory (HASL)-300 Method A-01-R-MOD	Field screening will be conducted to identify possible sediment zones of elevated radiological activity near storm water outfalls. The results of the screening will be used to select sediment samples for laboratory analyses in accordance with Appendix C of this work plan. Selected sediment samples will be analyzed by a laboratory for thorium and uranium isotopes that may have been previously used in the former nuclear laboratory located in the basement of former Building D.

Table 3-1

Summary of Sediment and Pore Water Sampling and Chemical Analyses-Cow Pen Creek and Dark Head Cove, 2013
Lockheed Martin Middle River Complex, Middle River, Maryland
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Sample number	Location	Sample depth	Sample analyses and methods	Rationale/purpose
SD-147 through SD-151 (five sediment cores)	Cow Pen Creek near outfall 005 at and around previous sediment sample SD-9	One core will be advanced at/near SD-9, and four cores will be advanced bracketing SD-9 in four directions approximately 10 feet from the previous SD-9 location. Four samples will be collected per core at each of five cores (20 samples total) at depth intervals of 0-6 inches, 6-18 inches, 18-30 inches, and 30-52 inches, plus two blind duplicate samples (10% rate) that will be collected in the shallow sample interval.	**Laboratory Analyses**: PCBs by SW846 Method 8082	Sediment samples will be collected at and around SD-9, a location which contained a PCB concentration greater than 50 micrograms per kilogram in sediment.
Bulk sampling of sediment SD-152 through SD-155 (four sample locations)	Three buckets from areas where PCBs in sediment range from 1-10 milligrams per kilogram (mg/kg) and one bucket where cadmium ranges from 5-30 mg/kg (e.g., sample SD-98)	Bulk sediment samples will be collected four 5-gallon buckets, and surface water will be collected in one plastic carboy. One bulk sediment sample will be collected per location (four samples).Samples will be collected from each bucket after the sediment is homogenized.	**Laboratory Analyses**: PAHs by SW846 Method 8270 (GC/SIM); PCBs by SW846 Method 8082; total priority pollutant metals (13 metals) by SW846 Method 6010C, 6020, and 7471A (mercury) Chemical analyses of the surface water sample will not be conducted; this sample will be held for future treatability testing.	Bulk sediment will be used to conduct bench-scale treatability tests for PCBs (three buckets) and cadmium (one bucket). The cove water sample collected in the carboy will be preserved and saved in case further bench-scale treatability tests are determined necessary

Table 3-1

Summary of Sediment and Pore Water Sampling and Chemical Analyses-Cow Pen Creek and Dark Head Cove, 2013
Lockheed Martin Middle River Complex, Middle River, Maryland
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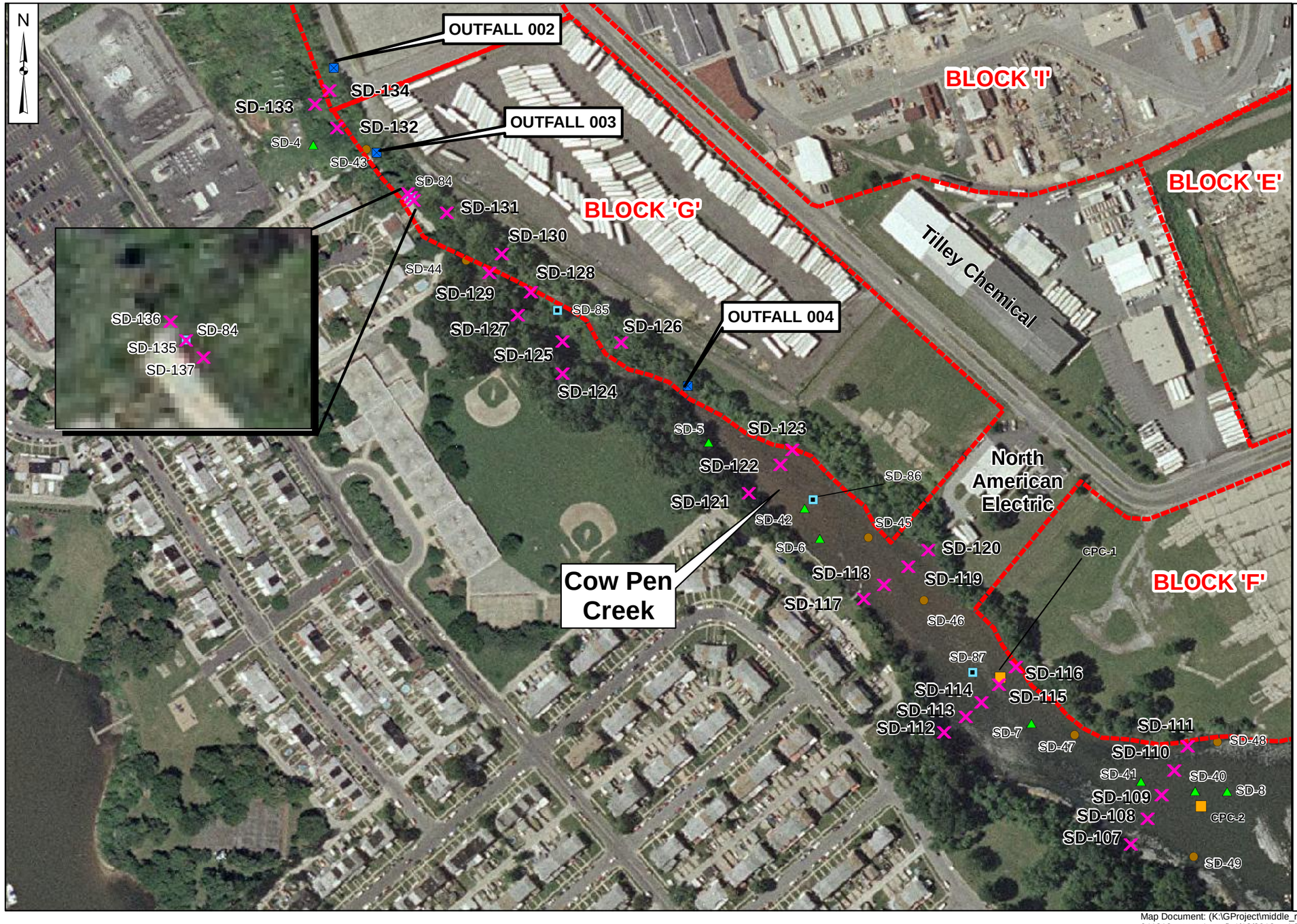
Sample number	Location	Sample depth	Sample analyses and methods	Rationale/purpose
Pore water sampling PPW-01A-E through PPW-05A-E (5 areas; 27 samples; 25 pore water samples plus two blank samples) ***Details of sampling are provided in Appendix E***	Dark Head Cove: five clusters having five passive pore water samplers per cluster	Six inches below water-sediment interface.	**Laboratory Analyses**: PCBs congeners USEPA Method 8270/860	Results will be used to establish pre-remediation *in situ* PCB concentrations in sediment pore water prior to remediation. Two clusters (PPW-01A-E and PPW-02A-E) will be collected in areas where bulk samples are collected for sediment treatability tests. Three locations (PPW-03A-E, PPW-04A-E, and PPW-05A-E) will be distributed across the areas where *in situ* treatment of sediment is planned.

GC = gas chromatography;
mg/kg = milligrams per kilogram;
MRC = Middle River Complex;
MSA = Martin State Airport;
PAHs = polycyclic aromatic hydrocarbons;
PCBs = polychlorinated biphenyls;
PPW = passive pore water;
SIM = selective ion methodology;
SD = sediment;
USEPA = United States Environmental Protection Agency



TETRA TECH

Figure 3-1
Proposed Cow Pen Creek Sediment Sample Locations, 2013
Lockheed Martin Middle River Complex
Middle River, Maryland

Legend

- Proposed 2013 Sediment Sample
- Sediment Sample Location- 2011
- Sediment Sample Locations- Nov 2008
- Sediment Sample Location- 2005
- Storm Drain Outfall
- Parcels

200 100 0 200 Feet

Drawn By: MP 2/27/12
Checked By:
Approved By:

Contract Number: 112IC02903

Map Document: (K:\GProject\middle_river\Maps\Figure 3-1_proposed sediment_sample_locations 041813_zoom A.mxd) 4/18/2013 -- 4:30:57 PM

TETRA TECH

Figure 3-2
Proposed Dark Head Cove Sediment Sample Locations, 2013
Lockheed Martin Middle River Complex
Middle River, Maryland

Legend

- Proposed Sediment Core/Sample Location- 2013
- Sediment Sample Location- 2011
- Sediment Sample Locations- Nov 2008
- Storm Drain Outfall
- Sediment Sample Location- 2005
- Treatability Testing Sample Location- 2011

100 50 0 100
Feet

Drawn By: MP 4/19/13
Checked By:
Approved By:

Contract Number: 112IC02903

Map Document: (K:\GProject\middle_river\Maps\Figure 3-1_proposed sediment_sample_locations 041813_zoom B.mxd) 4/19/2013 -- 10:00:21 AM

Section 4
Bench-Scale Treatability Testing

Tetra Tech, Inc. (Tetra Tech) will oversee bench-scale treatability testing to evaluate the effectiveness of several carbon/treatment amendments aimed at reducing the bioavailability of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) in sediment adjacent to the Middle River Complex (MRC). Should concentrations of cadmium [Cd] in sediment pore water be in excess of its United States Environmental Protection Agency (USEPA) National Recommended Water Quality Criteria (NRWQC), it will also be included in the bench-scale treatability testing. Tetra Tech is subcontracting Dr. Upal Ghosh of the University of Maryland, Baltimore County (UMBC) to perform the bench-scale sediment treatability tests. Specific objectives of the treatability tests include:

1. Evaluating potential reduction in pore water PCB/PAH concentrations after amendment with activated carbon, using the following materials:
    a. powdered activated carbon (PAC)
    b. granular activated carbon (GAC)
    c. organoclay
    d. biochar
    e. black carbon/coke
2. Evaluating potential reduction in PCB bio-uptake by benthic organisms (possibly oligochaetes or amphipods) after amending with activated carbon
3. Measuring pore water dissolved Cd concentration in two sediment samples and evaluating if further bioavailability reduction testing is necessary based on site-specific Cd screening level (i.e., the freshwater NRWQC for Cd, corrected for hardness). If initial sediment pore water Cd concentrations are greater than the screening level, then bench-scale testing for potential reduction in Cd concentrations will be performed.
4. If potential risk to benthic organisms exists, various Cd sorbents will be evaluated, to include, at a minimum, the amendments shown to be effective for adsorbing PCBs/PAHs.

Coal-based activated carbon, coconut-shell activated carbon, biochar, apatite, organoclay, mersorb, and/or thiol-functionalized silica will also be evaluated as indicated.

UMBC will provide a bench-scale treatability study work plan, included as Appendix D. The following section summarizes the rationale and general procedures used for the treatability tests. The actual work plan will provide additional details that are not provided here.

Activated carbon was shown to be an effective sorbent for PCBs and PAHs in previous treatability studies. Risk to benthic organisms in sediments is primarily driven by PAHs dissolved in pore water. Thus, changes in PAH bioavailability can be assessed by measuring changes in the concentration of freely dissolved PAHs using passive samplers. PCBs can be introduced into the food chain through benthic organisms or via flux from sediment to overlying water and uptake by pelagic organisms. Thus, PCBs will be assessed using both pore water concentrations and uptake in benthic organisms.

Treatability tests to be performed follow:

- Sediment and pore water PCB/PAH measurement in untreated sediment. Two sediment samples will be analyzed in triplicate for PCB congeners and PAHs (i.e., the 16 United States Environmental Protection Agency [USEPA] priority pollutant PAHs). Analyses for total organic carbon (TOC) and native black carbon will also be performed. Pore water will be analyzed in triplicate for PCB congeners and PAHs using passive equilibrium samplers. These measurements will serve as the baseline for comparison after treatment with sorbent amendments.

- Amendment of PCB/PAH-impacted sediment using various sorbents (i.e. PAC, GAC, organoclay, biochar, black carbon/coke), including two different doses of activated carbon (2% and 5%). Each amendment listed above will be tested using (two) sediment samples containing different PCB concentrations (one sample with mid-range PCB concentrations [nominal 2 parts per million] and one sample with high PCB concentrations [greater than 5 parts per million]). Amended sediments will be allowed to equilibrate for one month before assessing changes in bioavailability.

- Assessment of PCB/PAH pore water concentrations after treatment with amendments. Pore water PCB/PAH concentrations in treated and untreated sediments will be measured to assess changes in PCB/PAH partitioning after treatment. Pore water testing will be conducted in triplicate and will use a passive sampling technique.

- Bioaccumulation studies with treated and untreated sediments. Bioaccumulation assays following standard test guidelines will be conducted in the laboratory using a freshwater oligochaete or an estuarine amphipod (depending on site salinity). This will measure the effectiveness each amendment has to reduce biological uptake of PCBs and PAHs near the

base of the benthic food chain. Bioaccumulation studies will be conducted in quadruplicate.

A two-phase approach may be used to evaluate the effectiveness of *in situ* sorbent amendments for cadmium, if pore water Cd concentrations are higher than the freshwater NRWQC for Cd (corrected for hardness).The phased approach for amending Cd is described below:

Phase 1: Measure freely dissolved Cd concentration in sediment pore water. The concentration of freely dissolved Cd in mid-range and high PCB concentration sediment will be measured in the laboratory along with pore water hardness. These measurements will serve as the baseline for comparison after treatment with sorbent amendments. Previous field measurements indicated site salinity ranges from 2.4 to 3.9 parts per trillion (ppt), so the freshwater NRWQC for cadmium will be used as the criterion to determine whether Cd will be included in the treatability study. The freshwater NRWQC for cadmium (based on a water hardness of 100 milligrams per liter [mg/L]) is 0.25 µg/L. Freely dissolved Cd concentrations may be below the NRWQC or below detection limits when pore water concentration is corrected for hardness. If that occurs, further studies to reduce pore water Cd will not be attempted. Conversely, if freely dissolved cadmium concentrations are found to be well above the NRWQC, Phase 2 of this study will be initiated. Analytical methods with detection limits below the NRWQC for Cd will be used.

Phase 2 (as needed): Evaluate reduction of pore water Cd concentration after amendment using various sorbents, focusing on the most effective amendments for PCB/PAHs. If the hardness-corrected Cd pore water concentrations are elevated, treatability studies will be conducted using a range of sorbent amendments. At a minimum, the amendments that effectively reduce PCBs and PAHs will be tested. The following amendments may also be tested: coal-based activated carbon, coconut-shell activated carbon, biochar, apatite, and organoclay. The testing dose of each sorbent will be 5% by dry weight. After dosing, the samples will be allowed to equilibrate in open beakers for one month, after which sediment pore water cadmium concentrations will be measured.

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Section 5
Project Deliverables

Tetra Tech, Inc. (Tetra Tech) will compile field investigation records (sediment boring logs, test results, field notes, etc.) into one comprehensive document summarizing the 2013 field program for Lockheed Martin Corporation (Lockheed Martin) review and eventual distribution to Maryland Department of the Environment (MDE). Field activities, including sampling locations, sample collection and handling, analytical or laboratory results, and testing results, will be documented in this report. The report will also describe recent and historic investigations, include analytical summary tables and figures (depicting all sediment sampling locations), and describe the distribution of analytes detected in the environmental media sampled at each sampling location. The environmental geographic information system (EGIS) database will be updated and used to prepare graphical representations of sampling locations and results by sediment depth intervals.

The report will present analytical data in tabular form and compare them to applicable criteria. All project-specific sampling techniques and the standard operating procedures implemented at each sampling location will also be described. The report will summarize sampling and related tasks completed and present the investigators' findings and conclusions.

Following completion of the bench-scale treatability testing, University of Maryland, Baltimore County (UMBC) will generate a comprehensive report summarizing, interpreting, and discussing the results. Analytical results will be provided in summary tables with detected concentrations and detection limits presented. Screening and regulatory criteria will be compared to results in tables and in the text of the report. Laboratory data and associated documentation including chains-of-custody will be included in an appendix. When treatability testing is completed, UMBC's report will be appended to Tetra Tech's report.

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Section 6
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APPENDIX A – HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
FOR
LOCKHEED MARTIN CORPORATION

MULTIMEDIA CHARACTERIZATION

LOCKHEED MARTIN MIDDLE RIVER COMPLEX

MIDDLE RIVER, MARYLAND

TETRA TECH, INC.
20251 Century Boulevard Suite 200
Germantown, Maryland 20874-7114

Revision 4
April 2013

HEALTH AND SAFETY PLAN
FOR
MULTIMEDIA CHARACTERIZATION
AT
LOCKHEED MARTIN CORPORATION
LOCKHEED MARTIN MIDDLE RIVER COMPLEX

2323 EASTERN BOULEVARD
MIDDLE RIVER, MARYLAND

Submitted to:
Lockheed Martin Corporation
Lockheed Martin Middle River Complex

Submitted by:
Tetra Tech
20251 Century Boulevard, Suite 200
Germantown, Maryland 20874

REVISION 4
April 2013

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APPROVED FOR SUBMITTAL BY:

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PROJECT HEALTH AND SAFETY OFFICER
TETRA TECH
PITTSBURGH, PENNSYLVANIA

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1.0 INTRODUCTION

This Health and Safety Plan (HASP) has been developed to provide the minimum practices and procedures for Tetra Tech, Inc. (Tetra Tech) and subcontractor personnel engaged in Multimedia Characterization activities at the Lockheed Martin Middle River Complex (LMC MRC) in Middle River, Maryland.

This HASP must be used in conjunction with the Tetra Tech Health and Safety Guidance Manual (HSGM). The HSGM contains Tetra Tech Health and Safety Standard Operating Procedures (SOPs), as well as detailed reference information on a variety of topics referenced in this HASP. This HASP and the contents of the Guidance Manual were developed to comply with the requirements stipulated in 29 CFR 1910.120 (OSHA's Hazardous Waste Operations and Emergency Response Standard) and applicable sections of 29 CFR 1926 (Safety and Health Regulations for Construction).

All contractor responsibilities stipulated in Section 1.0 of the Lockheed Martin Remediation Contractor's ESH Handbook (LM Handbook) will be adhered to. The LM Handbook can be found in Attachment I of this HASP.

Copies of all pertinent environmental, safety and health (ESH) records must be maintained at the job site. This includes, but is not limited to, this site-specific HASP, the Tetra Tech Health and Safety Guidance Manual, personnel training documentation, evidence of enrollment in a medical surveillance program, accident/injury reporting, work area inspections, periodic safety meetings, MSDS's, air monitoring data, waste container inspections, etc. These records must also be provided electronically to the Lockheed Martin Project Lead.

This HASP has been developed using the latest available information regarding known or suspected chemical contaminants and potential physical hazards associated with the proposed work and site. The HASP will be modified if the scope of work changes or if new information regarding site conditions, hazards, or contaminants of concern becomes available. If deviations are encountered from the field work plan, the contractor shall A) notify to the Lockheed Martin Project Lead and B) suspend work to assess changes to the work plan(s) and the HASP. Changes to the work plan(s) and the HASP shall be reviewed by the Project Lead. Procedures addressing changes to this HASP as described in Section 6 of the LM Handbook (Attachment I) will be followed.

1.1 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibilities for site safety and health for Tetra Tech employees conducting field activities under this field effort. All personnel assigned to participate in the field work have the primary responsibility for performing all of their work tasks in a manner that is consistent with the Tetra Tech Health and Safety Policy, the health and safety training that they have received, the contents of this HASP, and in an overall manner that protects their personal safety and health and that of their co-workers. The following persons are the primary point of contact and have the primary responsibility for observing and implementing this HASP and for overall on-site health and safety.

- The Tetra Tech Project Manager (PM) is responsible for the overall direction and implementation of this HASP.

- The Field Operations Manager (FOL) manages field activities, executes the work plan, and enforces safety procedures as applicable to the work plan.

- The Project Health and Safety Officer (PHSO) is responsible for developing this HASP in accordance with applicable OSHA regulations. Specific responsibilities include:
  - Providing information regarding site contaminants and physical hazards.
  - Establishing air monitoring and decontamination procedures.
  - Assigning personal protective equipment based on task and potential hazards.
  - Determining emergency action procedures.
  - Identifying appropriate emergency contacts.
  - Stipulating training and medical surveillance requirements.
  - Providing standard work practices to minimize potential injuries and exposures associated with hazardous waste site work.
  - Modify this HASP, where and when necessary.

- The Site Safety Officer (SSO) supports site activities by advising the PM on the aspects of health and safety on site. These duties may include the following:
  - Coordinate health and safety activities with the FOL.
  - Select, inspect, implement, and maintain personal protective equipment.
  - Establish work zones and control points.
  - Implements air-monitoring program for onsite activities.
  - Verify training and medical status of onsite personnel status in relation to site activities.
  - Implements hazard communication, respiratory protection, and other associated safety and health programs as necessary.

- Coordinates emergency services.
- Provides site specific training for onsite personnel.
- Investigates accidents and injuries (see Attachment II Incident Report Form)
- Provides input to the PHSO regarding the need to modify, this HASP, or other applicable health and safety associated documents as per site-specific requirements.

- The Project Health Physicist (PHP) supports site activities by advising the PM on the aspects of health and safety on site. These duties may include the following:
  - Coordinate radiological activities with the FOL.
  - Select, implement, and survey personal protective equipment.
  - Establish radiological areas.
  - Provides site specific training for onsite personnel.
  - Provides input to the PHSO regarding the need to modify, this HASP, or other applicable health and safety associated documents as per site-specific requirements.

- Compliance with the requirements of this HASP are monitored by the SSO and coordinated through the Tetra Tech Health and Safety Manager (HSM).

Note: In some cases one person may be designated responsibilities for more than one position. For example, the FOL may also be responsible for the SSO duties. This action will be performed only as credentials, experience, and availability permits.

1.2 STOP WORK

All employees are empowered, authorized, and responsible to stop work at any time when an imminent and uncontrolled safety or health hazard is perceived. In a Stop Work event (immediately after the involved task has been shut down and the work area has been secured in a safe manner) the employee shall contact the Project Manager and the Corporate Health and Safety Manager. Through observations and communication, all parties involved shall then develop, communicate, and implement corrective actions necessary and appropriate to modify the task and to resume work. If worked was stopped for radiological reasons, Project Manager and Corporate Health and Safety Officer will consult with PHP prior to resuming work.

1.3 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Lockheed Martin Middle River Complex **Address:** Middle River, Maryland

LMC Contact: Tom Blackman **Phone Number:** (240) 460-7508
Scott Lapp (410) 682-0365 office
(410) 967-8745 cell
John Morgan (410) 682-1382 office
(410) 215-4530 cell

Purpose of Site Visit: Multimedia Characterization activities

Proposed Dates of Work: April 2013 until completion

Project Team:

Tetra Tech Management Personnel:	Discipline/Tasks Assigned:	Telephone
Mike Martin	Regional Manager	(301) 528-3022 office (410) 707-5259 cell
Tony Apanavage	Project Manager (PM)	(301) 528-3021 (301) 233-8230 cell
TBD	Field Operations Leader (FOL)	
TBD	Site Safety Officer (SSO)	
Matthew M. Soltis, CIH, CSP	Health and Safety Manager	(412) 921-8912
Clyde Snyder	Project Health and Safety Officer (PHSO)	(412) 921-8904
Amy Stanford	Project Health Physicist (PHP)	(706) 832-7394

Non-Tetra Tech Personnel	Affiliation/Discipline/Tasks Assigned	Telephone
John Morgan	Facilities Manager	(410) 682-1328
Mike Musheno	Environment Safety & Health/Projects	(610) 656-4012
Tom Ambrose	Facilities Supervisor	(410) 682-1308
Chief Philip Johnston	LMC Security Office Site Security	(410) 682-1050
Tom Blackman	Project Lead	(240) 460-7508

Hazard Assessment (for purposes of 29 CFR 1910.132) for HASP preparation has been conducted by:

Prepared by: Clyde Snyder

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a planning effort to direct and guide field personnel in the event of an emergency. In the event of an emergency, the field team will primarily evacuate and assemble to an area unaffected by the emergency and notify the appropriate local emergency response personnel/agencies. Workers who are ill or who have suffered a non-serious injury may be transported by site personnel to nearby medical facilities, provided that such transport does not aggravate or further endanger the welfare of the injured/ill person. The emergency response agencies listed in this plan are capable of providing the most effective response, and as such, will be designated as the primary responders. These agencies are located within a reasonable distance from the area of site operations, which ensures adequate emergency response time.

Tetra Tech personnel may participate in minor event response and emergency prevention activities such as:

- Initial fire-fighting support and prevention
- Initial spill control and containment measures and prevention
- Removal of personnel from emergency situations
- Provision of initial medical support for injury/illness requiring only first-aid level support
- Provision of site control and security measures as necessary

2.2 EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, emergencies resulting from chemical, physical, or fire hazards are the types of emergencies which could be encountered during site activities. To minimize or eliminate the potential for these emergency situations, pre-emergency planning activities will include the following (which are the responsibility of the SSO and/or the FOL):

- Coordinating with Lockheed Martin Middle River and/or local emergency response personnel to ensure that Tetra Tech emergency action activities are compatible with existing emergency response procedures.

- Establishing and maintaining information at the project staging area (support zone) for easy access in the event of an emergency. This information will include the following:

  - Chemical Inventory (of chemicals used onsite), with Material Safety Data Sheets.

- Onsite personnel medical records (Medical Data Sheets).
- A log book identifying personnel onsite each day.
- Hospital route maps with directions (these should also be placed in each site vehicle).
- Emergency Notification - phone numbers.

The Tetra Tech FOL will be responsible for the following tasks:

- Identifying a chain of command for emergency action.

- Educating site workers to the hazards and control measures associated with planned activities at the site, and providing early recognition and prevention, where possible.

- Periodically performing practice drills to ensure site workers are familiar with incidental response measures.

- Providing the necessary equipment to safely accomplish identified tasks.

2.3 EMERGENCY RECOGNITION AND PREVENTION

2.3.1 Recognition

Through the hazard assessment, it has been determined that the following potential hazards that could be encountered:

Physical Injury resulting from:

Struck By: High-pressure lines could become disconnected and whip resulting in possible injury. Prevention methods include having locking/ or pinned hose connections and whip checks to prevent disconnection.

Entanglement: Entanglement hazards exist with the conveyor auger and rotating pump components. To minimize these hazards equipment will be inspected to ensure guarding is in place. If the auger conveyor is not equipped with a safety interlock on the lid to the auger, then administration controls will be put in place to control persons accessing an unguarded rotating auger. See Section of the HSGM for additional direction.

Chemical Exposure: The scope of this work involves possible exposure to chemical contaminants site personnel will:

- Review site MSDSs and have ready any emergency response measures necessary for response. This includes an eyewash station and safety shower or drench hose if required.

- Locate a hospital that has decontamination capabilities and can provide care to chemical exposed personnel.

Foreseeable emergency situations that may be encountered during site activities will generally be recognizable by visual observation. A clear knowledge of the signs and symptoms of overexposure to contaminants of concern may alert personnel of the potential hazards concerning themselves or their fellow workers.

Tetra Tech will minimize or eliminate exposure to recognized hazardous substances covered by OSHA. OSHA requires that exposure to hazardous materials that are not directly covered be monitored and maintained below the limits set forth by the American Conference of Governmental Industrial Hygiene (ACGIH), National Institute for Occupational Safety and Health (NIOSH), and manufacturers' recommended limits. OSHA and the ACGIH have established required or suggested exposure limits for various chemicals in use today. For materials that have more than one established exposure limit, the most stringent exposure limit will apply when determining exposure limits, monitoring requirements, effective control technologies, employee training, and reporting.

In determining the substances that are in use and the areas of exposure, the SSO will develop a program to monitor the operation. The PHSO will determine the potential for exposure and will monitor appropriately for the determination of hazard levels. In addition, the SSO will make any recommendations deemed necessary for the protection of worker health and safety. When hazards are identified, they will be addressed in accordance with the following prevention measures to eliminate the workplace hazards:

- Whenever possible, engineering controls will be implemented to eliminate or control hazards,
- Followed by administrative controls
- As a last resort, the use of personal protective equipment.

These potential hazards, are discussed in detail in Sections 5.0 and 6.0. Additionally, early recognition will be supported by periodic site surveys to eliminate any conditions that may predispose site personnel or properties to an emergency. These surveys will consist of ensuring:

- Approach paths to monitoring wells are maintained (cleared, mowed, etc.)
- Monitoring well protective casings are cleared of spider and insect nests.
- All equipment is inspected and ready for use looking for items such as guards, connections are pinned or whip checked control potential flailing in the event the connect disconnects.
- Ensure emergency equipment is staged, inspected, and is ready for immediate response.
- Ensure personnel are employing protective equipment as described in this HASP.

The FOL and the SSO will constitute the site evaluation committee responsible for these periodic surveys. Site surveys will be conducted at least once a week during the initiation of this effort. These surveys will be documented in the Project Logbook.

2.3.2 Prevention

Tetra Tech and subcontractor personnel will minimize the potential for emergencies by following the Health and Safety Guidance Manual and ensuring compliance with the HASP and applicable OSHA regulations. Daily site surveys of work areas, prior to the commencement of that day's activities, by the FOL and/or the SSO will also assist in prevention of illness/injuries when hazards are recognized early and control measures initiated.

2.3.3 Fire Prevention / Flammable Liquids

Tetra Tech and subcontractor personnel are responsible for fire prevention and protection in all of their work areas at all times during the duration of this field effort (24 hours per day/seven days per week). Since fuels will be maintained on site approved ABC fire-fighting extinguishers must be provided. Tt personnel and subcontractor personnel will only fight fires in the incipent stage (small fires) when there is no danger of injury to personnel. Fire beyond the incipant stage requires immediate site evacuation and notification of the Fire Department.

The Lockheed Martin Project Lead will be notified as soon as possible of any fire, if Tetra Tech or subcontractor personnel use a Lockheed Martin fire extinguisher, and of any and all fires that are extinguished. In case of fire, Tetra Tech and subcontractor personnel will call 9-1-1.

All flammable and combustible liquids must be stored, dispensed and used in accordance with OSHA regulations and the Uniform Fire Code. Bonding and grounding of containers containing flammable liquids will be required.

All fire prevention/flammable liquids safety procedures and requirements stipulated in Section 3.15 of the LM Handbook (Attachment I) will also be adhered to.

2.4 EVACUATION ROUTES, PROCEDURES, AND PLACES OF REFUGE

An evacuation will be initiated whenever recommended hazard controls are insufficient to protect the health, safety or welfare of site workers. Specific examples of conditions that may initiate an evacuation include, but are not limited to the following: severe weather conditions; fire or explosion; monitoring instrumentation readings which indicate levels of contamination are greater than instituted action levels; and evidence of personnel overexposure to potential site contaminants.

In the event of an emergency requiring evacuation, personnel will immediately stop activities and report to the designated safe place of refuge unless doing so would pose additional risks. When evacuation to the primary place of refuge is not possible, personnel will proceed to a designated alternate location and remain until further notification from the Tetra Tech FOL. Safe places of refuge will be identified prior to the commencement of site activities by the SSO and will be conveyed to personnel as part of the pre-activities training session. This information will be reiterated during daily safety meetings. Whenever possible, the safe place of refuge will also serve as the telephone communications point for that area. During an evacuation, personnel will remain at the refuge location until directed otherwise by the Tetra Tech FOL or the on-site Incident Commander of the Emergency Response Team. The FOL or the SSO will perform a head count at this location to account for and to confirm the location of site personnel. Emergency response personnel will be immediately notified of any unaccounted personnel. The SSO will document the names of personnel onsite (on a daily basis) in the site Health and Safety Logbook. This information will be utilized to perform the head count in the event of an emergency.

Evacuation procedures will be discussed during the pre-activities training session, prior to the initiation of project tasks. Evacuation routes from the site and safe places of refuge are dependent upon the location at which work is being performed and the circumstances under which an evacuation is required. Additionally, site location and meteorological conditions (i.e., wind speed and direction) may dictate evacuation routes. As a result, assembly points will be selected and communicated to the workers

relative to the site location where work is being performed. Evacuation should always take place in an upwind direction from the site.

2.5 EMERGENCY CONTACTS

Prior to initiating field activities, personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. Table 2-1 provides a list of emergency contacts and their associated telephone numbers. This table must be posted where it is readily available to site personnel. Facility maps should also be posted showing potential evacuation routes and designated meeting areas.

Any pertinent information regarding allergies to medications or other special conditions will be provided to medical services personnel. This information is listed on Medical Data Sheets filed onsite (see Attachment III). If an exposure to hazardous materials has occurred, provide hazard information from Table 6-1 to medical service personnel**.**

The Lockheed Martin Project Lead shall be contacted immediately in the event of a fatal or serious injury, and unpermitted environmental release, or any ESH incident that is likely to generate significant publicity or an adverse situation for Lockheed Martin. Detailed requirements are describe in Section 1.15 of the LM Handbook (Attachment I).

In the event of an emergency not requiring 9-1-1, LMC facility personnel should be contacted in the order presented on Table 2-1.

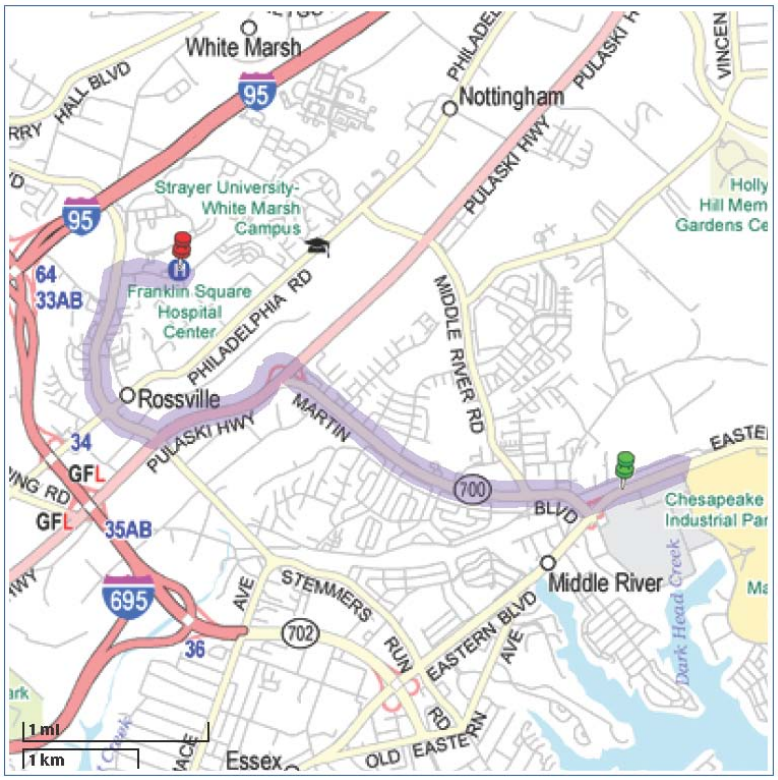
TABLE 2-1

EMERGENCY CONTACTS
LOCKHEED MARTIN MIDDLE RIVER COMPLEX, MARYLAND

AGENCY	TELEPHONE
EMERGENCY (Police, Fire, and Ambulance)	**911**
Franklin Square Hospital	(410) 682-7000
State of Maryland Emergency Response Center	(410) 974-3551
Local Emergency Planning Coordinator's office	(410) 887-2919
Chemtrec	(800) 424-9300
National Response Center	(800) 424-8802
Poison Control Center	(800) 222-1222
Mike Martin, Regional Manager	(301) 528-3022 office (410) 707-5259 cell
PM, Tony Apanavage	(301) 528-3021 office (301) 233-8230 cell
HSM, Matthew M. Soltis, CIH, CSP	(412) 921-8912
PHSO, Clyde Snyder	(412) 921-8904 (724) 516-0907 cell
Amy Stanford (PHP)	(706) 832-7394
Tom Blackman, Project Lead	(240) 460-7508
Mike Musheno, ESH/ Projects	(410) 682-1315 office (610) 656-4012 cell
Scott Lapp	(410) 682-0365 office (410) 967-8745 cell
John Morgan, Facilities Manager	(410) 682-1382 office (410) 215-4530 cell
Tom Ambrose, Facilities Supervisor	(856) 842-2590 cell
Chief Philip Johnston, LMC Security	(410) 682-1050

2.6 EMERGENCY ROUTE TO HOSPITAL

FIGURE 2-1
ROUTE TO HOSPITAL



From: **2323 Eastern Boulevard, Middle River 21220, Maryland**
To: **Franklin Square Hospital Center(Baltimore), MD**
Total Distance: **5.0 miles (8.0km)**
Total Estimated Time: **0 hrs., 13mins.**

Directions

2323 Eastern Boulevard, Middle River 21220, Maryland to Franklin Square Hospital Center(Baltimore), MD
Distance: 5.0 miles (8.0km) Time: 0 hrs., 13mins.

1. Start out heading EAST on EASTERN BOULEVARD. Drive for 0.3 miles.
2. Make a U-turn at MD-150 E. Drive for 0.3 miles.
3. Take exit on your RIGHT towards MD-700 / MARTIN BLVD / US-40. Drive for 0.2 miles.
4. Go STRAIGHT on MD-700 W. Drive for 1.6 miles.
5. Take US-40 W on your LEFT. Drive for 1 mile.
6. Turn RIGHT onto ROSSVILLE BOULEVARD. Drive for 1 mile.
7. Turn RIGHT onto FRANKLIN SQUARE DRIVE. Drive for 0.3 miles.
8. Turn LEFT onto HOSPITAL DRIVE. Drive for a short distance.
9. You have reached Franklin Square Hospital Center(Baltimore), MD

2.7 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

Tetra Tech personnel will be working in close proximity to each other at LMC MRC. As a result, hand signals, voice commands, and line of site communication will be sufficient to alert site personnel of an emergency.

If an emergency warranting evacuation occurs, the following procedures are to be initiated:

- Initiate the evacuation via hand signals, voice commands, or line of site communication
- Report to the designated refuge point where the FOL will account for all personnel
- Once non-essential personnel are evacuated, appropriate response procedures will be enacted to control the situation.
- If personnel have been evacuated from a radiological area, contact the PHP.
- Describe to the FOL (FOL will serve as the Incident Coordinator) pertinent incident details.

In the event that site personnel cannot mitigate the hazardous situation, the FOL and SSO will enact emergency notification procedures to secure additional assistance in the following manner:

Dial 911 and call other pertinent emergency contacts listed in Table 2-1 and report the incident. Give the emergency operator the location of the emergency, the type of emergency, the number of injured, and a brief description of the incident. Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies.

2.8 PERSONAL PROTECTIVE EQUIPMENT (PPE) AND EMERGENCY EQUIPMENT

A first-aid kit, eye wash units (or bottles of disposable eyewash solution) and fire extinguishers (strategically placed) will be maintained onsite and shall be immediately available for use in the event of an emergency. This equipment will be located in the field office as well as in each site vehicle. At least one first aid kit supplied with equipment to protect against bloodborne pathogens will also be available on site. Personnel identified within the field crew with bloodborne pathogen and first-aid training will be the only personnel permitted to offer first-aid assistance.

Safety eyewear meeting American National Standards Institute (ANSI) Z87.1 is required in areas designated as “Eye Projection Required” and is also required on all jobs where a potential injury to the eye is possible whether or not the area is posted.

Safety shoes and boots which meet the ANSI Z41 Standard shall be provided when impact and/or compression hazards exist.

Appropriate NIOSH-approved respiratory protective devices must be worn when applicable state and/or federal action levels or OSHA permissible exposure levels are exceeded. For Block E ½ face Air Purifying Respirators will be provided for the grass cutting activity.
Hearing protection must be worn in all areas posted to indicate high noise level or where employees are exposed to noise levels in excess of the OSHA action level (85 dBA over an 8-hour time-weighted average or a dose of fifty percent).

Protective clothing such as suits, aprons, boots or gloves shall be worn where there is a hazard to the body through dermal contact with chemicals, dusts, heat or other harmful agents or conditions.

Hard hats meeting the ANSI Z89.1 Standard will be worn in all areas where there is danger of impact to the head or hazard from falling or moving objects.

All personal protective clothing and equipment will be used and approved as detailed in Section 3.1 of the LM Handbook (Attachment I).

Protective clothing for radiological work, if applicable, will be worn in accordance with Tetra Tech Radiologicial Protection Operating Procedures (Tt RPOP), found in the project work plan.

2.9 HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE

Tetra Tech and subcontractor personnel conducting work at Lockheed Martin will adhere to Title 29, Code of Federal Regulations, Section 1910.120 – Hazardous Waste Operations and Emergency Response or the applicable state OSHA standards.

Tetra Tech and/or subcontractor personnel will to perform periodic work area inspections to determine the effectiveness of the site safety and health plan and to identify and correct unsafe conditions in the work area. These inspections shall be documented and available to Lockheed Martin upon request for review.

The requirements and regulations described in Section 3.20 of the LM Handbook (Attachment I) will be adhered to.

2.10 DECONTAMINATION PROCEDURES / EMERGENCY MEDICAL TREATMENT

During any site evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. Decontamination will be postponed if the incident warrants immediate evacuation. However, it is unlikely that an evacuation would occur which would require workers to evacuate the site without first performing the necessary decontamination procedures.

Tetra Tech personnel will perform rescue operations from emergency situations and may provide initial medical support for injury/illnesses requiring only "Basic First-Aid" level support, and only within the limits of training obtained by site personnel. Basic First-Aid is considered treatment that can be rendered by a trained first aid provider at the injury location and not requiring follow-up treatment or examination by a physician (for example; minor cuts, bruises, stings, scrapes, and burns). Personnel providing medical assistance are required to be trained in First-Aid and in the requirements of OSHA's Bloodborne Pathogen Standard (29 CFR 1910.1030). Medical attention above First-Aid level support will require assistance from the designated emergency response agencies. Attachment II provides the procedure to follow when reporting an injury/illness, and the form to be used for this purpose.

2.11 INJURY/ILLNESS REPORTING

Any pertinent information regarding allergies to medications or other special conditions will be provided to medical services personnel. This information is listed on Medical Data Sheets filed onsite (see Attachment III). If an exposure to hazardous materials has occurred, provide information on the chemical, physical, and toxicological properties of the subject chemical(s) to medical service personnel.

If any Tetra Tech personnel are injured or develop an illness as a result of working on site, the Tetra Tech “Injury/Illness Procedure” (Attachment II) must be followed. Following this procedure is necessary for documenting of the information obtained at the time of the incident.

Tetra Tech personnel will contact the LMC personnel in the order presented in Table 2-1 in the event of a fatality injury, environmental release (spill), near-miss incident, or an ESH incident that is likely to generate significant publicity. A written report of the incident/injury/spill and corrective action(s) must be submitted to LMC personnel within one (1) day of the incident.

Section 8.1 of the LM Handbook (Attachment I) describing the requirements of accident, injury, illness and incident reporting will be addressed.

2.11.1 TOTAL Incident Reporting System

TOTAL is Tetra Tech’s online incident reporting system. Use TOTAL to directly report health and safety incidents, notify key personnel, and initiate the process for properly investigating and addressing the causes of incidents, including near-miss events. An incident is considered any unplanned event. It may include several types of near misses, events where no loss was incurred, or incidents that resulted in injuries or illness, property or equipment damage, chemical spills, fires, or damage to motor vehicles.

A copy of the TOTAL incident reporting form is included in Attachment II. TOTAL is an intuitive system that will guide you through the necessary steps to report an incident within 24 hours of its occurrence. TOTAL is a that helps Tetra Tech to better track incidents, analyze root causes, implement corrective action plans, and share lessons learned.

TOTAL is maintained on the Tetra Tech Intranet site at https://my.tetratech.com/

Once on the "My Tetratech" site, TOTAL can be found under the Health and Safety tab, Incident Reporting section, select "Report an Incident (TOTAL)". This will connect you directly to TOTAL. TOTAL can also be accessed directly from the internet using the following web address: http://totalhs.tetratech.com/

Note: When using the system outside the Tetra Tech intranet system or when operating in a wireless mode, a VPN connection will be required. The speed of the application may be affected dependent upon outside factors such as connection, signal strength, etc. Enter the system using your network user name and password. The user name should be in the following format - TT\nickname.lastname.

2.12 DRILL/INCIDENT AFTER ACTION CRITIQUE

The FOL will conduct a drill or exercise to test the Emergency Action Plan. A critique with the site personnel after each drill or incident will be conducted. This critique provides a mechanism to review the incidents and exercises or drills to determine where improvements can be made. For incidents recorded in TOTAL, the FOL will utilize the Lessons Learned component for the critique.

3.0 SITE BACKGROUND

3.1 SITE HISTORY

The LMC MRC is located at 2323 Eastern Boulevard in Middle River, Maryland. The site consists of approximately 180 acres of land and twelve main buildings. The subject property also includes perimeter parking lots, an athletic field, Lot D (presently a vacant lot with a concrete foundation for former Building D), a trailer and parts storage lot, and a vacant waterfront lot. The site is bounded by Eastern Boulevard (Route 150) to the north, Dark Head Creek to the south, Cow Pen Creek to the west, and Martin State Airport to the east.

Currently, LMC MRC activities at the site are limited to facility and building management and maintenance. There are two main tenants at the site, Middle River Aircraft Systems (MRAS) and Naval Electronics & Surveillance Systems (NE&SS), also referred to as Vertical Launch Systems. MRAS conducts design, manufacturing, fabrication, testing, overhaul, and repair and maintenance of aeronautical structures, parts, and components for military and commercial applications. NE&SS conducts fabrication, assembly, testing and support of vertical launch systems. Historically, the property has been used for aircraft and missile launching systems design, development, and sales.

The purpose of these investigations are to characterize soil (surface/subsurface), surface water, groundwater, sediment, and indoor air quality in areas of the facility. Based on review of available facility information during the Phase I Environmental Site Assessment, no indication of current or historical site activities, within these areas, potentially resulting in a release of any hazardous substances or petroleum products was identified.

The facility is divided into blocks for the purpose of site investigations. The blocks included for investigation in this HASP are the following:

- Block D
- Block E
- Block F
- Block G
- Block H
- Block I*

*Work in Block I will not be conducted at this time information in this HASP is placed only for reference purposes at this time.

3.2 BLOCK E BUILDING D RAD INVESTIGATION

Recognized environmental condition (REC) #1 (Former Building D) is the only one of the three RECs located in Block E that were identified in the Phase I environmental site assessment that has a radiological concern. This investigation takes place in Tax Block E in former Building D. Former Building D, which was built in the early 1940s for final assembly of aircraft frames, was demolished in 1972. The building had an assembly floor (first floor), and a basement (current concrete slab), and occupied approximately 400,000 square feet.

The former basement areas were used for welding, extrusion milling, engine preparation, and assembly. The northwestern and southwestern portions of the basement housed several offices and laboratories used for radiological operations. Cleaning, plating, and finishing work areas were located along the southern interior wall near the building's center.

Since the building was demolished it had been used for storage, including the storage of airplane carcasses from the Martin State Airport air museum.

A radiological survey of REC #1 (Former Building D) was performed in April 2004 to determine if radiological activities possibly conducted in Building D had affected the underlying environmental media. The survey focused on the remaining Former Building D foundation slab where suspected radiological activities may have occurred. A cobalt-60 source was also located in the wet lab. The radiological survey covered two areas where isotopes were known to have been used, based on information obtained from MRC personnel who had been present when such operations occurred during the late 1950s–1960s. The primary area was in the southwestern portion of the building, along the southern exterior wall; the secondary area was immediately north of the first area, along the western exterior wall of Former Building D.

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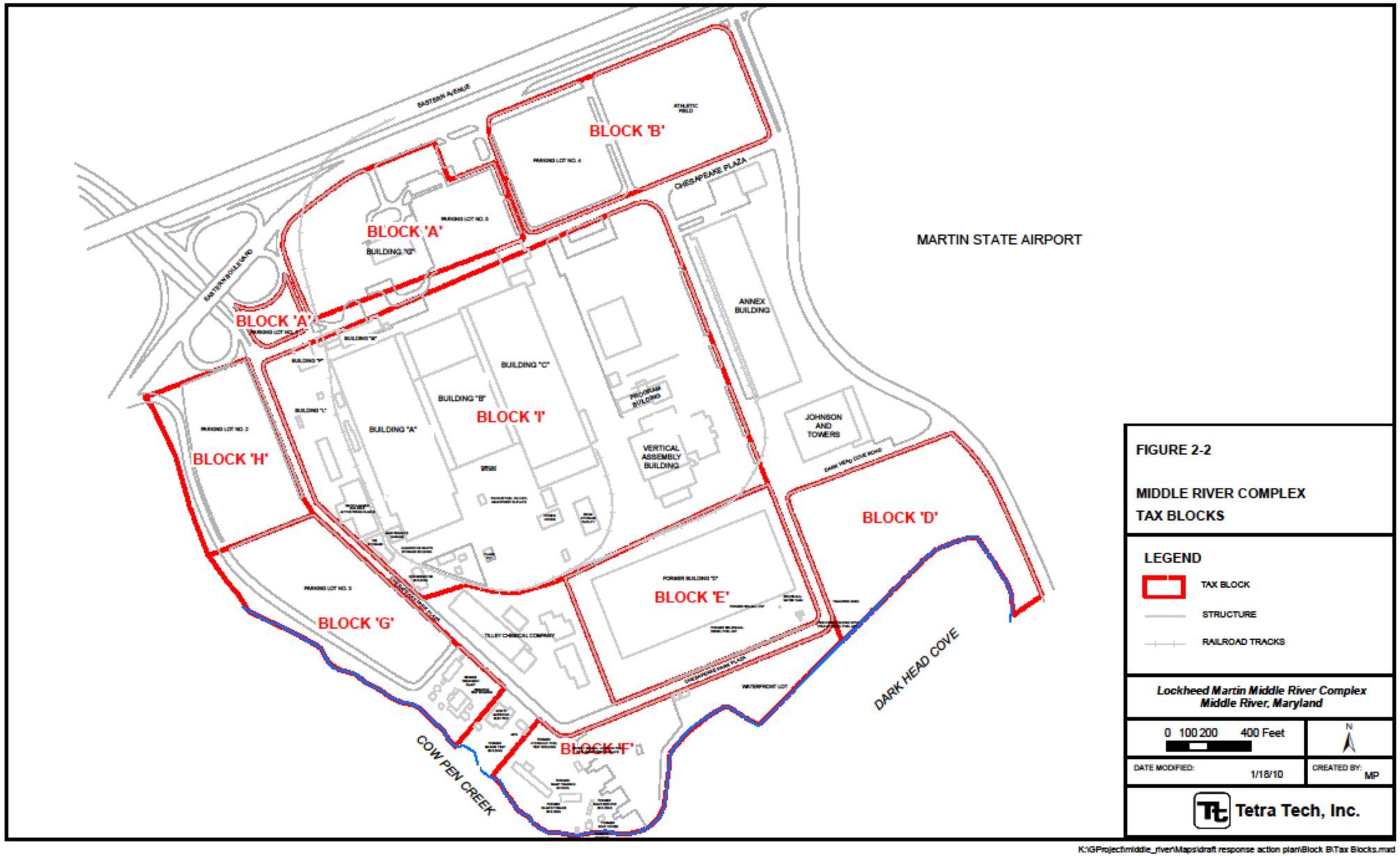
The radiological survey uses alpha and beta monitors and a gamma radiation survey instrument; see the Work Plan for more detailed explanation. See Figure 3-1 for the specific location of each block.

FIGURE 3-1

SITE MAP



K:\GProject\middle_river\Maps\draft response action plan\Block B\Tax Blocks.mxd

4.0 SCOPE OF WORK

This section discusses the specific tasks that are to be conducted as part of this scope of work. These tasks are the only ones addressed by this HASP. Any tasks to be conducted outside of the elements listed here will be considered a change in scope requiring modification of this document. The PM or a designated representative will submit the requested modifications to this document to the HSM.

Specific tasks to be conducted include the following:

- Mobilization/demobilization Activities
- Vegetation Management
  - Including grass cutting in Block E
- Indoor Air Quality Sampling using Summa Canisters
- Soil borings via Direct Push Technology (DPT)
- Soil Excavation, Removal and Replacement Blocks E, G and I
- Institu Remediation Blocks E and G including:
  - Soil Excavation
  - Pipe Installation
  - Extraction Well installation
  - Pre Contructed Pump Station Installation
  - Pre Constructed Pump Station Removal From Flatbed Truck And Placement
- Test Pits, Excavations
- Membrane Interface Probe via DPT
- Concrete Coring
  - Installation Of Permanent Soil Gas Vapor Monitoring Points
- Monitoring Well Installation
  - Installation and Development using DPT
  - Soil Vapor Points Installation
- Multimedia sampling including
  - Surface Water and Sediment Sampling from a Barge
  - Groundwater
  - Soil Vapor Points Sampling
  - Surface and Subsurface soil
  - Storm Water Sampling
  - Sediment Sampling
- Decontamination
  - Decontamination of grass cutting equipment at Block E

- Geophysical Survey
- Geographical Survey
- IDW Management
- Building D Rad Investigation
- Block E Additional Media Characterization:
  - Work Area Exposure Surveys
  - Collection of Background Samples
  - Collection of Soil, Concrete, and Perch Water Samples
  - Perform Surface Scans and Removable Contamination Surveys for Personnel Protection During Sampling and Imaging Operations.

For more detailed description of the planned tasks associated with LMC MRC, refer to the Work Plan (WP). Any tasks to be conducted outside of the elements listed here will be considered a change in scope requiring modification of this document. All requested modifications to this document will be submitted to the HSM by the PM or a designated representative.

No other activities are anticipated to be necessary. If it becomes apparent that additional or modified tasks must be performed beyond those listed above, the work is not to proceed until the FOL or SSO notifies the Project Manager and the HSM, so that any appropriate modifications to this HASP can first be developed and communicated to the intended task participants.

5.0 IDENTIFYING AND COMMUNICATING TASK-SPECIFIC HAZARDS AND SAFE WORK PRACTICES

The purpose of this section is to identify the anticipated hazards and appropriate hazard prevention/hazard control measures that are to be observed for each planned task or operation. These topics have been summarized for each planned task through the use of task-specific Safe Work Permits (SWPs), which are to be reviewed in the field by the SSO with all task participants prior to initiating any task. Additionally, potential hazard and hazard control matters that are relevant but are not necessarily task-specific are addressed it the following portions of this section.

Section 6.0 presents additional information on hazard anticipation, recognition, and control relevant to the planned field activities.

In the event of an emergency, not requiring calling 9-1-1, LMC facility personnel should be contacted in the order presented on Table 2-1.

5.1 GENERAL SAFE WORK PRACTICES

In addition to the task-specific work practices and restrictions identified in the SWPs (Attachment IV) the following general safe work practices are to be followed when conducting work on-site.

- Eating, drinking, chewing gum or tobacco, taking medication, or smoking in contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists is prohibited.

- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area.

- If a source of potable water is not available at the work site that can be used for hands-washing, the use of waterless hands cleaning products will be used, followed by actual hands-washing as soon as practicable upon exiting the site.

- Avoid contact with potentially contaminated substances including puddles, pools, mud, or other such areas.

- Avoid, kneeling on the ground or leaning or sitting on equipment.

- Keep monitoring equipment away from potentially contaminated surfaces.

- Plan and mark entrance, exit, and emergency evacuation routes.

- Rehearse unfamiliar operations prior to implementation.

- Buddies should maintain visual contact with each other and with other on-site team members by remaining in close proximity to assist each other in case of emergency.

- Establish appropriate safety zones including support, contamination reduction, and exclusion zones.

- Minimize the number of personnel and equipment in contaminated areas (such as the exclusion zone). Non-essential vehicles and equipment should remain within the support zone.

- Establish appropriate decontamination procedures for leaving the site.

- Immediately report all injuries, illnesses, and unsafe conditions, practices, and equipment to the SSO.

- Observe co-workers for signs of toxic exposure and heat or cold stress.

- Inform co-workers of potential symptoms of illness, such as headaches, dizziness, nausea, or blurred vision.

5.2 VEGETATION MANAGEMENT

Grass Cutting Safety

Chemical hazards are possible at Block E in the form of particulates (PCB's) during grass cutting operations. No chemical hazards are anticipated at the other Middle River Sites as part of this activity.

Block E Grass Cutting Personal Protective Equipment

During grass cutting operations at Block E the tractor/mower will not be removed from the site without being decontaminated for PCB's. The tractor/mower will be stored in a storage shed on site. The building will be locked when not in use. Grass cutting personnel will wear the following PPE.

- Tyvek Suit either blue or green in color (disposed of and changed after each round of grass cutting)
- Work Gloves (disposed of and changed after each round of grass cutting)i

- **Grass Cutting personnel will be prepared to wear a Half-Face tight fitting respirator with a hepa or dust filter following the tenants of the Respiratory Protection Program. (See Respiratory Protection Program in Attachment XII of this HASP). This will only be required if significant dust is generated that would cause exposure to PCB's. PCB's will attach to dust and could cause exposure if dust that obscures vision is produced.**
- Rubber Boots
- Cool Vests if required due to heat conditions
- Safety Glasses colored the UV Ray Protection
- Ball Cap for UV Ray Protection

All Block Physical hazards:

All vegetation removal equipment will be:

- Inspected in accordance with Federal safety and transportation guidelines, OSHA and manufacturers design and documented as such using Equipment Inspection Checklist provided in Attachment V.
- Only manufacturer approved parts may be used in repair of site equipment.
- Operated by knowledgeable ground crew.
- Restrictions at the operation (All personnel not directly supporting this clearance activity will remain at least 50-100 feet from the point of this operation).
- Hand signals will be established by both the chipper operator and backhoe operator prior to the commencement of clearing activities.
- All personnel will be instructed in the location and operations of the emergency shut off device(s). This device will be tested initially (and then periodically) to insure its operational status.
- Work areas will be kept clear of clutter to permit escape, if necessary.

All Block Weed Trimmer Safety

Practicing proper weed trimmer safety is important to your well being, and to the safety of those around you as you work. Emergency departments report thousands of injuries being treated each year that are related to weed eater use. A majority of these injuries were to the eyes.

One of the first and best places to start with lawn trimming safety is to read the operator's manual. It's full of personal protection recommendations, trouble shooting help, and basis maintenance routines that need to be followed. Practicing proper weed trimming safety can help prevent injuries, save time and money on repairs to both the equipment and to your property.

- Dress Properly
  - wear steel toed approved work boots

  - wear long pants
  - wear safety goggles to protect eyes
  - wear ear muffs to counteract trimmer noise
- Prep The Site
  - walk the area to be trimmed before you start
  - remove any debris, sticks, stones, children's toys etc
  - clear the area of people and pets, and be aware of them as you work
- Prep The Trimmer
  - check that guards and shields are in place
  - ensure there is enough nylon line on the spool
  - fill the gas tank when the engine is cold
  - let the engine cool down first when refilling is necessary
  - don't spill gas or light a match or smoke around gasoline
- Weed Trimmer Safety While Operating
  - start trimmer by laying it down in a clear area
  - hold the trimmer down firmly as you pull the engine start cord when the unit is harnessed to you, or held above ground level
  - keep the muffler side away from you to avoid burning your arms
  - be aware of keeping your balance and good footing, especially on slopes
  - lower the throttle speed when trimming near people or cars to reduce the speed of projected objects
  - never raise the cutting head above knee height
  - hold the trimmer so the debris is directed away from you
  - if the machine starts to shake or vibrate, shut it down immediately

Following these weed trimmer safety practices, along with routine service and maintenance, will keep your trimmer in top shape for seasons to come and more importantly, keep you safe and protected.

TIP: Always disconnect the spark plug before working on any power tool. Keep this in mind when you're cleaning out the grass guard at the end of your work.

Chipper Operations

Recommended Safety Practices:

- All safety devices and controls will be tested prior to the start of work, and checked periodically to insure equipment is safe for operation.

- Buddy system - At least two persons will be in close contact with one another when operating the chipper. One to engage safety controls to assist the other worker should the need arise.
- Work gloves, long hair, loose fitting clothing will be secured to avoid snagging and entanglement in brush or moving chipper components.
- Personnel will not place hands or feet past the entry plane of the feed hopper.
- Brush and limbs will be fed butt first, to allow these materials to sweep past the worker to avoid any hooking or dragging actions.
- Feed the brush and limbs from the side of the feed hopper.
- Once the blades takes hold of brush or limbs, step back, to avoid entanglement.
- Lay short materials on top of longer materials then feed materials by pushing the longer materials into the chipper.

Chainsaw Operations

Recommended Safe Work Practices:

- Inspect the chainsaw prior to each use. Insure the blade is adjusted and sharp, and all parts are lubricated per the manufacturer's instruction.
- Test all safety devices initially and then periodically to insure a safe operational status.
- When starting the chainsaw, place it on a firm surface. Place your foot in the hand guard at the rear of the saw, grip the top handle, pull the start cord with the free hand. Never attempt to start the saw free hand, or by placing it on your knee.
- Never cut with tip of the chain saw blade.
- Plan the cut. Know where the tree will fall. Have a clear escape plan when dropping trees greater than 2 inches in girth.
- Preview the tree to be dropped looking for insect nests bees and hornets that may be nesting in hollowed out trunks and tree tops.
- Do not stand between falling trees, branches, equipment or other trees.
- Never cut above your head.
- Cut only wood with the chain saw.
- Where prescribed safety equipment as described in the Safe Work Permit.
- Monitor, the condition of the saw during use, make adjustments, as necessary.
- When cutting a limb, cut from the opposite side of the trunk, the trunk will act as a shield to protect the worker.
- Be attentive as to how the trunk may move when removing limbs, keep yourself out of the pathway of falling limbs or branches.
- Keep the work area free from clutter to avoid potential slip, trip, and fall hazards.

Hand Tools

If hand tools (brush hooks, machetes, etc.) are used to clear brush and small trees the following precautions should be followed:

- Inspect handles are they in good condition (no cracks, splinters, loose heads/cutting apparatus.
- Check cutting tools edges all blades should be sharp without knicks or gouges in the blade.
- All hand tools (brush hooks, machetes, etc.) should be kept in a sheath when not in use.
- A 10-foot perimeter will be established around areas where brush clearing is being conducted.

Note: Excessive noise levels (raising your voice to speak to someone within two feet) will be require the use of hearing protection.

General Safety Requirements for Clearing and Grubbing

- Avoid insect nesting areas, employ repellents. Report potential hazards to the SSO.
- A backhoe or hand tools (rakes, pitch forks, etc.) will be used to pull brush away from piles to avoid nesting areas. Do not use hands or feet for this purpose.
- Traffic considerations:
  - Establish safe zones and routes of approach to the operation.
  - All personnel working among equipment traffic are required to wear reflective vests.
  - Secure all loose clothing articles to avoid possible entanglement.
  - Boundaries will be established based on the size of trees give sufficient space to keep personnel away from hazards (noise, flying projectiles, etc.)

5.3 DRILLING (HSA/DPT/HANDCART MOUNTED DPT UNIT/ROTOSONIC) SAFE WORK PRACTICES

The following Safe Work Practices are to be followed when working near operating drilling equipment.

5.3.1 Before Drilling

- Identify underground utilities, buried structures, and aboveground utility lines before drilling. Tetra Tech personnel will use the Utility Locating and Excavation Clearance Standard Operating Procedure provided in the Tetra Tech Health and Safety Guidance Manual.

- Drill rigs will be inspected by the SSO or designee, prior to the acceptance of the equipment at the site and prior to the use of the equipment. Needed repairs or identified deficiencies will be corrected prior to use. The inspection will be accomplished using the Equipment Inspection Checklist provided in Attachment V. Additional inspections will be performed at least once every 10-day shift or following repairs.

- Check operation of the Emergency Stop/Kill Switch and/or the "Dead Man's" operational controls. These operational checks are required initially as part of the equipment pre-use inspection, and then periodically thereafter. Periodic checks are required at least weekly, or more frequently if recommended by the rig manufacturer.

- Ensure that machine guarding is in place and properly adjusted.

- Block drill rig and use out riggers/levelers to prevent movement of the rig during operations.

- The work area around the point of operation will be graded to the extent possible to remove any trip hazards near or surrounding operating equipment.

- The driller's helper will establish an equipment staging and lay down plan. The purpose of this is to keep the work area clear of clutter and slips, trips, and fall hazards. Mechanisms to secure heavy objects such as drill flights will be provided to avoid the collapse of stacked equipment.

- Potentially contaminated tooling will be wrapped in polyethylene sheeting for storage and transport to the centrally located equipment decontamination unit.

- Prior to each instance of engaging the HSA drill rig, the Driller will look to ensure that the drilling area is clear of personnel and obstructions, and verbally alert everyone in the area that the rig is about to be engaged.

- Prior to the start of boring operations, one individual will be designated at the person responsible for immediate activation of the emergency stop device (if applicable) in the event of an emergency. This individual will be made known to the field crew and will be responsible for visually checking the work area and verbally alerting everyone of boring operations prior to engaging the equipment.

5.3.2 During Drilling

- The Driller will ensure that an individual is constantly stationed at a location were the drill rig emergency stop switch can be immediately engaged.

- Minimize contact to the extent possible with contaminated tooling and environmental media.

- Support functions (sampling and screening stations) will be maintained a minimum distance from the drill rig of the height of the mast plus five feet or 35-feet for Rotosonic/HSA, 25-feet for DPT operations whichever is greater to remove these activities from within physical hazard boundaries.

- Only qualified operators and knowledgeable ground crew personnel will participate in the operation of the drill rig.

- During maintenance, use only manufacturer provided/approved equipment (i.e. auger flight connectors, etc.)

- In order to minimize contact with potentially contaminated tooling and media and to minimize lifting hazards, multiple personnel should move auger flights and other heavy tooling.

- Only personnel absolutely essential to the work activity will be allowed in the exclusion zone.

5.3.3 After Drilling

- Equipment used within the exclusion zone will undergo a complete decontamination and evaluation by the SSO to determine cleanliness prior to moving to the next location, exiting the site, or prior to down time for maintenance.

- Motorized equipment will be fueled prior to the commencement of the day's activities. During fueling operations equipment will be shutdown and bonded to the fuel source.

- When not in use drill rigs will be shutdown, and emergency brakes set and wheels will be chocked to prevent movement.

- The mast will be completely lowered and outrigger completely retracted during movement to decontamination or the next location.

- Areas subjected to subsurface investigative methods will be restored to equal or better than original condition. Any contamination that was brought to the surface by drilling or DPT operations will be removed and containerized. Physical hazards (debris, uneven surfaces, ruts, etc.) will be removed, repaired or otherwise corrected. In situations where these hazards cannot be removed these areas will be barricaded to minimize the impact on field crews working in the area.

5.3.4 Concrete Coring Operations

The following safe work practices will be employed during concrete coring operations:

- Identify underground utilities before commencing any concrete operations.
- Use wetting techniques to minimize dust and friction.
- When applying water to the core bit the operator should apply water until the slurry begins to look like heavily creamed coffee.
- Wear the well-fitting nitrile gloves (rather than cotton or leather gloves) when in coring.
- Wash and dry hands before putting on gloves and every time that you remove your gloves.
- Replace grossly contaminated or worn-out gloves.
- Make sure the coring machine is properly anchored.
- Standing on the machine may cause the bit to bind up in the hole
- Use the manufacturers recommended speed (revolutions per minute) for the diameter of the bit used.
- The coring machine will be inspected to ensure housings; plugs; guards are intact, and the coring machine is in good operating order.
- If the power source to be employed is not through a Ground Fault Circuit Interrupter (GFCI) then a temporary GFCI plug extension shall be put in place.

- A shop vac or similar device also connected to the GFCI will be used to collect the water employed during the coring process. All water in the coring area will be cleaned to reduce the potential for slip, trip and falls. Place floor wet signs as necessary from all approach venues.

- The preferred method is to bolt the coring machine to the floor during coring operations. It is however acceptable to utilize sand bags or similar weighted devices to control movement during this activity.

- No open core holes will be permitted after the termination of the shift. All cores will be placed back in the holes or the holes will be fitted for their permanent casings for the sub-slab soil gas vapor monitoring points.

- All core holes finished with protective casings or finished using concrete will be finished to grade again to prevent slip, trips, and/or falls.

5.4 TREATMENT SYSTEM INSTALLATION

JRW Bioremediation L.L.C. provides substrates and nutrients for anaerobic bioremediation. The substrates provided is a highly soluble material lactoil® soy microemulsion. This system adds a carbon substrate to the system to establish and maintain an anaerobic environment capable of promoting reductive dechlorination for a period of time sufficient to completely dechlorinate the contaminants of concern.

5.4.1 Excavation for Pipline Installation

- Utility clearances must be in place prior to the beginning of excavation (in accordance with the Tetra Tech Utility Locating SOP and complete Utility Locate/Excavation Clearance Permit Request).
- Excavation boundaries must be demarcated with appropriate warning signs (e.g., construction activities in progress).
- Traffic patterns for equipment and the loading of trucks must be established. This pattern should form a loop to minimize backing, an activity which causes many accidents.
- Traffic patterns for foot and small vehicular traffic must keep workers away from heavy equipment.
- Traffic patterns for heavy equipment must be constructed to maintain traffic flow a minimum of 10 feet from unsupported walls or excavation boundaries.
- Excavation along thoroughfares will require the use of warning signs, barricades and flag-persons for alteration of traffic patterns, as necessary.
- Ground personnel should be provided with reflective vests to increase visibility and air horns to signal loud trucks and heavy equipment.
- Ground activities with heavy equipment must be supported with a ground spotter.

- The operators should be instructed that they are to follow the instructions provided by the ground spotter unless another party is otherwise authorized.
- Surface encumbrances within the intended work area of the excavation will be removed or supported, as necessary, in accordance with OSHA 1926.651(a).
- Prior to being put into service at the site, the excavator will be inspected by the SSO, and this inspection will be documented using the applicable equipment inspection forms.
- Heavy equipment will be positioned and operated so that it never approaches closer than 4 feet from the edge of an open excavation (other than the boom and bucket portion of the excavator).
- A decontamination station should be established at the loading and off-loading areas to flush mud and dirt from the wheels and tires as well as any areas of the vehicle impacted during the loading operation.

Note: Tetra Tech personnel WILL NOT enter a trench past 4 feet deep

5.4.2 Positioning Pump Building and Equipment

Site personnel will assist each other when positioning the pumping unit. The following procedures will be followed when placing the pre-built pumping units:

- Wear leather gloves. lift heavy objects using the legs and not the back.
- Use wheeled transport equipment for heavy loads.
- Keep hands away from potential pinch points during handling.
- Wear steel toe shoes/boots.
- Ensure that influent supply and discharge hoses and electrical outlet are within reaching distance.

5.4.3 Critical Lift

A non-routine lift requires additional detailed planning and additional or more than normal safety precautions. Critical lifts include lifts made when the load weight is 75% or more of the rated capacity of the lifting equipment at a specific configuration (boom angle, lift radius, swing, etc.); lifts which require the load to be lifted, swung, or placed out of the operator's view; lifts made with more than one piece of lifting equipment; lifts involving non-routine or technically difficult rigging arrangement(s); hoisting of personnel with a crane or derrick; or any lift which the lifting equipment operator believes should be considered critical. Any lift of 30,000 pounds or more should be considered a critical lift, regardless of the crane capacity. The 30,000 pound criteria should be evaluated by the Project Manager and the Site Safety Officer (SSO) for the advisability of lowering the criteria based on project-specific factors such as:

- Capacity of the lifting equipment to be employed on the project, frequency
- Nature of the lifting activities, and availability of experienced personnel.

- Establishment of project-specific criteria for determination of critical lifts should be documented by the Project Manager.

5.4.4 Critical Lift Plan

A plan will prepared by the crane operator, lift supervisor, project engineer (or designee), and rigger, as applicable, prior to making a critical lift. The critical lift plan will be documented, and reviewed by and signed by all personnel involved with the lift.

5.4.5 Failure Mode

There are two generally recognized modes of failure of cranes when the rated capacity is exceeded, depending on the crane configuration: a structural failure occurs when the boom, jib, or other component of the crane suddenly fails (there is usually no advance warning of an impending structural failure); an overturning failure occurs when the crane is pulled over by the weight of the load (there may be advance warning of an impending overturning failure as weight is transferred from the outboard tires, crawler track, or outriggers, causing these to rise as the back side of the crane becomes “light”).

5.4.6 Lift Personnel

Lift supervisor:

- A competent person who has extensive knowledge and experience in lifting operations.

Qualified Operator

- An operator who is qualified to operate the crane in accordance with the standards promulgated in OSHA 29 CFR 1926.1427, who is licensed or certified to operate the crane, or who:
  - Has extensive knowledge and experience, and who has successfully demonstrated the ability to operate the equipment and to solve or resolve problems related to operation of the equipment.
  - One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project. OSHA 29 CFR 1926 Subpart CC – cranes and derricks in construction.

Note: Critical Lifts will be in compliance with the Tetra Tech Safe Work Procedure DCN5-37 Critical Lift Safe Practices and and Critical Lift Plan Master Checklist in Attachment X.

5.4.7 Safe Load Securing Guidelines

Loads are secure and do not exceed manufacturer's specifications and legal limits for the vehicle. Vehicles will be equipped with only necessary equipment, laid out or positioned in the safest configuration. Loads, equipment and other items shall be tied down or secured before commencing motion, and total weight shall never exceed the weight limitations of the vehicle.

- Loads, equipment and other items transported external to the driving compartment or on a trailer shall be:
  - Secured in such a manner to prevent against the loss of the load via leaking, spilling, blowing off or falling from the motor vehicle.
  - Contained, immobilized or secured in such a manner to prevent shifting.
  - If likely to roll, restrained by chocks, wedges, a cradle or other equivalent means to prevent rolling.
  - If considered top heavy and capable of tipping, secured in such a manner to prevent tipping.
  - If placed beside each other and secured by transverse tie-downs, either placed in direct contact with each other or prevented from shifting towards each other while in transit.
  - Securing devices and systems shall be capable of withstanding the following three forces, applied separately:
    - 0 Deceleration in the forward direction.
    - 0 Acceleration in the reverse direction.
    - 0 Acceleration in a lateral direction.
- The manufacturer shall apply any tie-down points added to a vehicle, or the tie-down points shall
- meet manufacturer's specifications.
- Loads, equipment and other items transported under a pickup truck bed-covering device shall be
- considered secured.
- The driver shall verify that loads, equipment and other items transported inside a vehicle's driving
- compartment are secure and/or positioned to eliminate or minimize safety risks to the occupants.
- When loading these items, the driver shall consider:
  - Transporting them in the trunk of a car (e.g., a suitcase or computer bag).
  - Stowing them under or behind a seat, glove box or armrest console.
  - Covering them with netting or holding them in the seats with seatbelts or similar devices.

Note: Loading will be accomplished using theTetra Tech Safe Work Procedure SWP 5-38 Safe Load Securing Guidelines in Attachment XI.

5.4.8 Handling Procedures for Lactoil

- Store unopened under dry conditions at temperatures between 50°F and 85°F.
- Diluted product should be used within 3 days to avoid microbial growth and activity which may cause gas buildups in containers and visible growth which may foul equipment.
- Following injection of material, wells should be flushed with clean water to prevent microbial growth.

5.5 SAFE BOATING PRACTICES (I.E., WORKING FROM WATER VESSELS/BARGES)

Offshore soil boring activities will require site personnel to work from barges in tidal bodies of water. To avoid potential hazards associated with working on water (drowning), the field team shall employ lifelines (tie-off procedure), safety harnesses, when on the barge. U.S. Coast Guard (USCG) approved personal flotation devices (PFD) will be on hand for all participants and will be used. Due to the obvious hazards associated with working on water during inclement weather, field activities may be temporarily suspended or terminated at the discretion and direction of the FOL or SSO. Tetra Tech personnel will also follow the Tetra Tech procedures for working over water outlined in Standard Opering Procedure SWP 5-6 found in Attachment VI.

Refer to the Tetra Tech Boat Safety Checklist in Attachment VII of this HASP.

5.5.1 U.S.C.G. Flotation Device Types

Use the following information to determine the proper type of U.S.C.G. PFD.

Off Shore Life Jacket (Type I, 22lbs buoyancy)

Type I life jacket is the best choice for rough or open waters. This type will float you the best and is favorable if rescue may be long in coming. This type will turn an unconscious person upright in the water. Though is bulky it does have a highly visible color for easier detection.

Near Shore Buoyant Vest (Type II, 15.5lbs buoyancy)

Type II is a good choice for calmer waters. It will turn most unconscious persons face-up in the water. Though it is less bulky than Type I, it is not intended for long hours in calm or rough water.

Flotation Aid (Type III, 15.5lbs buoyancy)

Type III is probably the most comfortable device offering more freedom of movement, such as water skiing or fishing, but is not intended for rough water. Also, an unconscious person may end up face-down in the water.

Throwable Devices (Type IV)

Throwable devices are intended for calm waters with heavy boat traffic where help is always close. It is not intended for unconscious persons or non-swimmers or long hours in the water. They are good backups for the other devices.

Site personnel shall wear Type III personal flotation devices in the event someone falls overboard, boats sinks or capsizes. Type IIIs were selected as they offer the most flexibility for working while still meeting minimum requirements for buoyancy. In situations where personal flotation devices cannot be worn due to the task to be conducted, the flotation devices shall be immediately available/accessible. It is recommended that personal flotation devices be continually worn during colder months due to the potential for hypothermia to restrict muscle movement and therefore, self rescue and maintaining buoyancy. In addition, a single Type IV Throwable Flotation Device shall be maintained on board the boat with at least 90 feet of 3/8 polypropylene line.

When work activities take personnel within four feet of navigable waters edge personnel will have immediately accessible a lifeline with a throwing bag or Type IV flotation device facilitate extraction from the water. Personnel working on water's edge will do so using the buddy system to assist in rescue efforts, if needed.

Device	Type	Description
Off Shore Life Jacket	Type I 22lbs buoyancy	Best in rough or open waters. Floats best especially in long time rescue. Will turn unconscious upright. Bulky but highly visible.
Near Shore Buoyant Vest	Type II, 15.5lbs buoyancy	Good in calmer waters. Will turn most unconscious face-up. Less bulky. Not for long time rescue.
Flotation Aid	Type III 15.5lbs buoyancy	Most comfortable device offering more freedom of movement. Not intended for rough water. Unconscious may end up face-down
Throwable Devices	Type IV	Throwable devices for calm waters with heavy boat traffic where help is always close. Not for unconscious, non-swimmers or long hours. Good backups for the other devices.

5.5.2 U.S.C.G Boat Regulations

No person born on or after April 1, 1986 shall operate a vessel that is fitted with propulsion machinery of more than ten (10) horsepower on waterways unless the person has successfully completed a boating safety education program as approved by the director of the Department of Environmental Management. Certain bodies of water in some states may also have local restrictions as to type and size of watercraft or motor horsepower, restricted use areas, boat speed, and times for use. The FOL is responsible for checking with appropriate local authorities to identify and address any additional requirements/restrictions.

The U.S.C.G. requires boats to have the following equipment on board:

- One personal flotation device per person
- A sound producing device such as an air horn or whistle which can be heard one half mile.

Speed Limits

Any motorboat or vessel operated within a harbor or inlet or any pond of other confined body of water shall not exceed 45 mph from sunrise to sunset and 25 mph during periods of darkness or restricted visibility. Lower speed limits may be regulated in certain areas.

Reckless and Negligent Operation

Negligent or grossly negligent operation of a vessel which endangers lives and/or property is prohibited by law. A civil penalty may be imposed by the Coast Guard for this offense under federal laws. An operator may be subjected to a fine of up to $5,000 and or imprisonment for up to one year, or both. The Maryland penalty is a fine of up to $500 for the first offense.

Some examples of actions that may constitute negligent or grossly negligent operation include but are not limited to:

- Operating in a swimming area
- Operating under the influence of alcohol or drugs.
- Excessive speed in the vicinity of other boats or in dangerous waters.
- Hazardous water skiing practices
- Bow riding, also riding on seatback, gunwale or transom.

Termination of Use

A Maryland Natural Resources Police Officer who observes a boat being operated in an unsafe condition and who determines that an especially hazardous condition exists may direct the operator to take immediate steps to correct the condition, including returning to port. Termination for unsafe use may be imposed for, but is not limited to:

- Insufficient number of USCG approved Personal Flotation Devices.
- Insufficient fire extinguishers.
- Overloading beyond manufacturer's recommended safe loading capacity.
- Improper navigation light display.
- Ventilation requirements for tank and engine spaces not met.
- Fuel leakage.
- Fuel in bilges.
- Improper backfire flame control.

Boating Accident Reports

The operator of any boat involved in an accident must stop, render assistance, and offer identification. An accident report must be made to the Department within 48 hours if:

- A person dies within 24 hours;
- A person loses consciousness or receives medical treatment beyond first aid or is disabled more than 24 hours;
- A person disappears from the vessel under circumstances that indicate death or injury.

Accidents must be reported within 10 days if damage to all vessels and other property totals more than $500.00 or an earlier report is not required. Running aground or hitting a fixed or floating object is considered a boating accident. Boating accident report forms (DNR-149) are obtainable from the Natural Resources Police. They must be submitted to the Natural Resources Police by the operator of the vessel or vessels involved. Accident reports are required by federal law and furnish information for use in accident prevention. Information from individual reports will not be publicly disclosed nor may the information be used in court.

Rendering Assistance

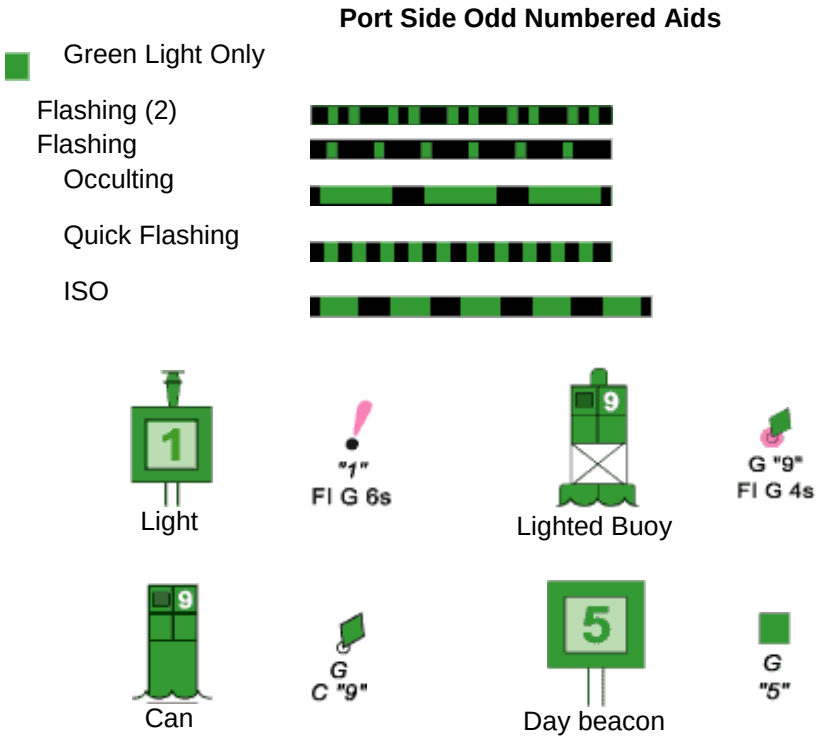
Federal law requires the operator of a vessel to provide assistance that can be safely provided to any individual in danger on the water. Persons who fail to provide assistance may be subject to fine or imprisonment.

Vessels Required to be Registered in Maryland

All vessels, whether commercial or recreational, must be registered in Maryland if it is equipped with any kind of primary or auxiliary mechanical propulsion; if it is not currently documented with the U. S. Coast Guard; and if it is being used principally in Maryland. An owner of a federally documented vessel, though exempt from state numbering requirements, shall apply to the Maryland Department of Natural Resources for documented use decals, and is subject to the state excise tax requirements.

5.5.3 Uniform State Waterway Marking System (USWMS)

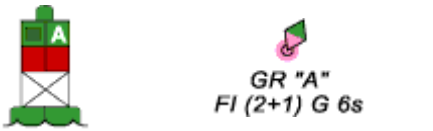
Lateral System (As Seen Entering From Seaward)



Preferred Channel No Numbers-May Be Lettered
Preferred Channel To Starboard Topmost Band Green

Green Light Only

Composite Group Flashing (2+1)



Day beacon

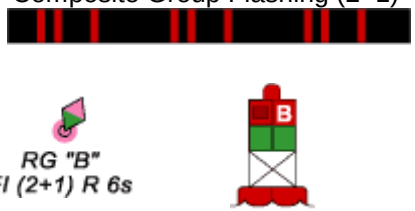
Can

Preferred Channel No Numbers-May Be Lettered

Preferred Channel To Port Topmost Band Red

Red Light Only

Composite Group Flashing (2+1)



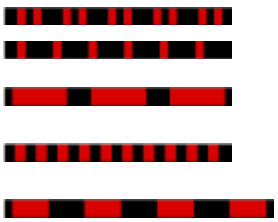
Nun

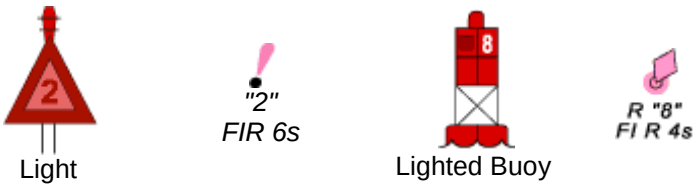
Day beacon

Starboard Side Even Numbered Aids

Red Light Only

Flashing (2)
Flashing
Occulting
Quick Flashing
ISO





Light

Lighted Buoy

Nun

R
N"6"

Day beacon

R
"2"

Lateral Aids to Navigation generally indicates which side of an aid to navigation a vessel should pass when channels are entered from seaward. In the absence of a route leading from seaward, the conventional direction of buoyage, generally follows a clockwise direction around landmasses. The most important characteristic of an aid is its color. The "3R" rule "Red Right Returning" is the essential rule of thumb for using the lateral system. This means that when entering one body of water from a larger body of water (i.e. returning to a harbor from a bay or sound), keep the red aids to starboard (right) side and green aids to port (left) side. In addition, each aid is numbered, and these numbers increase as entering from seaward.

Preferred Channel Marks are found at junctions of navigable channels and often mark wrecks or obstructions. A vessel may normally pass this aid on either side, but the top color band indicates the preferred channel. If the top band of the aid is red, it is treated as a red mark and kept to starboard as the vessel passes it while returning from sea. Caution: It may not always be possible to pass on either side of preferred channel aids to navigation. The appropriate nautical chart should always be consulted.

Lateral System

May show green reflector or light

Port Side

Solid Black Buoy
(Being replaced by Green Can Buoy)

Usually found in pairs pass between these buoys

_ Looking upstream _

May show red reflector or light

Starboard Side

Solid Red Buoy
(Being replaced by Red Nun Buoy)

Cardinal System

May show white reflector or light

Red striped white buoy

Do not pass between buoy and nearest shore

Black topped white buoy

Pass to north or east of buoy

Red topped white buoy

Pass to south or west of buoy

5.6 PERMANENT SOIL GAS VAPOR MONITORING POINTS WITHIN BUILDINGS SAFE WORK PRACTICES

Installation of permanent soil gas vapor monitoring points (VMP) will be conducted within buildings on site. Soil gas monitoring points will be installed at various locations using electric powered concrete coring machine will be used to push through the concrete floor.

Prior to installation of the VMPs, appropriate procedures will be followed to address the potential presence of asbestos-containing materials (ACM) at all proposed VMP locations. An outside contractor licensed by the State of Maryland to manage all aspects of asbestos will perform inspections and sampling if necessary to determine the absence or presence of ACM prior to any work being performed. If necessary, ACM such as floor tile will be removed to facilitate installation of the new VMPs. All removed materials will be replaced to prevent any potential tripping hazards. After final locations have been established, Tetra Tech will initiate subsurface utility clearance. Tetra Tech will place a call to Miss Utility and, in addition, will use a private utility locating service (Enviroscan) to identify and mark subsurface utilities and anomalies. All utilities within a 15-foot radius of each designated drilling location will be located using the appropriate technology and marked with paint. Standard utility locating methods may not be effective based on the presence of subsurface metal (rebar) or the presence of metal-stored materials. In the case that standard methods are not effective, alternative methods such as line tracing will be utilized to effectively identify and mark any utilities. Proposed VMP boring locations may be offset based on the results of the asbestos or subsurface utility survey.

Operation of electric powered equipment within enclosed areas such as buildings presents the hazard of dusts generated during concrete coring. Additional hazards that may be present during these operations include, increased noise levels, contact with utilities, electrocution hazards (particularly if water is

present). Use wetting methods to suppress airborne dusts generated during concrete coring within a building.

5.7 EXCAVATION SAFE WORK PRACTICES

Soil excavation activities will be performed through the use of a track or wheel mounted excavator that is outfitted with a boom and excavator bucket that is adequate to complete the entire excavation task in a manner that will not involve or require any entry into the open excavation by any person or by any part of the excavator except for the boom/bucket. The process for performing the excavation and the visual inspections will involve the following:

- First, any surface encumbrances within the intended work area of the excavation will be removed or supported, as necessary, in accordance with OSHA 29 CFR 1926.651(a).

- The FOL will assure that the intended excavation area is cleared of any utility installations that may reasonably be expected to be encountered during excavation work (in accordance with the Tetra Tech Utility Locating SOP and with OSHA 29 CFR 1926.651 [b]).

- Prior to being put into service at the site, the excavator will be inspected by the SSO, and this inspection will be documented.

- The excavator will be positioned and operated so that it never approaches closer than 4 feet from the edge of an open excavation (other than the boom and bucket portion of the excavator).

- At no time during the active operation of the excavator will any person (other than the operator) be permitted to approach the vehicle closer than a distance of the length of the excavator boom and bucket (fully-extended) plus 5 feet, but not less than 25 feet, whichever is greater.

- After a test pit has been created, and after the excavator has been either removed or completely neutralized or shut down, Tetra Tech personnel may approach to perform the visual inspection activities. Tetra Tech personnel will not be permitted to enter any open excavation or approach closer than 2 feet from the edge of an open excavation.

Hazards associated with these activities may include:

- Being struck by the excavator or being trapped between an immovable object and the excavator.
- Being struck by truck traffic being loaded out.

- Slips, trips, and falls associated with movement over uneven terrain or over the sidewall of the excavation
- Contact with contaminants of concern.

Control measures will include:

- The Tetra Tech Site Safety Officer will serve as the Excavation Competent Person (as defined in OSHA 29 CFR 1926.651 [b], as "*one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them".*

- Assuring that all personnel remain clear of the operating excavator at all times during its operation (a minimum "no approach" zone of 25 feet from the excavator or the length of the fully extended excavator boom/bucket length plus 5 feet, whichever is greater).

- ***All work tasks will be performed in a manner that does not require any entry into an open excavation***. In fact all persons are to be restricted form approaching within 2 feet of the edge of any open excavation.

- The FOL and the Excavator Operator will establish and maintain clear communications at all times. Also, the FOL is responsible for assuring that all persons are aware that it is their responsibility to remain outside of the "No Approach" Zone and out of the operator's blind spots.

- Hard hat, hearing protection and a high visibility vest will be required by all persons working near the excavation work area. Also, all personnel will be required to wear steel toe safety footwear, preferably with sole designs that include an aggressive lug to enhance traction

- Personnel will be made aware that they are to never place him/herself between the excavator and an immovable object.

- The assignment of an Excavation Competent Person is also an important part of hazard recognition, evaluation, and control to protect personnel during excavation activities.

Excavation Competent Person (ECP)

The ECP is responsible for addressing responsibilities as defined in OSHA 29 CFR 1926 Subpart P. For this project, the SSO will serve as the ECP. Specific ECP responsibilities include the following:

- Assuring that surface encumbrances are avoided, removed, or supported in accordance with (IAW) OSHA 29 CFR 1926.651 (a)

- Assuring that the FOL has accomplished the utility locating/avoidance processes prior to beginning any excavation (IAW OSHA 29 CFR 1926.651 [b])

- Assuring that no load (e.g., excavator boom or bucket) passes over the head of any person (IAW OSHA 29 CFR 1926.651[e])

- Assuring that adjacent structures, sidewalks, etc. are not undermined by excavation activities.

- Assuring that stockpiled material is placed in a location, at a height, and in a manner that does not represent the hazard of employees being struck by loose or falling materials.

- Because it is anticipated that excavations will be backfilled to grade the same day that they are created, the need to perform visual inspections (such as daily and after rain events, as specified in OSHA 29 CFR 1926.651[k][1]) should not be necessary. However, if such a need is encountered due to inclement weather or other reason, the ECP will be responsible for performing and documenting these excavation inspections. The inspection checklists in Attachment V are provided for this purpose.

- Assuring that stockpiled material will be placed no closer than 4 feet from the edge of an open excavation.

5.8 HAND AND POWER TOOL SAFE WORK PRACTICES

The following safe work practices will be employed during hand and power tool usage:

- All hand and power tools will be maintained in a safe condition.
- Electrical power tools shall be grounded or double insulated with proper assured equipment grounding inspections or Ground Fault Interrupter (GFI) circuit protection provided.
- Pneumatic power tools shall be secured to the hose or whip by some positive means.
- Only properly trained Contractor employees shall operate power-actuated tools.
- All grinding machines shall conform to OSHA and ANSI requirements.

Hand and power tool use procedures are detailed in Section 3.16 of the LM handbook and will be followed.

5.9 HOUSEKEEPING / CLEANUP SAFE WORK PRACTICES

Housekeeping procedures described in Section 5.0 of the LM Handbook (Attachment I) will be addressed and the following housekeeping practices will be employed during this field effort:

- Ensure discharge permits and/or Stormwater Pollution Prevention Plans (if applicable) are available at the project job site.

- Tetra Tech and/or subcontractor personnel will clean up its respective work area(s) and maintain work areas free from all slip, trip, and fall hazards at all times.

- Debris shall be kept cleared from work areas, passageways, stairs, and in and around buildings or other structures. The work area must be left free from accumulation of waste and rubbish at the end of each work shift.

- Combustible scrap and debris shall be removed at regular intervals during the course of work. Safe means shall be provided to facilitate such removal.

- At the end of each working day and/or the conclusion of work being performed, the work area will be restored to the same degree of neatness as when work commenced.

- Tetra Tech and/or subcontractor will furnish necessary equipment and/or receptacles to remove waste and rubbish from the job site unless otherwise specified by Lockheed Martin.

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6.0 HAZARD ASSESSMENT AND CONTROLS

This section provides reference information regarding the chemical and physical hazards which may be associated with activities that are to be conducted as part of the scope of work.

6.1 CHEMICAL HAZARDS

The areas in this investigation have been characterized. Based on historical data from past use and previous sampling events the following contaminants were found to exist at the site:

- VOCs
- SVOCs
- Metals
- PCBs

Although the above chemicals are identified as site contaminants, the latest sampling data indicates that the chemicals in Table 6-1 are the primary contaminants of concern to site personnel performing intrusive work. Although all the chemical contaminants listed above may be present, not all are approaching levels of concern from a human health aspect. The chemicals of concern (COCs) listed below could approach airborne concentrations reaching current occupational exposure limits (OEL). Table 6-1 below shows these and/or common types of these constituents, and a comparison of potential worst case air concentrations (when available) with current Occupational Exposure Limits (OELs).

TABLE 6-1
COMPARISON OF COPCs, AVAILABLE WORST-CASE AIR CONCENTRATIONS, AND CURRENT OCCUPATIONAL EXPOSURE LIMITS

Contaminant of Concern (in soil)	Maximum Concentration In Soil	Worst-Case Air Concentration That Could Be Encountered	Current OSHA PEL or ACGIH TLV
Block D			
Acetone	3.1 mg/kg in soil	500 ppm	OSHA: 1000 ppm ACGIH: 500 ppm, TWA_8
Benzene	0.22 mg/kg in soil	13.78 ppm	ACGIH: 0.5 ppm TWA_8 1 ppm STEL
Carbon Disulfide	0.035 mg/kg in soil	5.85 ppm	OSHA: 4 ppm
Methylene Chloride	1.4 mg/kg in soil	367.4 ppm	OSHA: 25 ppm

TABLE 6-1
COMPARISON OF COPCs, AVAILABLE WORST-CASE AIR CONCENTRATIONS, AND CURRENT OCCUPATIONAL EXPOSURE LIMITS

Contaminant of Concern (in soil)	Maximum Concentration In Groundwater	Worst-Case Air Concentration That Could Be Encountered	Current OSHA PEL or ACGIH TLV
Acetone	34 ug/l	.02 ppm	OSHA: 1000 ppm ACGIH: 500 ppm, TWA_8
Benzene	.23 ug/l	.02 ppm	ACGIH: 0.5 ppm TWA_8 1 ppm STEL
1,2-Dichloroethene	6.3 ug/l	.27 ppm	OSHA: 200 ppm ACGIH: 200 ppm, TWA_8
Trichloroethylene	38 ug/l in water	2.85 ppm	OSHA: 100 ppm ACGIH: 10 ppm, TWA_8

Block E

Contaminant of Concern (in soil)	Maximum Concentration In Soil	Worst-Case Air Concentration That Could Be Encountered	Current OSHA PEL or ACGIH TLV
Acetone	800 mg/kg in soil	115,888.42 ppm	OSHA: 1000 ppm ACGIH: 500 ppm, TWA_8
Benzene	31 mg/kg in soil	5,179.61 ppm	ACGIH: 0.5 ppm TWA_8 1 ppm STEL
Carbon Tetrachloride	16 mg/kg in soil	517.85 ppm	OSHA: 10 ppm ACGIH: 5 ppm TWA_8
Chlorobenzene	16 mg/kg in soil	94.46 ppm	OSHA: 75 ppm ACGIH: 10 ppm, TWA_8
1,2-Dichloroethene	18 mg/kg in soil	1,275.31 ppm	OSHA: 200 ppm ACGIH: 200 ppm, TWA_8
Ethyl Benzene	14 mg/kg in soil	89.71 ppm	OSHA: 100 ppm ACGIH: 20 ppm, TWA_8
Methylene Chloride	360 mg/kg in soil	94,473.69 ppm	OSHA: 25 ppm ACGIH: 50 ppm, TWA_8
Naphthalene	140 mg/kg in soil	32.24 ppm	OSHA: 10 ppm ACGIH: 10 ppm TWA_8
PCB's	1800 mg/kg in soil	1800 ppm	OSHA: 1 mg/m3 ACGIH: 0.5 mg/m3
Styrene	14 mg/kg in soil	50.58 ppm	OSHA: 100 ppm ACGIH: 20 ppm TWA_8
Tetrachloroethylene	31 mg/kg in soil	160.64 ppm	OSHA: 100 ppm ACGIH: 25 ppm TWA_8

Block E			
Contaminant of Concern (in soil)	**Maximum Concentration In Soil**	**Worst-Case Air Concentration That Could Be Encountered**	**Current OSHA PEL or ACGIH TLV**
Toluene	44 mg/kg in soil	703.65 ppm	OSHA: 200 ppm ACGIH: 20 ppm TWA_8
1,1,1-Trichloroethane	21 mg/kg in soil	1,068.43 ppm	OSHA: 10 ppm ACGIH: 10 ppm TWA_8
Trichloroethylene	25 mg/kg in soil	868.96 ppm	OSHA: 100 ppm ACGIH: 10 ppm, TWA_8
Xylenes	46 mg/kg	232.12 ppm	OSHA: 350 ppm TWA_8 ACGIH: 350 ppm, TWA_8
Contaminant of Concern (in water)	**Maximum Concentration In Water**	**Worst-Case Air Concentration That Could Be Encountered**	**Current OSHA PEL or ACGIH TLV**
Benzene	18 ug/l	1.25 ppm	ACGIH: 0.5 ppm TWA_8 1 ppm STEL
1,1-Dichloroethene	300 ug/l in water	80.77 ppm	OSHA: NA ACGIH: 5 ppm, TWA_8
Trichloroethylene	30,000 ug/l in water	2,249.03 ppm	OSHA: 100 ppm ACGIH: 10 ppm, TWA_8
Vinyl Chloride (VOC)	27 ug/l in water	12.01 ppm	OSHA: 1 ppm, TWA_8 5 ppm Ceiling

Block F			
Contaminant of Concern (in soil)	**Maximum Concentration In Soil**	**Worst-Case Air Concentration That Could Be Encountered**	**Current OSHA PEL or ACGIH TLV**
Carbon Disulfide	.007 mg/kg in soil	1.19 ppm	OSHA: 4 ppm
Napthalene	159 mg/kg in soil	36.62 ppm	OSHA: 10 ppm ACGIH: 10 ppm TWA_8
Contaminant of Concern (in water)	**Maximum Concentration In Water**	**Worst-Case Air Concentration That Could Be Encountered**	**Current OSHA PEL or ACGIH TLV**
Carbon Disulfide	25 ug/l in water	4.73 ppm	OSHA: 4 ppm

Block G			
Contaminant of Concern (in soil)	**Maximum Concentration In Soil**	**Worst-Case Air Concentration That Could Be Encountered**	**Current OSHA PEL or ACGIH TLV**
1,1-Dichloroethene	0.007 mg/kg in soil	1.8 ppm	OSHA: NA ACGIH: 5 ppm, TWA_8

Block G

Contaminant of Concern (in soil)	Maximum Concentration In Soil	Worst-Case Air Concentration That Could Be Encountered	Current OSHA PEL or ACGIH TLV
Benzene	50 ug/l	3.46 ppm	ACGIH: 0.5 ppm TWA_8 1 ppm STEL
1,1-Dichloroethene	670 ug/l in water	180.39 ppm	OSHA: NA ACGIH: 5 ppm, TWA_8
1,2-Dichloroethene	180 ug/l in water	7.85 ppm	OSHA: 200 ppm ACGIH: 200 ppm, TWA_8
Trichloroethylene	3500 ug/l in water	262.39 ppm	OSHA: 100 ppm ACGIH: 10 ppm, TWA_8
Vinyl Chloride (VOC)	37 ug/l in water	16.46 ppm	OSHA: 1 ppm, TWA_8 5 ppm Ceiling

Block H

Contaminant of Concern (in soil)	Maximum Concentration In Soil	Worst-Case Air Concentration That Could Be Encountered	Current OSHA PEL or ACGIH TLV
Carbon Disulfide	3 mg/kg in soil	501.25 ppm	OSHA: 4 ppm
Methylene Chloride	4.9 mg/kg in soil	1,285.89 ppm	OSHA: 25 ppm
Napthalene	180 mg/kg in soil	41.46 ppm	OSHA: 10 ppm ACGIH: 10 ppm TWA_8

Block I
Note: At this time work will not be conducted in Block I but this info is placed here for future investigations.

Contaminant of Concern (in soil)	Maximum Concentration In Soil	Worst-Case Air Concentration That Could Be Encountered	Current OSHA PEL or ACGIH TLV
Benzene	0.45 mg/kg	28.19 ppm	ACGIH: 0.5 ppm TWA_8 1 ppm STEL
Carbon Disulfide	.091 mg/kg in soil	4 ppm	OSHA: 4 ppm
1,1-Dichloroethane	4.3 mg/kg	482.98 ppm	OSHA: 100 ppm TWA_8 ACGIH: 100 ppm, TWA_8
Methylene Chloride	.11 mg/kg in soil	28.87 ppm	OSHA: 25 ppm
1,1,1-Trichloroethane	22 mg/kg	1,119.31 ppm	OSHA: 350 ppm TWA_8 ACGIH: 350 ppm, TWA_8
Lead	2,600 mg/kg	4.81 mg/m3	OSHA: 0.05 mg/m3 TWA_8 ACGIH: 0.05 mg/m3, TWA_8

Table Notes:

TWA_8: Average air concentration over an 8-hour work period that is not to be exceeded
OSHA Ceiling: Concentration in air that is not to be exceed

Note: All sites contain various metals, however none above occupational exposure limits if visible dust is observed. Area wetting methods will be used to suppress dust at all locations.

As indicated in Table 6-1, are from a worst-case scenario, COC concentrations immediately above a captured air phase above contaminated soil or water (such as in the head space during soil drilling or excavation activities) could potentially reach concentrations that exceed the OELs. However, in regarding the results of this data evaluation, it is important to recognize the following:

- The planned work area is outdoors with ample natural ventilation that will reduce any airborne VOCs through dilution and dispersion
- The soil value used in this evaluation was the ***highest*** concentration detected during the most recent soil sampling events

As a result of these factors, it is possible that workers participating in site activities may encounter airborne concentrations of COCs that could represent an occupational exposure concern, however it is unlikely. To monitor this route, real-time direct reading monitoring instruments will be used (as described in Section 7.0). This will be performed during the intrusive tasks in soil and IDW management activities, as these tasks are the most likely to involve encountering/releasing any VOCs into the airphase.

Potential exposure concerns to the COCs may also occur through ingestion, or coming into direct skin contact with contaminated groundwater. The likelihood of worker exposure concerns through these two routes are considered unlikely, provided that workers follow good personal hygiene and standard good sample collection/sample handling practices, and wear appropriate PPE as specified in this HASP. Examples of onsite practices that are to be observed that will protect workers from exposure via ingestion or skin contact include the following:

- No hand-to-mouth activities on site (eating, drinking, smoking, etc.)
- Washing hands upon leaving the work area and prior to performing any hand to mouth activities
- Wearing surgeon's-style gloves whenever handling potentially-contaminated media, including groundwater and any potential free product, sampling equipment, and sample containers.

6.1.1 Volatile Organic Compounds (VOCs)

The majority of VOCs are often related to chlorinated solvents and associated degradation products, paint thinners, dry cleaning solvents, constituents of petroleum fuels (e.g. gasoline and natural gas), and crude oil tanking. Symptoms of exposure to VOCs can include abdominal pain, irritation of the skin, eyes, nose, and throat, dizziness, tremors, vomiting, GI bleeding, enlarged liver, pallor of the extremities, and frostbite like-symptoms.

Short-term exposure to VOCs, such as TCE and VC, can cause irritation of the nose and throat and central nervous system (CNS) depression, with symptoms such as drowsiness, dizziness, giddiness, headache, loss of coordination. High concentrations have caused numbness and facial pain, reduced eyesight, unconsciousness, irregular heartbeat and death. Very high concentrations have produced death due to CNS effects, and, in rare cases, irregular heart beat. Permanent nervous system damage and/or liver injury have resulted from severe overexposure.

6.1.2 Metals

The physical effects of poisoning from the heavy metals tend to be a very slow process and occur over a long period of continued exposure to the source of the toxic metal. The physical symptoms which are typically induced by the presence of toxic metals in the body tend to be very vague and can include symptoms such as persistent fatigue, the appearance of splitting and blinding headaches, the presence of an upset stomach, disorders such as colic and even anemia in some cases. The central nervous system is the main part of the human body likely to be affected by the presence of toxic metals. Symptoms of a disrupted central nervous system include the appearance of muscular tremors, the development of spells of dizziness, the presence of insomnia, the poor concentration abilities in the person and a sudden lack of muscular coordination in the body.

6.1.3 Polychlorinated Biphenyl

PCBs were widely used as dielectric and coolant fluids, for example in transformers, capacitors, and electric motors. Due to PCBs' environmental toxicity and classification as a persistent organic pollutant, PCB production was banned by the United States Congress in 1979 and by the Stockholm Convention on Persistent Organic Pollutants in 2001.[1] According to the U.S. Environmental Protection Agency (EPA), PCBs have been shown to cause cancer in animals, and there is also evidence that they can cause cancer in humans.[3] A number of peer-reviewed health studies have shown a causal link between exposure to PCBs and non-Hodgkin Lymphoma, a frequently fatal form of cancer. Concerns about the toxicity of PCBs are largely based on compounds within this group that share a structural similarity and toxic mode of action with dioxin. Toxic effects such as endocrine disruption and neurotoxicity are also

associated with other compounds within the group. The maximum allowable contaminant level in drinking water is set at zero, but due to water treatment technologies a level of 0.5 parts per billion is the defacto level. The most commonly observed health effects in people exposed to extremely high levels of PCBs are skin conditions, such as chloracne and rashes, but these were known to be symptoms of acute systemic poisoning dating back to 1922. Studies in workers exposed to PCBs have shown changes in blood and urine that may indicate liver damage. Other symptoms included fatigue, headaches, coughs, and unusual skin sores.

6.2 EXHAUST GASES/FUMES CREATED DURING INDOOR ACTIVITIES

Short-term (acute) effects of workers exposed to high concentrations of exhaust gasses/fumes may include irritation of the eyes, nose, and throat; lightheadedness; heartburn; headache; weakness, numbness and tingling in the extremities; chest tightness; wheezing; and vomiting. Some studies have suggested that workers exposed to diesel/gasoline exhaust are more likely to have chronic respiratory symptoms such as persistent cough and mucous, bronchitis, and reduced lung capacity than unexposed workers. Of particular concern is the potential for exposure to carbon monoxide which is present in diesel and more predominately, in gasoline engine exhaust. Upon entering the bloodstream, carbon monoxide combines with hemoglobin over 200 times more tightly than oxygen. Hemoglobin, then, is unable to carry oxygen in the blood. Carbon monoxide may also combine with myoglobin which may cause muscle metabolism disturbances, especially in the heart. The degree of toxicity depends primarily on carbon monoxide concentrations, exposure time, individual susceptibility, and exertion level.

To prevent or minimize potential exposures to carbon monoxide and other exhaust gas constituents, safe work practices identified in Section 5.4 and air monitoring measures listed Section 7.1.2 will be used.

6.3 RADIOLOGICAL HAZARDS

Based on historical information, and the results of previous screening and sampling events, alpha, beta and gamma radiation may exist at Former Building D. Unstable radioactive elements can be found in a wide range of concentrations in all rocks, soil, and water. The most common radioactive elements, uranium and thorium, decay slowly and produce other radioactive elements, such as radium, which in turn undergo still further radioactive decay. These radioactive product elements have different chemical properties, decay at different rates, and emit different levels of radiation energy than either uranium or thorium. The two most common isotopes of radium (Ra) are Ra-226 and Ra-228. Ra-226 has a long half-life (1,600 years) compared to that of Ra-228 (5.75 years). A half-life is the time required for half of the initial amount of a radionuclide to decay. Ra-226 decays by emitting the nucleus of a helium atom (alpha particle), whereas Ra-228 emits an electron (beta particle). Radiological survey and soil sampling

activities will be performed to determine if remedial actions have removed radiological contamination to acceptable levels.

Of particular concern are exposures that occur as a result of inhalation of radium dusts or radium contaminated particles. However, site activities are unlikely to generate airborne dusts that can be inhaled. Rather the greatest potential for exposure is anticipated to be via ingestion of contaminated soils as a result of hand to mouth activities (eating, drinking, smoking, etc.). As a result, minimizing contact with potentially contaminated soils through the use of avoidance and ppe use as well as the implementation of sound decontamination procedures and personal hygiene practices will be used to prevent exposures to radium. Safe work permits contained in Attachment IV provide specific control methods that will be used to minimize potential exposures to site personnel.

6.4 SUB SLAB AND IAQ SAMPLING BUILDINGS A,B,C

Previous sampling data indicates the presence of VOC'S, within Block I (see Table 6-1) for concentrations.

6.5 PHYSICAL HAZARDS

The following is a list of physical hazards that may be encountered at the site or may be present during the performance of site activities.

- Slips, trips, and falls
- Cuts (or other injuries associated with hand tool use)
- Lifting (strain/muscle pulls)
- Ambient temperature extremes (heat stress)
- Pinches and compressions
- Vehicular and foot traffic
- Noise in excess of 85 dBA
- Flying projectiles
- Contact with underground or overhead utilities/electrical safety
- Heavy equipment hazards (rotating equipment, hydraulic lines, etc.)
- Compressed gas cylinders

Specific hazards are discussed further below, and are presented relative to each task in the task-specific Safe Work Permits.

6.5.1 Slips, Trips, and Falls

During various site activities there is a potential for slip, trip, and fall hazards associated with wet, steep, or unstable work surfaces. To minimize hazards of this nature, personnel required to work in and along areas prone to these types of hazards will be required to exercise caution, and use appropriate precautions (restrict access, guardrails, life lines and/or safety harnesses) and other means suitable for the task at hand. Site activities will be performed using the buddy system.

6.5.2 Strain/Muscle Pulls from Heavy Lifting

During execution of planned activities there is some potential for strains, sprains, and/or muscle pulls due to the physical demands and nature of this site work. To avoid injury during lifting tasks personnel are to lift with the force of the load carried by their legs and not their backs. When lifting or handling heavy material or equipment use an appropriate number of personnel. Keep the work area free from ground clutter to avoid unnecessary twisting or sudden movements while handling loads.

6.5.3 Heat/Cold Stress

Because of the length of planned project activities, the likely seasonal weather conditions that will exist during the planned schedule, and the physical exertion that can be anticipated with some of the planned tasks, it will be necessary for the field team to be aware of the signs and symptoms and the measures appropriate to prevent cold stress. This is addressed in detail in Section 4.0 of the Tetra Tech Health and Safety Guidance Manual, which the SSO is responsible for reviewing and implementing as appropriate on this project. Tetra Tech personnel will also follow the guidance for Heat Stress and prevention of Sun Exposure found in Tetra Tech Safe Work Procedures SWP 5-15 and 5-26 found in Attachment VIII.

6.5.4 Pinch/Compression Points

Handling of tools, machinery, and other equipment on site may expose personnel to pinch/compression point hazards during normal work activities. Where applicable, equipment will have intact and functional guarding to prevent personnel contact with hazards. Personnel will exercise caution when working around pinch/compression points, using additional tools or devices (e.g., pinch bars) to assist in completing activities.

6.5.5 Natural Hazards

Natural hazards such as poisonous plants, bites from poisonous or disease carrying animals or insects (e.g., snakes, ticks, mosquitoes) are often prevalent at sites that are being investigated as part of

hazardous waste site operations. To minimize the potential for site personnel to encounter these hazards, nesting areas in and about work areas will be avoided to the greatest extent possible. Work areas will be inspected to look for any evidence that dangerous animals may be present. Based on the planned location for the work covered by this HASP, encountering wild animals is not a likely probability.

During warm months (spring through early fall), tick-borne Lyme disease may pose a potential health hazard. The longer a disease carrying tick remains attached to the body, the greater the potential for contracting the disease. Wearing long sleeved shirts and long pants (tucked into boots and taped) will prevent initial tick attachment, while performing frequent body checks will help prevent long term attachment. Site first aid kits should be equipped with medical forceps and rubbing alcohol to assist in tick removal. For information regarding tick removal procedures and symptoms of exposure, consult Section 4.0 of the Health and Safety Guidance Manual.

Contact with poisonous plants and bites or stings from poisonous insects are other potential natural hazards. Long sleeved shirts and long pants (tucked into boots), and avoiding potential nesting areas, will minimize the potential for exposure. Additionally, insect repellents may be used by site personnel. Personnel who are allergic to stinging insects (such as bees, wasps and hornets) must be particularly careful since severe illness and death may result from allergic reactions. As with any medical condition or allergy, information regarding the condition must be listed on the Medical Data Sheet (see Attachment III of this HASP), and the FOL or SSO notified.

6.5.6 Vehicular and Equipment Traffic

Vehicle and equipment traffic hazards are present for both indoor and outdoor work. While conducting work inside Buildings A, B and C workers should be aware of various vehicles and equipment including but not limited to forklifts, golf carts, maintenance carts and bicycles. All indoor means of vehicular transport are either manual or propane powered as to avoid producing toxic fumes in an indoor environment. Caution should be taken while walking, riding or conducting work in these buildings. Pedestrian traffic should walk in painted aisles marked on the ground whenever possible and should take caution when approaching intersections in the buildings. Mirrors and motion alarms notify of pedestrian and vehicular traffic as they approach major intersections throughout the buildings, however, every intersection does not possess these same warning methods. Each worker must receive cart training provided by either the onsite maintenance contractor or a qualified person who has already received the training. Cart traffic shall always yield to pedestrian traffic. Each cart is also equipped with a horn that can be used when approaching an intersection or a blind corner to notify any oncoming traffic.

If working in or near streets or roadways, hazards associated with vehicular and equipment traffic are likely to exist during various site activities and whenever site personnel performed work on or near

roadways. Site personnel will be instructed to maintain awareness of traffic and moving equipment when performing site activities. When working near roadways, site personnel will wear high visibility vests. Also, when conducting work other methods of traffic safety will be utilized such as strategically positioning the worker's truck, the use of traffic cones, traffic signs and caution tape to quarantine off each work site. Workers shall also be aware of the potential for train traffic through the site. The train runs in a northern direction from Tilley Chemical (neighboring chemical packaging and distribution company) along the western side of Building A out to a railway located north of Eastern Boulevard. All personnel should be cautious of the train running thru work areas. At this time all work areas are not within the railroad right of way but site personnel should be cautious when working in the vicinity of the train tracks.

6.5.7 Inclement Weather

Project tasks under this Scope of Work will be performed outdoors. As a result, inclement weather may be encountered. In the event that adverse weather (electrical storms, snow, ice, tornadoes, etc.) conditions arise, the FOL and/or the SSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist.

6.5.8 Contact with Underground or Overhead Utilities/Electrical Safety

Contact with energized sources can result in severe injury and even death. There are two areas of concern with this potential hazard: contact with energized processing equipment and contact with energized utilities including underground utilities (i.e., electrical transmission lines, gas lines, water lines, etc.) and overhead utilities (i.e., power lines, etc.).

- Use and application of the Tetra Tech Standard Operating Procedure (SOP) for Utility Locating and Excavation Clearance found in the Tetra Tech Health and Safety Guidance Manual will be employed. This procedure provides step-by-step instructions for clearance of underground utilities, as well as avoidance techniques, and required documentation.

- Establishment of a suitable clearance distance (20-feet) from overhead utilities will be the primary method to control hazards conveyed through contact with these power sources.

- Identify underground utilities and buried structures before commencing any DPT operations. Follow the Tetra Tech Utility Locating and Excavation Clearance Standard Operating Procedure.

In addition, the electrical safety procedures stipulated in Section 3.9 of the LM Handbook and the overhead power line safety procedures in Section 3.14 of the LM Handbook will also be followed.

No hazardous energy work is being conducted as part of this field effort. However, should activities associated with lockout/tagout be required, the requirements stipulated in Section 3.5 of the LM Handbook (Attachment I) will also be adhered to.

6.5.9 Heavy Equipment Hazards

Ensure that workers are thoroughly trained and competent to perform their assigned task with the equipment used in investigation. Ensure that back-up alarms are functional on equipment. Heavy equipment will be subjected to an equipment inspection, upon arrival on-site and prior to leaving. This inspection will be recorded on the Equipment Inspection Checklist provided in Attachment V of this HASP. The equipment operators and on-site Supervisors responsible for the equipment are to ensure that the Equipment Inspection Checklist has been reviewed and completed, and that all moving parts are guarded if such parts are exposed. Check/test all emergency stop controls. Use escort vehicles with flashing lights to ward and control local traffic when moving large equipment to support area.

Only trained and authorized workers may operate heavy equipment, industrial vehicles and/or cranes. All manufacturer's specifications and limitations will be adhered to.

In addition, the heavy equipment, industrial vehicle, and crane operation safety procedures stipulated in Section 3.13 of the LM Handbook and will be followed.

6.5.10 Compressed Gas Cylinders

Work utilizing compressed gas cylinders is not anticipated as part of this field effort. However, if work utilizing compressed gas cylinders is required, this HASP will be updated/amended as necessary and the procedures in Section 3.17 of the LM Handbook (Attachment I) will be followed.

7.0 AIR AND RADIATION MONITORING

The COCs outlined in Section 6 have the potential to be present in concentrations that could present an inhalation hazard during planned site activities at the individual blocks. To assure that such exposures are avoided and documented, a direct reading instrument will be used to monitor worker exposures to chemical hazards present at the various blocks. A Photoionization Detector (PID) using a lamp energy of 11.7 eV will be used to monitor the air when conducting site activities. For Block I only a Flame Ionization Detector (FID) will be used to detect the presence of 1,1 Dichloroethane which is not detected by the PID. A Draeger Tube 0.5/a will be used when the presence of VOCs is confirmed. The PID will be used for most onsite activities to screen source areas (sample locations, monitoring wells, etc.) and worker breathing zones for volatile and detectable site contaminants. The presence of elevated airborne concentrations of volatile organic compounds will suggest an increased exposure threat to site personnel and will require site activities to be suspended until readings return to background levels. The use of personal protective equipment and the observance of the other control requirements presented in this HASP have been selected to minimize potential for personnel exposures to hazardous concentrations (known or unknown) of site contaminants.

Some COCs (PAHs, PCB, metals) are not volatile and are unable to be detected with traditional field instrumentation (photoionization detectors). For metals visible dust will require area wetting to control the dust since the level of the contaminants are above the visible spectrum. Generation of dusts should be minimized. If airborne dusts are observed, use area wetting methods. Site contaminants may adhere to or be part of airborne dusts or particulates. Although unlikely to be present, the generation of dusts should be minimized to avoid inhalation of contaminated dusts or particulates.

Instruments will be used primarily to monitor source points and worker breathing zone (BZ) areas, while observing instrument action levels. The SSO shall obtain and document the daily background reading at an upwind, unaffected area and observe for readings above that background level. The SSO shall monitor source areas (e.g., above collected samples and confined areas, etc.) for the presence of any reading above the daily-established background level. If elevated readings are observed above the PEL, the SSO shall monitor the workers' BZ areas. If elevated readings are observed, the following process will be followed:

- The SSO shall order site personnel to stop work and retreat upwind to a safe, unaffected area, where they will remain until further directed by the SSO.

- The SSO shall begin wetting procedures to control dust and then re-approach the work area while continuously monitoring the BZ areas.

- Only when levels are below the PEL standard in BZ areas will work be permitted to resume.

- If background levels are not regained, the SSO will contact the HSM for additional direction.

There is a sampling task where the use of DRIs will not be required that is for the marine operations (surface water and sediment sampling tasks from a small water vessel/boat and drilling soil borings from a barge). An evaluation of available data from previous investigations at the intended sampling areas did not identify any volatile substances (only low concentrations of metals, PCBs, and PAHs. Furthermore, these types of substances only represent an inhalation concern if they are either present in inhalable air as suspended solid particulates in sizes that can be inspired into to the body, or if they are heated to very high temperatures and are present as fumes. Neither of these types of situations is plausible for the marine operations. Therefore, DRI usage will not be required for those tasks only.

Tetra Tech will issue or cause to be issue all necessary personal protective equipment and air monitoring equipment prior to commencing the job to all its agents and personnel, including full instructions and training on the use of the equipment. The requirements included in Section 3.1 of the LM Handbook (Attachment I) addressing monitor equipment will be followed.

Radiological contaminants of concern are alpha, beta and possibly gamma sources. Past actions have likely removed much of the site contamination; however this effort is to determine if contamination exists and to determine background levels. For this reason, a radiological field survey and sampling will be performed to identify any areas of elevated radioactivity. Radiological work will be monitored by the PHP in accordance with Tt RPOP. Action levels are established in the project work plan.

7.1 INSTRUMENTS AND USE

Instruments will be used primarily to monitor source points and worker breathing zone areas, while observing instrument action levels. The SSO shall obtain and document the daily background (BG) reading at an upwind, unaffected area and observe for readings above that BG level. The SSO shall monitor source areas (e.g., monitoring wells) for the presence of any reading above the daily-established BG level. If elevated readings are observed, the SSO shall monitor the workers breathing zone (BZ) areas with the PID. If the appropriate instrument Action Level is exceeded (see below), the following process will be followed:

- The SSO shall order all personnel to stop work and retreat upwind to a safe, unaffected area, where they will remain until further directed by the SSO.

- The SSO shall allow at least 5 minutes to pass so that the work area can ventilate, and will then re-approach the work area while continuously monitoring the BZ areas.

- Only when BG levels are regained in BZ areas will work be permitted to resume.

- If BG levels are not regained, the SSO will contact the HSM for additional direction.

I**nstrument Action Levels**: Monitoring instruments use will follow the action levels specified below:

- A Draeger Tube 0.5/a will be used when the presence of VOCs is confirmed:
  - If the readings are Benzene, the action level is 5 ppm/sustained 10 minutes/4 times/day
  - If readings are not Benzene, the action levels are as follows:

Instrument Action Levels:

The use of either a PID will be acceptable at all sites, provided that the following action levels are observed:

ACTION LEVELS			
Location	**Instrument**	**Action Level**	**Exposure Time**
Block D	PID with 11.7 eV lamp	1 ppm	4 exposures of 5 minutes one day
Block E	PID with 11.7 eV lamp	7 ppm	4 exposures of 5 minutes one day
Block F	PID with 11.7 eV lamp	1000 ppm	4 exposures of 5 minutes one day
Block G	PID with 11.7 eV lamp	7 ppm	4 exposures of 5 minutes one day
Block H	PID with 11.7 eV lamp Precautionary use	10 ppm	4 exposures of 5 minutes one day
Block I*	PID with 11.7 eV lamp	1 ppm	4 exposures of 5 minutes one day
Block I* (1,1 Dichloroethane only)	FID	1,900 ppm	4 exposures of 5 minutes one day

***Reference only at this time**

7.1.1 Carbon Monoxide Detector and Colorimetric Tubes for Nitrogen Dioxide

A direct-read carbon monoxide detector such as a Draeger PAC III Single Gas Monitor, an Industrial Scientific T82 Single Gas Monitor (or equivalent) will be used during all soil boring and concrete coring operations performed in Building B146 to evaluate airborne concentrations of carbon monoxide. Although other exhaust gases may be present, carbon monoxide has been selected as the primary indicator

compound to determine potential exposure concerns. Conservative action levels for carbon monoxide have been established to prevent potential exposures to other exhaust gas compounds including oxides nitrogen and sulfur.

As a precautionary measure, colorimetric tubes for nitrogen dioxide (NO_2) will also be available for use and will be required whenever elevated CO readings are observed. To evaluate NO2 concentrations a Nitrogen Dioxide Draeger tube (0.5/c) will be used. These tubes detected NO2 at concentrations ranging from 0.5 to 10 ppm or 5 to 25 ppm depending on the number of pump strokes that are used. For the purpose of determining exposure concerns, the lower range will be used which will require 5 strokes of the hand pump. A color change from pale grey to blue grey indicates the presence of NO_2.

7.1.2 Radiation Survey Instrument

Radiological instruments will be used for field survey and sampling as described below. Radiological surveys will be performed in accordance with the guidance provided in the Tt RPOP.

Instrument	Detector	Type of Activity Detected	Survey Type
Ludlum Model 2350 Digital Data Logger	Phoswhich Probe	Alpha/Beta	Contamination Surveys (counts per minute [cpm])
Ludlum Model 2241 Scaler/Ratemeter	2” x 2” Ludlum Model 44-10 NaI Scintillation Probe	Gamma	Dose Rate Surveys (cpm)
Ludlum Model 19 Survey Meter	1” x 1” Sodium Iodide (NaI)Tl scintillator	Low-Level Gamma	Dose Rate (micro Röntgen per hour [µR/hr])

7.2 INSTRUMENT MAINTENANCE AND CALIBRATION

Hazard monitoring instruments will be maintained and pre-field calibrated by the equipment provider (i.e., rental agency used). Operational checks and field calibration will be performed on site instruments each day prior to their use. Field calibration will be performed on instruments according to manufacturer’s recommendations. These operational checks and calibration efforts will be performed in a manner that complies with the employees health and safety training, the manufacturer's recommendations, and with the applicable manufacturer standard operating procedure (which the SSO must assure are included with the instrument upon its receipt onsite). Field calibration efforts must be documented. Figure 7-1 is provided for documenting these calibration efforts. This information may instead be recorded in a field operations logbook, provided that the information specified in Figure 7-1 is recorded. This required information includes the following:

- Date calibration was performed
- Individual calibrating the instrument
- Instrument name, model, and serial number
- Any relevant instrument settings and resultant readings (before and after) calibration
- Identification of the calibration standard (lot no., source concentration, supplier)
- Any relevant comments or remarks

Radiological instruments will be calibrated with known source before field use. Pre-operational checks will be performed on the instruments each day before use in accordance with the guidance provided in the Tt RPOP.

7.3 DOCUMENTING INSTRUMENT READINGS

The SHSO is responsible for ensuring that air monitoring instruments are used in accordance with the specifications of this HASP and with manufacturer's specifications/recommendations. In addition, the SHSO is also responsible for ensuring that all instrument use is documented. This requirement can be satisfied either by recording instrument readings on pre-printed sampling log sheets or in a field log book. **This includes the requirement for documenting instrument readings that indicate no elevated readings above noted daily background levels (i.e., no-exposure readings)**. At a minimum, the SHSO must document the following information for each use of an air monitoring device:

- Date, time, and duration of the reading
- Site location where the reading was obtained
- Instrument used (e.g., PID, etc.)
- Personnel present at the area where the reading was noted
- Other conditions that are considered relevant to the SHSO (such as weather conditions, possible instrument interferences, etc.)

Radiological surveys and instrument pre-operational checks will be documented in accordance with the Tt RPOP.

FIGURE 7-1

DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: _____ **PROJECT NO.:** _____

Date of Calibration	Instrument Name and Model	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot Number)	Remarks/ Comments
				Pre-Calibration	Post-Calibration	Pre-Calibration	Post-Calibration		

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

This section is included to specify health and safety training and medical surveillance requirements for Tetra Tech personnel participating in on site activities. Tetra Tech personnel must complete 40 hours of introductory hazardous waste site training prior to performing work at the LMC MRC. Tetra Tech personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training within the past 12 months before being cleared for site work. In addition, 8-hour supervisory training in accordance with 29 CFR 1910.120(e)(4) will be required for site supervisory personnel. Tetra Tech and subcontractor personnel working on site who are potentially exposed to hazardous substances shall receive initial and annual refresher training in accordance with 29 CFR 1910.120(e) – Hazardous Waste Operations and Emergency Response or the applicable state OSHA standard. Lockheed Martin shall be provided with electronic copies of the training certificates.

Documentation of Tetra Tech introductory, supervisory, and refresher training as well as site-specific training will be maintained at the site. Copies of certificates or other official documentation will be used to fulfill this requirement.

The requirements described in Section 3.20.3 of the LM Handbook (Attachment I) addressing training will be followed.

8.2 SITE-SPECIFIC TRAINING

Tetra Tech SSO will provide site-specific training to Tetra Tech employees who will perform work on this project. Figure 8-1 will be used to document the provision and content of the project-specific and associated training. Site personnel will be required to sign this form prior to commencement of site activities. This training documentation will be employed to identify personnel who through record review and attendance of the site-specific training are cleared for participation in site activities. This document shall be maintained at the site to identify and maintain an active list of trained and cleared site personnel.

The Tetra Tech SSO will also conduct a pre-activities training session prior to initiating site work. This will consist of a brief meeting at the beginning of each day to discuss operations planned for that day, and a review of the appropriate Safe Work Permits with the planned task participants. A short meeting may also be held at the end of the day to discuss the operations completed and any problems encountered.

8.3 MEDICAL SURVEILLANCE

Tetra Tech personnel participating in project field activities will have had a physical examination meeting the requirements of Tetra Tech's medical surveillance program. Documentation for medical clearances will be maintained in the Tetra Tech Pittsburgh office and made available, as necessary, and will be documented using Figure 8-1 for every employee participating in onsite work activities at this site. Tetra Tech shall provide evidence of employee enrollment in a medical surveillance program. Lockheed Martin does not provide medical surveillance examinations to contractor employees.

The medical surveillance requirements described in Section 3.20.4 of the LM Handbook (Attachment I) will be followed.

Each field team member, including visitors, entering the exclusion zone(s) shall be required to complete and submit a copy of the Medical Data Sheet (see Attachment III of this HASP). This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SITE VISITORS

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by Tetra Tech
- Regulatory personnel (i.e. EPA, MDEP, OSHA)
- Property Owners
- Authorized Personnel
- Other authorized visitors

Non Tetra Tech personnel working on this project are required to gain initial access to the facility by coordinating with the Tetra Tech FOL or designee and following established facility access procedures.

Once access to the base is obtained, personnel who require site access into areas of ongoing operations will be required to obtain permission from the PM. In addition, site visitors wishing to observe operations in progress will be escorted by a Tetra Tech representative and shall be required to meet the minimum requirements discussed below:

- Site visitors will be directed to the FOL/SSO, who will sign them into the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), the entity which they represent, and the purpose of the visit.

- Site visitors must be escorted and restricted from approaching any work areas where they could be exposed to hazards from Tetra Tech operations. If a visitor has authorization from the client and from the Tetra Tech Project Manager to approach our work areas, the FOL must assure that the visitor first provides documentation indicating successfull completion of the necessary OSHA introductory training, receive site-specific training from the SSO, and that they have been physically cleared to work on hazardous waste sites. Site visitors wishing to enter the exclusion zone will be required to produce the necessary information supporting clearance to the site. This shall include information attesting to applicable training and medical surveillance as stipulated in Section 8.0 of this document. In addition, to enter the site operational zones during planned activities, visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this HASP. All jobsite visitors must have a safety orientation prior to commencing work or touring the site. A visitor log will be kept to document the orientation.

- Once the site visitors have completed the above items, they will be permitted to enter the operational zone. Visitors are required to observe the protective equipment and site restrictions in effect at the site at the time of their visit. Visitors entering the exclusion zones during ongoing operations will be accompanied by a Tetra Tech representative. Visitors not meeting the requirements, as stipulated in this plan, for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause the termination of on site activities until the unauthorized visitor is removed from the premises. Removal of unauthorized visitors will be accomplished with support from local law enforcement personnel.

FIGURE 8-1

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing field activities at LCM MRC and that I have received site-specific training which included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- Emergency response procedures (evacuation and assembly points)
- Incipient response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Review of the use of Safe Work Permits
- Stop Work Procedures

I have been given the opportunity to ask questions and all of my questions have been answered to my satisfaction. The dates of my training and medical surveillance requirements indicated below are accurate.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam

9.0 SITE CONTROL

This section outlines the means by which Tetra Tech will delineate work zones and use these work zones in conjunction with decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a three-zone approach will be used during work at this site. This approach will be comprised of an exclusion zone, a contamination reduction zone, and a support zone. It is also anticipated that this approach will control access to site work areas, restricting access by the general public, minimizing the potential for the spread of contaminants, and protecting individuals who are not cleared to enter work areas.

Radiological areas, if applicable, will be posted independently of work zones in accordance with the Tt RPOP.

9.1 EXCLUSION ZONE

The exclusion zone will be considered the areas of the site of known or suspected contamination. It is anticipated that the areas around active/intrusive activates will have the potential for contaminants brought to the surface. These areas will be marked and personnel will maintain safe distances. Once active/intrusive activities have been completed and any surface contamination has been removed, the potential for exposure is again diminished and the area can then be reclassified as part of the contamination reduction zone. The exclusion zones for this project are those areas of the site where active work (DPT work areas, drilling, installation, and sample collection, etc.) is being performed plus a designated area of at least 25 feet surrounding the work area. Exclusion zones will be delineated as deemed appropriate by the FOL, through means such as erecting visibility fencing, barrier tape, cones, and/or postings to inform and direct personnel.

9.1.1 Exclusion Zone Clearance

An Exclusion Zone (EZ) will be established at each well installation/sampling location. The purpose of establishing and maintaining these localized exclusion zones is to define areas where more rigorous safety and health protection measures will be required and to designate areas restricted to non-essential and unauthorized personnel. The size and dimensions of these EZs will vary based on the nature of the planned activities, and may be subject to change at the SSO's discretion based on factors such as visual observations, nearby concurrent operations, and other factors. However, the following dimensions represent basic considerations for establishing EZs:

- DPT and associated concurrent sampling activities. The EZ for this activity will be set at the height of the mast, plus five feet surrounding the point of operation, with a minimum of 25-feet. This distance will also apply when surface and subsurface soil sampling from behind these type rigs.

- Monitoring well development, purging, construction and use, and collecting groundwater soil, sediment samples, water level readings and indoor air sampling. The EZ for these activities will be set to encompass an area of at least 10-feet surrounding the well head.

- Decontamination operations. The EZ for this activity will be set at 25 feet surrounding the gross contamination wash and rinse as well as 25-feet surrounding the heavy equipment decontamination area. Sample equipment decontamination boundaries will be set at 10-feet surrounding hand wash and rinse areas.

- Investigative Derived Waste (IDW) area will be constructed and barricaded. Only authorized personnel will be allowed access.

EZs will be marked using barrier tape, traffic cones and/or drive pole, or other readily-visible devices. Signs may also be posted at the SSO's discretion to inform and direct site personnel and site visitors. EZs shall remain marked until the SSO has evaluated the restoration effort and has authorized changing the zone status.

A pre-startup site visit will be conducted by members of the identified field team in an effort to identify proposed subsurface investigation locations, conduct utility clearances, and provide upfront notices concerning scheduled activities within the facility.

Subsurface activities will proceed only when utility clearance has been obtained. In the event that a utility is struck during a subsurface investigative activity, the emergency numbers provided in Section 2.0, Table 2-1, will be notified.

9.2 CONTAMINATION REDUCTION ZONE

The contamination reduction zone (CRZ) will be a buffer area between the exclusion zone and any area of the site where contamination is not suspected. This area will also serve as a focal point in supporting exclusion zone activities. This area will be delineated using barrier tape, cones, and postings to inform and direct facility personnel. Decontamination will be conducted at a central location. Equipment potentially contaminated will be bagged and taken to that location for decontamination.

9.3 SUPPORT ZONE

The support zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. The support zones will be established at areas of the site where away from potential exposure to site contaminants during normal working conditions or foreseeable emergencies.

9.4 SAFE WORK PERMITS

Exclusion Zone work conducted in support of this project will be performed using Safe Work Permits (SWPs) to guide and direct field crews on a task by task basis. An example of the SWP to be used is provided in Figure 9-1. Partially completed SWPs for the work to be performed are attached (Attachment IV) to this HASP. These permits were completed to the extent possible as part of the development of this HASP. It is the SSO's responsibility to finalize and complete all blank portions of the SWPs based on current, existing conditions the day the task is to be performed, and then review that completed permit with all task participants as part of a pre-task tail gate briefing session. This will ensure that site-specific considerations and changing conditions are appropriately incorporated into the SWP, provide the SSO with a structured format for conducting the tail gate sessions, as well will also give personnel an opportunity to ask questions and make suggestions. All SWPs require the signature of the FOL or SSO.

9.5 SITE SECURITY

As this activity will take place at an active facility, the first line of security will be provided by the facility entrance/gate restricting the general public. The second line of security will take place at the work site referring interested parties to the FOL and LMC Contact.

Security at the work areas will be accomplished using field personnel. This is a multiple person operation, involving multiple operational zones. Tetra Tech personnel will retain complete control over active operational zones.

The site contact will serve as the focal point for facility personnel and interested parties and will serve as the primary enforcement contact.

9.6 SITE VISITORS

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by Tetra Tech
- Regulatory personnel (i.e. EPA, MDEP, OSHA)
- Property Owners
- Authorized Personnel
- Other authorized visitors

Non Tetra Tech personnel working on this project are required to gain initial access to the facility by coordinating with the Tetra Tech FOL or designee and following established facility access procedures.

Once access to the base is obtained, personnel who require site access into areas of ongoing operations will be required to obtain permission from the PM. In addition, site visitors wishing to observe operations in progress will be escorted by a Tetra Tech representative and shall be required to meet the minimum requirements discussed below:

- Site visitors will be directed to the FOL/SSO, who will sign them into the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), the entity which they represent, and the purpose of the visit.

- Site visitors must be escorted and restricted from approaching any work areas where they could be exposed to hazards from Tetra Tech operations. If a visitor has authorization from the client and from the Tetra Tech Project Manager to approach our work areas, the FOL must assure that the visitor first provides documentation indicating that he/she/they have successfully completed the necessary OSHA introductory training, receive site-specific training from the SSO, and that they have been physically cleared to work on hazardous waste sites. Site visitors wishing to enter the exclusion zone will be required to produce the necessary information supporting clearance to the site. This shall include information attesting to applicable training and medical surveillance as stipulated in Section 8.0 of this document. In addition, to enter the site operational zones during planned activities, visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this HASP. All jobsite visitors must have a safety orientation prior to commencing work or touring the site. A visitor log will be kept to document the orientation.

- Once the site visitors have completed the above items, they will be permitted to enter the operational zone. Visitors are required to observe the protective equipment and site restrictions in effect at the site at the time of their visit. Visitors entering the exclusion zones during ongoing operations will be accompanied by a Tetra Tech representative. Visitors not meeting the requirements, as stipulated in this plan, for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause the termination of on site activities until the unauthorized visitor is removed from the premises. Removal of unauthorized visitors will be accomplished with support from local law enforcement personnel.

9.7 SITE MAP

Once the areas of contamination, access routes, topography, and dispersion routes are determined, a site map will be generated and adjusted as site conditions change. These maps will be posted to illustrate up-to-date collection of contaminants and adjustment of zones and access points.

9.8 BUDDY SYSTEM

Personnel engaged in on site activities will practice the "buddy system" to ensure the safety of personnel involved in this operation.

9.9 COMMUNICATION

As personnel will be working in proximity to one another during field activities, a supported means of communication between field crew members will not be necessary.

External communication will be accomplished by using the cell phones/telephones at predetermined and approved locations. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of activities at the LCM MRC, the FOL will determine and arrange for telephone communications.

9.10 SELF-AUDITS

The procedures outlined in Section 7 of the LM Handbook (Attachment I) addressing self-audits will be adhered to.

Tetra Tech and/or subcontractor personnel will perform periodic work area/project field inspections to monitor compliance with project environmental, safety and health requirements. The name of Tetra Tech’s jobsite health and safety (H&S) representative will be provided to Lockheed Martin prior to starting work at the jobsite.

For jobs that are ongoing, an annual H&S audit shall be conducted and for jobs with a duration of less than one year at least one audit shall occur. A competent H&S representative designated by the Tetra Tech shall perform the audit. Unsafe acts and/or non-compliance conditions noted during inspections shall be corrected immediately.

The documentation related to the audits and inspections shall be submitted electronically to the Lockheed Martin Project Lead.

FIGURE 9-1
SAFE WORK PERMIT

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): _____

II. Primary Hazards: Potential hazards associated with this task: _____

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech

V. Protective equipment required

Level D ☐ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required

Yes ☐ Specify on the reverse
No ☐

Modifications/Exceptions: _____

VI.	**Chemicals of Concern**	**Hazard Monitoring**	**Action Level(s)**	**Response Measures**

Primary Route(s) of Exposure/Hazard: _____

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes ☐ No
Chemical/splash goggles	☐ Yes ☐ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☐ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type –)	☐ Yes ☐ No
Impermeable apron	☐ Yes ☐ No	Work/rest regimen	☐ Yes ☐ No
Steel toe Work shoes or boots	☐ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☐ No
High Visibility vest	☐ Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: _____

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____

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10.0 SPILL CONTAINMENT PROGRAM AND WASTE MANAGEMENT PLAN

10.1 SCOPE AND APPLICATION

It is not anticipated that bulk hazardous materials (over 55-gallons) will be generated or handled at any given time as part of this scope of work. It is also not anticipated that such spillage would constitute a danger to human health or the environment. However, as the job progresses, some potential may exist for accumulating Investigative Derived Wastes (IDW) such as decontamination fluids, soil cuttings, disposable sampling equipment and PPE.

10.2 POTENTIAL SPILL AREAS

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, limited areas are vulnerable to this hazard including:

- Resource deployment
- Waste transfer
- Central staging

It is anticipated that the IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of these analyses will determine the method of disposal.

10.3 LEAK AND SPILL DETECTION

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums area will be conducted during working hours to visually determine that storage vessels are not leaking. If a leak is detected, the contents will be transferred, using a hand pump, into a new vessel. The leak will be collected and contained using absorbents such as Oil-Dry, vermiculite, or sand, which are stored at the vulnerable areas in a conspicuously marked drum. This used material, too, will be containerized for disposal pending analysis. Inspections will be documented in the project logbook.

In case of a spill or release of hazardous chemicals, Tetra Tech shall immediately notify the Lockheed Martin Project Lead, and/or if the severity of the spill warrants, the local fire department by calling 9-1-1. Tetra Tech shall take all necessary steps to control the spread of the release and to provide site control to prevent unauthorized personnel from entering the affected area.

Section 8.2 of the LM Handbook (Attachment I) pertaining to spill reporting will be addresses.

10.4 PERSONNEL TRAINING AND SPILL PREVENTION

Personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and the SSO will serve as the Spill Response Coordinators for this operation, should the need arise.

10.5 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the types of equipment that should be maintained at the staging areas for the purpose of supporting this Spill Prevention/Containment Program.

- Absorbent materials such as: Sand, clean fill, vermiculite, or other non combustible absorbent (Oil-dry)
- Drums (55-gallon U.S. DOT 1A1 or 1A2)
- Shovels, rakes, and brooms
- Hand pump
- Container labels

Hazardous materials shall be stored in designated areas and all containers effectively closed. Spill equipment/supplied shall be readily available to contain and/or mitigate accidental spills of hazardous materials.

10.6 SPILL CONTROL PLAN

This section describes the procedures the Tetra Tech field crew members will employ upon the detection of a spill or leak.

- Notify the SSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove non-essential personnel.

- Employ the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.

- Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.

- Re-containerize spills, including 2-inch of top cover impacted by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate Emergency Response agencies will be carried out by the FOL or SSO in accordance with the procedures discussed in Section 2.0 of this HASP.

As mentioned above, in the event of a spill or release of hazardous chemicals, Tetra Tech will immediately notify the LMC personnel in the order presented in Table 2-1, and/or if the severity of the spill warrants, the local fire department by calling 9-1-1.

10.7 WASTE MANAGEMENT PLAN

Tetra Tech personnel will adhere to the decontamination and waste management procedures laid out the Tetra Tech HSGM and the Tetra Tech Decontamination of Field Equipment and Waste Handling Standard Operating Procedure (Attachment IX).

In addition, all requirements described in Sections 4.1 and 4.2 of the LM Handbook (Attachment I) will be addressed.

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11.0 CONFINED-SPACE ENTRY

It is not anticipated, under the proposed scope of work, that confined space and permit-required confined space activities will be conducted. **Therefore, personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces**. A confined space is defined as an area which has one or more of the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, manholes, sewers, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

Additionally, a Permit-Required Confined Space must also have one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly caving walls or by a floor that slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space, consult the Health and Safety Guidance Manual or call the PHSO. If confined space operations are to be performed as part of the scope of work, detailed procedures and training requirements will have to be addressed and this HASP will be updated/amended as necessary to address the confined space entry requirements detailed in Section 3.3 of the LM Handbook (Attachment I).

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12.0 HOT WORK

No hot work activities are being conducted as part of this field effort. Should hot work be required, this HASP will be amended/updated as necessary to include the requirements stipulated in Section 3.4 of the LM Handbook (Attachment I).

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13.0 USE OF LOCKHEED MARTIN MATERIALS AND EQUIPMENT

No Lockheed Martin materials, tools, equipment, PPE shall be used until authorized by Lockheed Martin.

No Tetra Tech personnel will start, stop, relocate, or adjust any Lockheed Martin process or production equipment without approval of the Lockheed Martin Project Lead. Details of these requirements are described in Section 3.6 of the LM Handbook.

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14.0 ELEVATED LOCATIONS / LADDERS / SCAFFOLDS

No elevated location work, ladder work, or scaffolding activities are being conducted as part of this field effort. Should any of these activities be required, this HASP will be amended/updated as necessary to include the requirements stipulated in Sections 3.10, 3.11, and 3.12 of the LM Handbook (Attachment I).

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16.0 EXCAVATIONS, TRENCHES, AND EARTHWORK

Excavation, trench work, or earthwork is being conducted as part of this field effort. The excavation, test pit work, required, in this HASP will include the requirements stipulated in Section 3.8 of the LM Handbook (Attachment I) and a trained, competent person will be designated to oversee the activities. Excavation safe work practices are outlined in Section 5.5 of this HASP

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17.0 ASBESTOS

Asbestos abatement work may be conducted as part of this field effort. This HASP includes the requirements stipulated in Section 3.19 of the LM Handbook (Attachment I) and can be found in Section 5.4 of this HASP.

Asbestos containing material (ACM) or presumed asbestos containing material (PACM) if it is to be disrupted, Tetra Tech and/or subcontractor personnel shall immediately report to the Lockheed Martin Project Lead and to other employers of employees working at the job site any anticipated work that could lead to the discovery, disturbance, and/or spill of ACM and/or PACM. All operations will cease and the Asbestos contractor called in to remove or investigate the suspected ACM. The approval of the Lockheed Martin Project Lead is required before resuming operations.

Tetra Tech and/or subcontractor personnel shall not disturb any pipe insulation, boiler insulation, or any other material reasonably suspected of containing asbestos until the Lockheed Martin is notified and approval is obtained.

Abatement of asbestos can be performed only by persons properly trained and licensed to perform such activities.

All requirements addressed in Section 3.18 of the LM Handbook pertaining to incidental asbestos exposure will be followed.

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18.0 NANOTECHNOLOGY

No nanotechnology work is being conducted as part of this field effort. Should it be required, this HASP will be amended/updated as necessary to include the requirements stipulated in Section 3.21 of the LM Handbook (Attachment I).

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19.0 WORK INVOLVING AIR EMISSIONS

No work involving air emissions is being conducted as part of this field effort. Should it be required, this HASP will be amended/updated as necessary to include the requirements stipulated in Section 4.3 of the LM Handbook (Attachment I).

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20.0 WORK INVOLVING WATER DISCHARGES

No work involving water discharges is being conducted as part of this field effort. Should it be required, this HASP will be amended/updated as necessary to include the requirements stipulated in Section 4.4 of the LM Handbook (Attachment I).

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21.0 MATERIALS AND DOCUMENTATION

The Tetra Tech Field Operations Leader (FOL) shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets
- Material Safety Data Sheets for chemicals brought on site, including decontamination solutions, fuels, sample preservatives, calibration gases, etc.
- A full-size OSHA Job Safety and Health Poster (posted in the site trailer)
- Training/Medical Surveillance Documentation Form (Blank)
- First-Aid Supply Usage Form
- Emergency Reference Form (Section 2.0, extra copy for posting)
- Directions to the Hospital

21.1 MATERIALS TO BE POSTED AT THE SITE

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations where posting these documents is not feasible (such as no office trailer), these documents should be separated and be immediately accessible.

- **Chemical Inventory Listing (posted)** - This list represents all chemicals brought on-site, including decontamination solutions, sample preservations, fuel, etc. This list should be posted in a central area.

- **MSDSs (maintained)** - The MSDSs should also be in a central area accessible to all site personnel. These documents should match all the listings on the chemical inventory list for all substances employed on-site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

- **The OSHA Job Safety & Health Protection Poster (posted – Attachment XIII)** - This poster should be conspicuously posted in places where notices to employees are normally posted, as directed by 29 CFR 1903.2 (a)(1). Each FOL shall ensure that this poster is not defaced, altered, or covered by other material. The law also states that reproductions or facsimiles of the poster shall be at least 8 1/2 by 14 inches with 10 point type.

- **Site Clearance (maintained)** - This list is found within the training section of the HASP (Figure 8-1). This list identifies all site personnel, dates of training (including site-specific training), and medical surveillance. The list indicates not only clearance, but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

- **Emergency Phone Numbers and Directions to the Hospital(s) (posted)** - This list of numbers and directions will be maintained at all phone communications points and in each site vehicle.

- **Medical Data Sheets/Cards (maintained)** - Medical Data Sheets will be filled out by on-site personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to all personnel to be carried on their person.

- **Personnel Monitoring (maintained)** - All results generated through personnel sampling (levels of airborne toxins, noise levels, etc.) will be posted to inform individuals of the results of that effort.

- **Placards and Labels (maintained)** - Where chemical inventories have been separated because of quantities and incompatibilities, these areas will be conspicuously marked using DOT placards and acceptable [Hazard Communication 29 CFR 1910.1200(f)] labels.

The purpose of maintaining or posting this information, as stated above, is to allow site personnel quick access. Variations concerning location and methods of presentation are acceptable providing the objective is accomplished.

21.2 HAZARD COMMUNICATION – USE OF HAZARDOUS MATERIALS

All hazardous substance (as defined by OSHA) brought onto Lockheed Martin remediation sites must be accompanied by a MSDS and the containers labeled in accordance with the Red OSHA Hazard Communication Standard, 29 CFR 1910.1200 or applicable state OSHA standard. Tetra Tech and subcontractor personnel will provide MSDSs for chemicals brought on site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application of the substances on site. A chemical inventory of the chemicals used on site will be developed using the Health and Safety Guidance Manual. The MSDSs will then be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request.

The Lockheed Martin Project Lead shall be notified prior to bringing any quantity of hazardous materials onto Lockheed Martin remediation sites. Hazardous materials shall be stored in designated areas and all

containers effectively closed. Spill equipment/supplied shall be readily available to contain and/or mitigate accidental spills of hazardous materials.

All other hazard communication requirements are detailed in Section 3.2 and Section 4.1 of the LM Handbook (Attachment I) and will be adhered to.

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22.0 ACRONYMS / ABBREVIATIONS

CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CSP	Certified Safety Professional
DPT	Direct Push Technology
DRI	Direct Reading Instrument
FOL	Field Operations Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
IDW	Investigation Derived Waste
MDEP	Maryland Department of Environmental Protection
N/A	Not Available
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PHP	Project Health Physicist
PHSO	Project Health and Safety Officer
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
SSO	Site Safety Officer
TBD	To be determined
TCE	Trichloroethene
Tt RPOP	Tetra Tech Radiological Protection Operating Procedures
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

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ATTACHMENT I

LOCKHEED MARTIN'S

REMEDIATION CONTRACTOR'S ESH

HANDBOOK

LOCKHEED MARTIN

REMEDIATION CONTRACTOR'S ESH HANDBOOK

June 10, 2009

Revision 1

Lockheed Martin Corporation
Energy, Environment, Safety & Health

A COPY OF THE JOB SPECIFIC HASP SHALL BE AVAILABE AT THE JOB SITE FOR THE DURATION OF THE PROJECT

REVISION STATUS

REVISION	DATE	COMMENTS
1	06/10/2009	

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CONTRACTOR'S ESH HANDBOOK

GENERAL

Lockheed Martin Corporation management at all levels is committed to conducting operations and activities in a manner that provides and maintains safe and healthful working conditions, protects the environment, and conserves natural resources.

This *Contractor's ESH Handbook* has been prepared to assist each project jobsite employer/contractor in satisfying its' contractual and legal accident prevention responsibilities, in such a manner that a safe, efficient operation is assured. All applicable requirements outlined in this handbook shall be incorporated into the contractor's site specific Safety and Health Plan The site specific Safety and Health plan shall be submitted to the Lockheed Martin Project Lead at least two weeks prior to starting work on any Lockheed Martin remediation projects.

This material must not be considered to be all inclusive as to the hazards that might be encountered, safe practices that should be performed, or safe conditions that should be maintained during the course of any project. Moreover, this handbook does not replace the contractor's legal obligation to its employees under all relevant environmental, safety and health requirements and laws. All legal standards not specifically referenced in this handbook shall apply when applicable.

1 CONTRACT RESPONSIBILITIES

The Contractor agrees to comply with all rules and procedures contained in this document, known as the *Remediation Contractor's ESH Handbook*, unless Lockheed Martin specifically agrees, in writing, to a modification or exemption. In addition, the Contractor and subcontractors, at any tier, shall:

1.1 Lockheed Martin is a drug free-work workplace. This requirement extends to contractors working on Lockheed Martin remediation projects. Additionally, the use of tobacco is not permitted on Lockheed Martin owned property.

1.2 Take all prudent and proper environmental, safety and health (ESH) precautions to protect Lockheed Martin employees, all other workers, and the public from ESH hazards associated with contractor activities.

1.3 Comply with all applicable Federal, State, municipal, local, and any other applicable occupational safety and health statutes, rules, ordinances, regulations, and requirements issued or imposed by any governmental authority (including, but not limited to *Title 29, Code of Federal Regulations Parts 1903, 1904, 1910* and *1926*).

1.4 Comply with all applicable Federal, State, municipal, local, and any other applicable air pollution statutes, rules, ordinances, regulations, and requirements issued or imposed by any governmental authority.

1.5 Comply with all Federal, State, municipal, local and Lockheed Martin hazardous materials, hazardous waste, and non-hazardous waste statutes, rules, ordinances, regulations, and requirements (including, but not limited to *Title 40, Code of Federal Regulations*).

1.6 Obtain the applicable ESH permits to conduct the work in compliance with local, state, federal ESH regulations and site requirements (including, but not limiting to *Title 29, Code of Federal Regulations, 1910 and 1926*).

1.7 Ensure that all employees and subcontractors have received the appropriate level of ESH training in accordance with applicable ESH regulations necessary for the performance of the work requested by Lockheed Martin.

1.8 To instruct, prior to commencement of operations, all employees on the jobsite about relevant governmental laws and regulations, specific hazards expected to be encountered and proper safety precautions to be observed. In addition, jobsite employees shall read and certify that they have read and understand the job specific health and safety plan (HASP). The certification forms provided by the contractor within the HASP shall be electronically sent to the Lockheed Martin Project Lead.

1.9 Provide all jobsite visitors with a safety orientation prior to commencing work or touring the site. A visitor log shall be kept to document the orientation.

1.10 To ensure Contractor's job specific health and safety plan (HASP) encompasses Federal, State, municipal, local and the Lockheed Martin requirements found within this document the HASP should contain a section on crisis management / emergency response. A copy of the job specific HASP shall be maintained at the job site where jobsite employees have access to a copy. All Contractor Project Managers shall be provided a copy of the *Contractor's ESH Handbook* found within the Lockheed Martin Request for Proposal or as an appendix of the Key National Contractor Agreement. Contractors shall flow these requirements down to their subcontractors.

1.11 Contractor understands that Lockheed Martin may immediately stop Contractor's work if Contractor violates any applicable Federal, State, municipal, local, or any other rules, regulations, and requirements, *Remediation Contractor's ESH Handbook* provisions, or other contract terms and conditions regarding environmental, safety and health compliance. Lockheed Martin shall not incur work stoppage charges unless the contractor demonstrates that the work stoppage was unwarranted for any of the reasons stated above. Any dispute regarding work stoppage charges must be resolved through binding arbitration.

1.12 Contractor is advised that the Project may be inspected from time to time by Lockheed Martin or a representative of Lockheed Martin. Periodic Lockheed Martin inspections in no way relieve the Contractor of their obligation to maintain its own inspection program to identify unsafe conditions or acts. ESH violations will be considered in evaluation of Contractor's performance.

1.13 Lockheed Martin is not responsible for training or supervising Contractor employees or abating workplace hazards created by the Contractor or to which the Contractor's employees are exposed.

1.14 Contractor agrees to maintain copies of all pertinent ESH records at the job site. Pertinent records include, but is not limited to, personnel training documentation, evidence of enrollment in a medical surveillance program, accident/injury reporting, work area inspections, periodic safety meetings, MSDS's, air monitoring data, waste container inspections, etc. These records shall also be provided electronically to the Lockheed Martin Project Lead.

1.15 Contractor shall contact the Lockheed Martin Project Lead immediately in the event of a fatal or serious injury, an unpermitted environmental release, or any ESH incident that is likely to generate significant publicity or an adverse situation for Lockheed Martin (e.g., alleged releases of contaminants beyond property boundaries, purported fish or wildlife impacts, allegations of adverse community health or property impacts, etc.)

2 DEFINITION

2.1 Contractor: any agent/agency engaged by Lockheed Martin through written contract (or other written agreement) to perform work on Lockheed Martin Remediation Sites. For the purposes of this *Remediation Contractor's ESH Handbook*, "Contractor" shall also include Contractor's subcontractors at any tier.

2.2 EPA: the Environmental Protection Agency.

2.3 Fed/OSHA: the Federal Occupational Safety and Health Administration

2.4 Hazard Communication Program: a written program meeting the requirements of Title 29, Code of Federal Regulations, Section 1910.1200 - Hazard Communication.

2.5 Lockheed Martin: Lockheed Martin Corporation, Corporate Energy, Environment, Safety & Health

2.6 Lockheed Martin Project Lead: the Lockheed Martin Corporate Environment, Safety & Health individual that has been designated to manage a specific project.

2.7 Lockheed Martin Contract Representative: the Lockheed Martin Corporate Environment, Safety & Health contract representative (Contract Administrator/Buyer) for the project.

2.8 RCRA: the Federal Resource Conservation and Recovery Act and all amendments or revisions.

3 SAFETY & HEALTH

Contractor shall comply with applicable provisions of Federal, State, municipal, local, and any other applicable occupational safety and health statutes, rules, ordinances, regulations and requirements. Contractor shall take all precautions for the protection of the safety and health of Contractor employees, subcontractor employees, and Lockheed Martin employees to prevent accidents or injury to them or to other persons on, about, or adjacent to site of work performance. Notwithstanding this handbook, Contractor will hold harmless Lockheed Martin for any incident, violation, regulatory agency inspection resulting in a finding, or any other ESH issue that occurs to a Contractor employee.

Within Section 3.0, Lockheed Martin is identifying specific requirements within the Federal regulations that need extra attention. These are not all encompassing and adherence to the all rules and regulations must be followed.

3.1 PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT

1926 Subpart E or 1910 Subpart I
1910.139 / 1926.103
ANSI Z87.1
ANSI Z41 Standard
ANSI Z89.1 Standard

3.1.1 Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

- Eye Protection. Safety eyewear meeting ANSI Z87.1 shall be worn in areas designated as "Eye Protection Required" and on all jobs where a potential injury to the eyes is possible whether or not the area is posted.
- Foot Protection. Affected employee(s) shall wear protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, and where such employee's feet are exposed to electrical hazards. Safety shoes and boots which meet the ANSI Z41 Standard shall be provided when impact and/or compression hazards exist. Soft-shoes, including but not limited to, tennis shoes, athletic shoes, moccasins, sandals, and open-toed or open-heeled shoes shall not be worn.
- Respiratory Protection Devices. Appropriate, MSHA/NIOSH-approved respiratory protective devices must be worn when applicable state and/or federal action levels or OSHA permissible exposure levels (PELs) are exceeded. Contractor must have fully implemented a respiratory protection program meeting the requirements of *Title 29, Code of Federal Regulations, Section 1910.139 / 1926.103* or applicable state OSHA regulations prior to issuing and using respiratory equipment. Contractor shall supply and maintain

appropriate air monitoring and respiratory protection equipment if inhalation hazards are anticipated.

- Protective Clothing such as suits, aprons, boots, or gloves shall be worn where there is a hazard to the body through dermal contact with chemicals, dusts, heat or other harmful agents or conditions.
- Hearing Protection (muffs and/or plugs) must be worn in all areas posted to indicate high noise level or where Contractor employees are exposed to noise levels in excess of the OSHA action level (85 dBA over a 8-hour time-weighted average or a dose of fifty percent).
- Hard Hats will be worn in all areas where there is a danger of impact to the head or hazard from falling or moving objects. Hard hats must meet the ANSI Z89.1 Standard.

3.1.2 Contractor will issue or cause to be issued prior to commencing the job all necessary personal protective equipment and air monitoring equipment to all its agents and employees, together with full instructions and training on the use of said equipment.

3.1.3 Contractor will meet all applicable Federal, Sate, municipal, local, and Lockheed Martin requirements for protective clothing and equipment. Contractor will properly supervise all its agents and employees to ensure protective clothing and equipment are used in conformance with applicable rules and regulations.

3.2 HAZARD COMMUNICATION - USE OF HAZARDOUS MATERIALS

Title 29, Code of Federal Regulations, Section 1926.59 Hazard Communication
Title 29, Code of Federal Regulations, Section 1910.1200 Hazard Communication

3.2.1 Contractor personnel shall not bring any hazardous substances (as defined by OSHA) onto Lockheed Martin remediation sites unless accompanied by a Material Safety Data Sheet (MSDS) and the containers are appropriately labeled. MSDS's must be maintained at the job site.

3.2.2 Contractor shall notify the Lockheed Martin Project Lead prior to bringing onto Lockheed Martin remediation sites any quantity of hazardous materials.

3.2.3 Contractor shall ensure all containers of hazardous materials are labeled in accordance with the Fed OSHA Hazard Communication Standard, 29 CFR 1910.1200 or applicable state OSHA standard.

3.2.4 Do not handle or use any hazardous material that does not have adequate safety warning labels.

3.2.5 Do not dump, drain or discharge any hazardous materials or wastes into any sink, drain or sewer.

3.2.6 The Lockheed Martin Project Lead shall inform the Contractor(s) of the identity of hazardous chemicals to which Contractor's employees may be exposed from

Lockheed Martin operations, if applicable. The Lockheed Martin Project Lead shall provide the following information:

- Where to obtain information concerning any hazardous substances used in Lockheed Martin operations that the Contractor's employees may come in contact with while performing their work;
- If Lockheed Martin owns or uses chemicals on a remediation site for any process where contractors could be exposed, Lockheed Martin shall make available to the Contractor Material Safety Data Sheets (MSDS) and sufficient information to permit the Contractor to train its employees on the hazards of the chemical Appropriate protective measure Contractor employees may take to protect themselves from exposure to known hazards from Lockheed Martin operations; and
- Appropriate work practice procedures (safety rules) for the location where work is to be performed.

3.2.7 Contractor shall ensure its employees are trained in the safe handling and use of hazardous materials in accordance with *29 CFR 1910.1200 - Hazard Communication* or the applicable state-OSHA hazard communication standard.

3.2.8 Contractor shall ensure that all applicable employees are medically qualified (as defined by OSHA) to perform the work assigned.

3.2.9 Hazardous materials shall be stored in designated areas and all containers effectively closed. Spill equipment/supplies shall be readily available to contain and/or mitigate accidental spills of hazardous materials.

3.3 CONFINED SPACE ENTRY

Title 29, Code of Federal Regulations, Section 1910.146 Permit-Required Confined Spaces

3.3.1 If Contractor or any other employee must enter a confined space (tank, vat, pit, sewer, etc.), the entry must be performed in accordance with the applicable state OSHA or federal OSHA regulations.

3.3.2 Before Contractor's employees are permitted entry into any confined space, the internal atmosphere shall be tested with a calibrated direct-reading instrument for the following conditions in the order given: 1) Oxygen content, 2) Flammable gases & vapors, and 3) Potential toxic air contaminants. Contractor shall furnish the air testing equipment and a person competent in the use of the testing equipment.

3.3.3 When possible, the Contractor shall notify the Lockheed Martin Project Lead prior to entering a permit required confined space. A permit shall be issued by the contractor prior to entry and electronically submit a copy to the Lockheed Martin Project Lead.

3.3.4 To ensure the safety of Contractor personnel during entry into confined spaces, the Contractor shall have a written confined space entry program.

3.4 HOT WORK REQUIREMENTS (i.e., welding, torch cutting, brazing, etc.)

Title 29, Code of Federal Regulations, Section 1910 Subpart Q
Title 29, Code of Federal Regulations, Section 1926 Subpart J

3.4.1 All hot work activities shall be conducted in accordance with the hot work permit requirements outlined in the site specific HASP (i.e., fire suppression equipment availability, removal of combustibles, fire watch, etc.).

3.4.2 Contractor personnel must secure all oxygen and acetylene cylinders in a manner that will prevent them from falling or tipping over. Oxygen and acetylene cylinders must be stored separately. Oxygen cylinders in storage must be separated from fuel gas cylinders a distance of 20 feet or by a noncombustible barrier 5 feet high. Acetylene cylinders shall not be stored horizontally, lying on their side.

3.4.3 When welding, Contractor personnel shall use welding curtains and/or suitable protective devices to protect persons from indirect exposure to welding flashes.

3.5 LOCKOUT / TAGOUT - Control of Hazardous Energy

Title 29, Code of Federal Regulations, Section 1910.147

3.5.1 Contractors are required to establish a written program and utilize procedures for affixing appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start-up or release of stored energy in order to prevent injury to employee.

3.5.2 Contractor shall not service and/or maintain machines and equipment in which the unexpected energization or start up of the machines or equipment, or release of stored energy could cause injury to employees. Servicing and/or maintaining such equipment shall not be conducted until appropriate energy control methods have been initiated.

The Contractor shall provide training to ensure that the purpose and function of the energy control program are understood by their employees and that the knowledge and skills required for the safe application, usage, and removal of the energy controls are acquired by the employees.

3.5.3 If Contractor needs to service or maintain Lockheed Martin equipment, Contractor(s) shall notify the Lockheed Martin Project Lead and/or on-site facility operator (if applicable) of the intended equipment service for any unscheduled maintenance.

3.5.4 Upon completion of the job, Contractor is to notify the Lockheed Martin Project

Lead and/or on-site facility operator (if applicable) so power can be resumed to the equipment after the lock-outs and tags have been removed.

3.6 USE OF LOCKHEED MARTIN MATERIALS AND EQUIPMENT

3.6.1 Contractor's employees shall not use Lockheed Martin tools, equipment, materials, or personal protective equipment unless otherwise authorized by Lockheed Martin.

3.6.2 Contractor shall not start or stop any production equipment without the approval of the Lockheed Martin Project Lead.

3.6.3 Contractor shall not adjust or relocate any Lockheed Martin process equipment without the approval of the Lockheed Martin Project Lead.

3.7 DANGEROUS OPERATIONS - WARNINGS AND BARRICADES

Title 29, Code of Federal Regulations, Section 1926, Subpart G-Signs, signals and barricades

3.7.1 Contractor shall isolate their work areas from Lockheed Martin operations, employees, and the public by using barricades or other effective means of isolation. Signs, signals and barricades shall be visible at all times where a hazard exists.

3.7.2 Contractor personnel shall erect and properly maintain, at all times, all necessary safeguards for the protection of Contractor personnel, Lockheed Martin employees and the public. This includes:

- If doing any overhead work, Contractor must utilize warning signs and barricades, or station someone on the ground to prevent passers-by from entering the area below the overhead work;
- Contractor must effectively barricade excavations, floor openings, etc., as required by OSHA regulations;
- Contractor must construct and maintain all scaffolds and working platforms in accordance with OSHA regulations; and
- If Contractor's equipment, barricades or other safeguards restrict fire lanes or fire equipment access, the Contractor shall notify the Lockheed Martin Project Lead about its notification to the local fire department.

3.7.3 Prior to commencing work, Contractor must inform Lockheed Martin Project Lead of any work posing a potential danger to personnel.

3.8 EXCAVATIONS, TRENCHES, EARTHWORK

Title 29, Code of Federal Regulations, Section 1926 Subpart P

3.8.1 Review the Lockheed Martin intrusive fieldwork requirements in Appendix A.

3.8.2 If workers are to enter excavations, a competent person must be designated and trained in soil classification and the recognition of trenching and excavation hazards.

3.8.3 Excavations and trenches shall be inspected by a competent person daily and after every rainstorm, earthquake, or other hazard-increasing occurrence.

3.8.4 Inspect the face, banks, and top daily when workers are exposed to falling or rolling materials.

3.8.5 Shore, bench, slope, or use equivalent methods to protect workers in excavations four feet deep or more.

3.8.6 Locate soil at least two feet from the edge of the excavation, or one foot from the edge when the excavation is less than five feet deep.

3.8.7 Ladders or steps shall be provided and secured in all trenches four feet or more in depth. Ladders shall be located to require no more than twenty-five feet of lateral travel before having access or egress and shall extend three feet above the top of the trench bank.

3.8.8 Install crossings with standard guardrails and toeboards when the excavation is more than 7½ feet deep.

3.8.9 All open trenches and other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public.

3.8.10 Do not excavate beneath the level of adjacent foundations, retaining walls, or other structures until a qualified person has determined that the work will not be hazardous. Support undermined sidewalks.

3.9 ELECTRICAL SAFETY

Title 29, Code of Federal Regulations, Section 1926 Subpart K-Electrical
Title 29, Code of Federal Regulations, Section 1910.269 Electrical Power Generation, Transmission and Distribution

3.9.1 Only qualified persons are permitted to work on electrical systems, as defined by *Title 29, Code of Federal Regulations Section 1910.269(a)(2).* Qualified persons shall be trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from other parts of electrical equipment;
- The skills and techniques necessary to determine the nominal voltage of exposed live parts;
- The minimum approach distances specified by OSHA corresponding to the voltages to which the qualified employee will be exposed; and

- The proper use of the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment.

3.9.2 Contractor personnel shall properly ground all electrical tools, mechanical digging or concrete breaking equipment and all other electrical equipment while in use.

3.9.3 All electrical work, installation and wire capacities shall be in accordance with the pertinent provisions of the National Electrical Code, ANSI and OSHA.

3.9.4 Covers or barriers must be installed on boxes, fittings, and enclosures to prevent accidental contact with live parts.

3.9.5 Temporary wiring installations must be grounded.

3.9.6 Electrical systems shall be de-energized utilizing appropriate lockout/tagout procedures prior to conducting work.

3.10 ELEVATED LOCATIONS / FALL PROTECT

Cal/OSHA General Industry Safety Orders, 8 CCR 3210
Title 29, Code of Federal Regulations, Section 1926 Subpart M – Fall Protection

3.10.1 California employers: Guardrails shall be provided on all open sides of unenclosed room openings, open and glazed sides of landings, balconies or porches, platforms, runways, ramps, or working levels more than 30 inches above the floor, ground, or other working areas. The railing must be provided with a toeboard where the platform, runway, or ramp is 6 feet or more above places where employees normally work or pass and the lack of a toeboard could create a hazard from falling tools, material, or equipment.

3.10.2 Contractor must provide fall protection systems whenever a worker is exposed to a fall of four feet or more (in construction the threshold is six feet). Guardrails are the most common forms of fall protection systems. If guardrail systems are not feasible, safety nets, personal fall arrest systems, positioning device systems, warning line systems, or some other demonstrated, effective means of fall protection shall be used. Fall protection systems and devices shall be inspected prior to each use Title 29, Code of Federal Regulations, Section 1926 Subpart M.

3.11 LADDERS

Title 29, Code of Federal Regulations, Section 1910 Subpart D – Walking and Working Surfaces
Title 29, Code of Federal Regulations, Section 1926 Subpart X - Ladders

3.11.1 The use of ladders with broken or missing rungs or steps, broken or split rails or other defective construction is prohibited.

3.11.2 Ladders shall extend no less than 36 inches above landing and be secured to

prevent displacement.

3.11.3 Portable ladders must be equipped with safety shoes.

3.11.4 Wooden ladders shall not be painted.

3.11.5 Do not use metal ladders for electrical work or near live electrical parts.

3.12 SCAFFOLDS

Title 29, Code of Federal Regulations, Section 1910.28 – Safety Requirements for Scaffolding
Title 29, Code of Federal Regulations, Section 1926 Subpart L - Scaffolds

3.12.1 Scaffolds must be provided for all work that cannot be done safely by employees standing on solid construction at least 20 inches wide, except where such work can be safely done from ladders.

3.12.2 Erection and dismantling of scaffolds shall be performed in accordance with good engineering practice.

3.12.3 Footings or anchorage for any scaffold shall be sound, rigid and capable of carrying the maximum intended load without settling or displacement.

3.12.4 No unstable objects such as concrete blocks shall be used to support scaffolds or planks.

3.12.5 Any part of a scaffold weakened or damaged shall be repaired or replaced immediately.

3.12.6 All scaffold planking shall be free of knots and cracks (Class A number) and shall completely cover the work platform.

3.12.7 Scaffold planks shall be laid tight, cleated at both ends or overlapped a minimum of 12 inches and nailed or bolted to prevent movement. Overlaps to occur directly above scaffold supports.

3.12.8 A safe and unobstructed means of access, such as a walkway, stair, or ladder shall be provided to all scaffold platforms.

3.13 HEAVY EQUIPMENT, INDUSTRIAL VEHICLES, AND CRANES

Title 29, Code of Federal Regulations, Section 1926 Subparts N, O and W

3.13.1 Only trained and authorized workers may operate heavy equipment, industrial vehicles, and/or cranes.

3.13.2 The Contractor shall designate a competent person who shall inspect all machinery and equipment prior to each use to make sure it is in safe operating condition.

3.13.3 The Contractor shall comply with the manufacturer's specifications and limitations applicable to the operation of any and all heavy equipment, industrial vehicles, and cranes.

3.13.4 Seatbelts are required to be worn if the vehicle has Roll-Over Protection Structures (ROPS).

3.13.5 The swing radius of cranes shall be barricaded.

3.13.6 Equipment shall not be lubricated while in use.

3.13.7 Rated load capabilities, recommended operating speeds, special hazard warning, specific hand signal diagrams and special instructions shall be visible to the operator while he is at the control station.

3.13.8 Contractor's employees shall not be allowed to work under the load of cranes. Tag lines shall be used on all loads.

3.14 OVERHEAD POWER LINES

Title 29, Code of Federal Regulations, Section 1926.550 (a) (15)

3.14.1 If work is to be performed near overhead power lines, the lines must be de-energized and grounded by the owner or operator of the lines, or other protective measures must be provided before work is started. Protective measures (such as guarding or insulating the lines) must be designed to prevent employees from contacting the lines.

3.14.2 Unqualified employees and mechanical equipment must stay at least 10 feet away from overhead power lines. If the voltage is over 50,000 volts, the clearance should be increased by four inches for each additional 10,000 volts.

3.14.3 When mechanical equipment is being operated near overhead lines, employees standing on the ground may not contact the equipment unless it is located so that the required clearance cannot be violated even at the maximum reach of the equipment.

3.14.4 A person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.

3.14.5 Any overhead wire shall be considered to be an energized line unless and until the person owning such line or the electrical utility authorities indicates that it is not energized.

3.15 FIRE PREVENTION / FLAMMABLE LIQUIDS

Title 29, Code of Federal Regulations, Section 1926 Subpart F or 1910 Subpart E

3.15.1 Contractor shall be responsible for fire protection in its work and operational areas,

including offices, tool rooms, and storage areas 24 hours per day, seven days per week through the duration of this Contract. Approved fire-fighting equipment, in adequate quantities, must be provided.

3.15.2 Contractor shall familiarize Contractor's employees with the locations of fire extinguishers in their respective work areas and ensure they are prepared to use them safely if necessary. In certain remote field locations or within abandoned (discontinued) facilities where fire extinguishers may not exist in the immediate work area, contractor shall provide and locate fire extinguisher(s) in close proximity to the active work area(s).

3.15.3 In case of fire, Contractor shall call 9-1-1. Contractor shall also inform all Contractor and Lockheed Martin employees in the area to evacuate to a safe place and direct arriving fire response personnel to the fire. Notify the Lockheed Martin Project Lead as soon as reasonably possible.

3.15.4 Contractor employees shall only attempt to put out a fire when such action can be performed safely.

3.15.5 If a Contractor employee uses a Lockheed Martin fire extinguisher, Contractor shall report its use to the Lockheed Martin Project Lead.

3.15.6 Contractor shall report all fires extinguished by the Contractor to the Lockheed Martin Project Lead.

3.15.7 Contractors are to store, dispense, and use flammable and combustible liquids in accordance with OSHA regulations and the Uniform Fire Code. Bonding and grounding of containers containing flammable liquids will be required.

3.15.8 Open flames and smoking shall not be permitted in flammable or combustible liquid storage areas.

3.15.9 Contractor shall provide sufficient fire extinguishers necessary for their work activities.

3.16 HAND AND POWER TOOLS

Title 29, Code of Federal Regulations, Section 1910 Subpart P – Hand and Portable Powered Tools and Other Hand-Held Equipment
Title 29, Code of Federal Regulations, section 1926 Subpart I – Tools Hand and Power

3.16.1 All hand and power tools, whether furnished by Contractor, or by Contractor’s employee, shall be maintained in a safe condition.

3.16.2 Electrical power tools shall be grounded or double insulated with proper assured equipment grounding inspections or Ground Fault Interrupter (GFI) circuit protection provided.

3.16.3 Pneumatic power tools shall be secured to the hose or whip by some positive means.

3.16.4 Only properly trained Contractor employees shall operate power-actuated tools.

3.16.5 All grinding machines shall conform to OSHA and ANSI requirements.

3.17 COMPRESSED GAS CYLINDERS

Title 29, Code of Federal Regulations, Section 1910.101 – Compressed Gases
Title 29, Code of Federal Regulations, Section 1926.350 – Gas Welding and Cutting

3.17.1 Compressed gas cylinders shall be secured in an upright position at all times.

3.17.2 When transporting, moving and storing cylinders, valve protection caps shall be in place and secured.

3.17.3 Compressed gas cylinders shall be kept away from excessive heat, shall not be stored where they might be damaged or knocked over by passing or falling objects, and shall be stored at least 20 feet away from highly combustible materials.

3.17.4 Cylinders shall be labeled as to the nature of their contents.

3.17.5 Oxygen cylinders in storage shall be separated from fuel gas cylinders or combustible materials a minimum of 20 feet or by a noncombustible barrier at least five feet high having a fire-resistant rating of at least one-half hour.

3.17.6 Acetylene cylinders shall be stored and used in a vertical, valve-end-up position only.

3.17.7 Anti-flashback arrestors shall be installed on all oxygen and acetylene cylinders.

3.18 INCIDENTAL CONTACT WITH ASBESTOS

3.18.1 This section applies to all contractors who incidentally disrupt the matrix of asbestos containing material (ACM) or presumed asbestos containing material (PACM); i.e., contractors who have not been specifically hired to perform ACM abatement.

3.18.2 Contractor shall immediately report to the Lockheed Martin Project Lead and to other employers of employees working at the job site any discovery, disturbance, and/or spill of ACM and/or PACM. Contractor(s) is to cease all operations in the immediate area of the suspect ACM and/or PACM and demarcate the area. The approval of the Lockheed Martin Project Lead is required before resuming operations.

3.18.3 Contractor shall not disturb any pipe insulation, boiler insulation, or any other material reasonably suspected of containing asbestos until the Contractor notifies the Lockheed Martin Project Lead. Lockheed Martin approval is required before operations may commence.

3.18.4 Abatement of asbestos can be performed only by persons properly trained and licensed to perform such activities

3.19 ASBESTOS ABATEMENT CONTRACTORS

3.19.1 This section applies to Contractors performing maintenance, construction, repair, renovation, demolition, salvage, or any other operation in which any material containing more than 1% asbestos is sanded, abrasive blasted, sawed, shoveled, removed, or otherwise handled in a manner that would generate airborne asbestos fibers. These requirements are in addition to any requirements contained in Contractor's scope of work.

3.19.2 All Contractors working with asbestos shall comply with applicable federal and state OSHA, EPA, local air district, and other applicable Federal, State, municipal, and local statutes, regulations, rules, and ordinances; and specific contract terms and conditions regarding the handling of, use of, and work involving asbestos.

3.19.3 The contractor shall ensure that a competent person, as defined by OSHA supervises all asbestos work performed within regulated areas.

3.19.4 Before commencing work, all asbestos abatement contractors shall supply to Lockheed Martin proof of:

- Asbestos abatement contractor certification by the state Contractor's License Board
- Liability insurance for Contractor employees engaged in asbestos work operations
- Copies of asbestos work notification letters to state OSHA
- Local air district Asbestos Demolition/Renovation Notification

3.19.5 Contractors shall minimize the creation and spread of airborne asbestos fibers by using appropriate work practices, engineering controls, and established procedures (i.e., wet methods, HEPA filter vacuums, negative pressure enclosure, local exhaust ventilation equipped with HEPA filter dust collection system, etc.).

3.19.6 All Class I, II and III asbestos work shall be conducted within regulated areas. The regulated area shall be demarcated in any manner that minimizes the number of persons within the area and protects persons outside the area from exposure to airborne asbestos. Where critical barriers or negative pressure enclosures are used, they may demarcate the regulated area. Signs shall be provided and displayed at each location where a regulated area is required to be established. Signs shall be posted at such a distance from such a location that an employee may read the signs

and take necessary protective steps before entering the area marked by the signs. Warning signs shall bear the following information:

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY

3.19.7 On multiple employer worksites requiring the establishment of a regulated area, the asbestos Contractor shall inform other employers on the site of the nature of the work with asbestos and/or PACM, of the existence of and requirements pertaining to regulated areas, and the measures taken to ensure that employees of such other employers are not exposed to asbestos.

3.19.8 Contractors shall package and label asbestos waste in accordance with federal and or applicable state OSHA requirements and federal or applicable state hazardous waste regulations. Labels shall be affixed to all products containing asbestos and to all containers containing such products, including waste containers. Labels shall be printed in large, bold letters on a contrasting background and shall contain the following information:

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

3.19.9 Contractors shall properly dispose of all asbestos waste. Proper disposal includes the use of hazardous waste manifests and Lockheed Martin approved and licensed waste haulers, and disposal facilities according to federal RCRA law and applicable state hazardous waste regulations. Contractor shall contact the Lockheed Martin Project Lead before transporting or disposing of any hazardous waste. Lockheed Martin must review all hazardous waste manifests prior to shipment.

3.19.10 Contractors shall ensure that employee exposure air monitoring is conducted as required by federal or applicable state OSHA regulations. All other air monitoring (i.e. clearance sampling) shall be conducted by a third-party contracted air monitoring firm not affiliated with the Contractor.

3.19.11 Contractor shall, at no cost to the employee, institute a training program for and ensure the participation of all employees engaged in asbestos-related work who may reasonably be expected to be exposed to asbestos fibers from asbestos containing construction materials.

3.19.12 Contractor shall institute a medical surveillance program for all employees who are or will be exposed to airborne concentrations of fibers of asbestos at or above the TWA and/or excursion limit.

3.20 HAZARDOUS WASTE OPERATIONS and EMERGENCY RESPONSE (HAZWOPER)

Title 29, Code of Federal Regulations, Section 1910.120 - Hazardous Waste Operations and Emergency Response

Title 29, Code of Federal Regulations, Section 1926.65 – Hazardous Waste Operations and Emergency Response

This section applies to Contractors performing hazardous waste-type activities. This includes operations that pose a potential or reasonable possibility for employee exposure to hazardous waste/chemical contaminants during site investigations, clean-up operations, abatement, or hazardous substance removal work (remedial actions). These requirements are in addition to any requirements contained in Contractor's scope of work.

3.20.1 Contractor shall provide a **site-specific safety and health plan** at least two (2) weeks prior to field mobilization to the Lockheed Martin Project Lead (global statement – move to the beginning).

Contractor shall provide a **safety and health plan** in accordance with *Title 29, Code of Federal Regulations, Section 1910.120 - Hazardous Waste Operations and Emergency Response* or the applicable state OSHA standard and, at a minimum, shall contain the following elements:

- Safety and health risk or hazard analysis for each anticipated site task
- Employee training requirements
- Personal protective equipment to be used by employees for each of the site tasks and operations
- Medical surveillance requirements
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used
- Site control measures
- Decontamination requirements and procedures
- Emergency response plan
- Confined space procedures (if applicable)
- Emergency response plan
- Confined space procedures (if applicable)
- Spill containment program
- Periodic documented safety meetings
- Periodic documented work area safety inspections and corrective actions

3.20.2 Contractors performing hazardous waste-type operations shall adhere to the requirements specified in *29 CFR 1910.120 - Hazardous Waste Operations and Emergency Response* or the applicable state OSHA standard.

3.20.3 Training: All Contractor and subcontractor employees working on site who are potentially exposed to hazardous substances shall receive initial and annual

refresher training in accordance with *29 CFR 1910.120(e) – Hazardous Waste Operations and Emergency Response* or the applicable state OSHA standard. Lockheed Martin shall be provided with electronic copies of the training certificates.

3.20.4 Medical Surveillance: Contractor employees must be enrolled in a medical surveillance program prior to performing hazardous waste operations. Upon Lockheed Martin request, Contractor shall provide evidence of employee enrollment in a medical surveillance program. Lockheed Martin does not provide medical surveillance examinations to Contractor employees.

3.20.5 Periodic work area inspections: Contractor agrees to perform periodic work area inspections to determine the effectiveness of the site safety and health plan and to identify and correct unsafe conditions in contractor's responsible work area. These inspections shall be documented and available to Lockheed Martin upon request for review.

3.21 MANAGEMENT OF NANOTECHNOLOGY

3.21.1 The Lockheed Martin Project Lead shall work with the designated contractor responsible for nanotechnology to implement this procedure and ensure areas where nanomaterials (materials incorporating engineered nanoparticles or nanoscale features that exhibit unique physical and chemical properties as a result of the nanoparticles or nanoscale features) will be used meet engineering control requirements of this procedure.

3.21.2 The contractor shall ensure that the safety and environmental hazards of nanomaterials are managed as described in the requirements of this section.

3.21.3 A plan must be developed and executed that addresses the following requirements:

3.21.3.1 **Hazard Analysis:** Identify potential adverse health effects and environmental impacts that could result from the chemical and physical properties exhibited by the nanomaterials and/or nanoparticles in use, to be used, under development, or to be developed at the site.

3.21.3.2 **Exposure Assessment**: Evaluate all tasks involving nanomaterials and identify where exposures could occur. The evaluation must include at a minimum, an evaluation of materials; chemical intermediates; by-products; end-products; waste products; processes; process equipment; the amount of material used; material form; degree of containment; duration of use; and work space including laboratory and manufacturing space.

3.21.3.3 **Exposure Control**

- Implement appropriate controls to mitigate worker exposure and environmental emissions identified in sections 3.21.2.1 and 3.21.2.2 of this procedure.

- Implement Control Bands as indicated on the Control Band Matrix below.

Exposure Duration	Bound Materials	Potential Release	Free / Unbound
Hazard Group A (Known to be inert)			
Short	1	1	2
Medium	1	1	2
Long	1	2	2
Hazard Group B (Understand reactivity/function)			
Short	1	2	2
Medium	1	2	3
Long	1	3	3
Hazard Group C (Unknown Properties)			
Short	2	2	3
Medium	2	3	4
Long	2	4	4

Duration Key:
Short - Less than 4 hrs/day; 2 days/week
Medium - Between 4 to 6 hrs/day; 3 to 5 days/week
Long - 6 to > 8 hrs/day; 3 to 5 days/week

Release Key:
Bound Materials: Nanoparticles in a solid matix e.g. polycarbonate
Potential Release: Nanoparticles in friable or solgel matrix
Free / Unbound: Nanoparticles unbound, not aggregated

Control Band:
1. General Ventilation and PPE
2. Engineering Controls and/or Respirators and additional PPE
3. Containment e.g. glove box
4. Specialist Advise

- Establish designated areas for Control Banding. The designated area shall, at a minimum, include warning signs informing employees that they are entering a nanomaterial work area as well as signs specifying administrative controls and personal protective equipment (PPE) required for entry.
- Identify appropriate administrative controls (e.g. good housekeeping methods, HEPA vacuums, wet wipe methods, employee training, safe work practices), engineering controls (e.g. containment, exhaust ventilation) and Personal Protective Equipment (e.g. respiratory protection, protective coveralls, gloves, goggles) based on Control Band and best industry practices.
- Develop and execute procedures for housekeeping, including clean-as-you-go practices that do not re-suspend particles.
- Develop and execute procedures for management of nanomaterial-associated waste.

4 ENVIRONMENTAL

Contractors shall comply with all applicable provisions of Federal, State, municipal, local, and other environmental statutes, rules, and regulations. Contractor shall take all necessary precautions to protect the environment. Contractor shall also store, transport, dispose, or otherwise handle hazardous wastes and non-hazardous wastes to prevent discharges of materials into the environment except in accordance with applicable governmental regulations.

4.1 HAZARD COMMUNICATION - USE OF HAZARDOUS MATERIALS

4.1.1 Contractor shall develop a Waste Management Plan in accordance with the requirements outlined in the LMC Remediation Waste Management Procedure in

Appendix B. Lockheed Martin shall approve the Waste Management Plan prior to work commencement.

4.1.2 Contractor must segregate hazardous from non-hazardous waste; all hazardous waste generated by its operations must be labeled in accordance with all governmental regulations.

4.1.3 Contractor shall dispose of all hazardous waste within the time frame stipulated by local, state, or federal regulations. Contractor shall not leave behind on Lockheed Martin remediation sites any containers of hazardous materials or waste (including drums, roll-offs, maintenance chemicals, etc.), empty or not, after the termination of operations.

4.1.4 In case of a spill or release of hazardous materials or waste, Contractor shall immediately notify the Lockheed Martin Project Lead and if the severity of the spill warrants, notify the local fire department (Call 9-1-1). The Contractor shall be liable for the costs of any spill resulting from Contractor's actions, including, but not limited to, costs of containment, cleanup, and disposal.

4.2 NON-HAZARDOUS WASTE DISPOSAL

4.2.1 Contractor shall develop a Waste Management Plan in accordance with the requirements outlined in the LMC Remediation Waste Management Procedure in Appendix B. This plan must be approved by the Lockheed Martin Project Lead.

4.3 WORK INVOLVING AIR EMISSIONS

4.3.1 Contractor shall work with the Lockheed Martin Project Lead to identify applicable Federal, state, and/or local permit application requirements for air emission sources (i.e., stationary point source, fugitive emissions, etc.) associated with the anticipated project.

4.3.2 Contractor shall submit permit applications and/or notifications to the Lockheed Martin Project Lead for review prior to submittal to the applicable regulatory agency.

4.3.3 Contractor shall abide by the requirements of the permit(s) and gather emissions data (as applicable) to document compliance. This data shall be electronically submitted to the Lockheed Martin Project Lead.

4.3.4 Contractor shall immediately contact the Lockheed Martin Project Lead in the event permit conditions are not met.

4.3.5 Ensure permits are posted on permitted equipment (or in close proximity) as required by the respective permit.

4.4 WORK INVOLVING WATER DISCHARGES

4.4.1 At no time is an unauthorized, unpermitted release allowed. Contractor shall notify the Lockheed Martin Project Lead in the event of a release and obtain the approval of Lockheed Martin before discharging any material into storm drains or sewers.

4.4.2 Contractor shall work with the Lockheed Martin Project Lead to identify applicable National Pollutant Discharge Elimination System (NPDES), Stormwater Pollution Prevention Plans (SWPPP), and POTW requirements associated with the anticipated project.

4.4.3 Contractor shall submit permit applications and/or Notice of Intent forms to the Lockheed Martin Project Lead for review prior to submittal to the applicable regulatory agency.

4.4.4 Contractor shall abide by the requirements of the discharge permit(s) and maintain discharge monitoring information and inspection data to document compliance. This documentation shall be electronically provided to the Lockheed Martin Project Lead.

4.4.5 Contractor shall immediately contact the Lockheed Martin Project Lead in the event permit conditions are not met.

5 HOUSEKEEPING / CLEANUP

5.1 Ensure discharge permits and/or SWPPP plans (as applicable) are available at the project job site.

5.2 Contractor shall continuously clean up its respective work area(s). Contractor shall maintain its work areas free from all slip, trip, and fall hazards at all times.

5.3 Debris shall be kept cleared from work areas, passageways, stairs, and in and around buildings or other structures. The work area must be left free from accumulation of waste and rubbish at the end of each work shift.

5.4 Combustible scrap and debris shall be removed at regular intervals during the course of work performed by Contractor. Safe means shall be provided to facilitate such removal.

5.5 At the end of each working day and/or the conclusion of work being performed, Contractor shall restore the work area to the same degree of neatness as when work commenced.

5.6 Contractor shall furnish necessary equipment and/or receptacles to remove waste and rubbish from the job site unless otherwise specified by the Lockheed Martin.

6 CHANGE MANAGEMENT

If deviations are encountered from the field work plan, the contractor shall A) notify to the Lockheed Martin Project Lead and B) suspend work to assess changes to the work plan(s) and the HASP. Changes to the work plan(s) and the HASP shall be reviewed by the PL.

7 REQUIREMENT TO PERFORM & DOCUMENT SELF-AUDITS

7.1 Contractor agrees to perform periodic work area/project field inspections to monitor compliance with project environmental, safety and health (ESH) requirements. The name of Contractor's jobsite ESH representative will be provided to Lockheed Martin prior to the Contractor starting work at the jobsite.

7.2 For jobs that are ongoing, an annual ESH audit shall be conducted and for jobs with a duration of less than one year at least one audit shall occur. A competent ESH representative designated by the Contractor shall perform the audit. Unsafe acts and/or non-compliance conditions noted during inspections shall be corrected immediately.

7.3 The documentation related to the audits and inspections shall be submitted electronically to the Lockheed Martin Project Lead.

8 ACCIDENT, INJURY, ILLNESS, INCIDENT and SPILL REPORTING

8.1 Contractor shall immediately contact the Lockheed Martin Project Lead and/or Lockheed Martin Safety & Health Manager in the event of a fatality, injury, environmental release (spill), near-miss incident, or any ESH incident that is likely to generate significant publicity. A written report of the incident/injury/spill and corrective action(s) taken shall be submitted to the Lockheed Martin Project Lead within one (1) day of the incident. Representatives from Lockheed Martin may conduct joint investigations with the contractor if deemed necessary.

8.2 In case of a spill or release of hazardous chemicals, Contractor shall immediately notify the Lockheed Martin Project Lead, and/or if the severity of the spill warrants, the local fire department by calling 9-1-1. Contractor shall take all necessary steps to control the spread of the release and to provide site control to prevent unauthorized personnel from entering the affected area. The Contractor shall be liable for the costs of any spill resulting from Contractor's actions, including, but not limited to, costs of containment, cleanup, and disposal.

9 FINES, PENALTIES AND COSTS

9.1 Contractor shall indemnify and hold Lockheed Martin harmless from any and all liability (including but not limited to fines and penalties), loss, cost, damage, or expense (including attorney's fees) suffered or incurred by Lockheed Martin by reason of Contractor's failure to comply with Federal, State, municipal, local or other laws, rules, regulations, ordinances and requirements, or failure to comply with generally accepted environmental safety and health practices.

10 LOCKHEED MARTIN ESH MANAGER

10.1 The Lockheed Martin ESH Manager is Jimmy Yeager. Contact Jimmy regarding any questions or concerns at (301) 873-1444 or via email at james.l.yeager@lmco.com.

Appendix A – LMC Requirements for Invasive Fieldwork

LMC Minimum
Requirements for Inv

Appendix B – LMC Waste Management Procedure

LMC Waste Mgmt
Procedure Rev 4

LOCKHEED MARTIN

CONTRACTOR'S ESH HANDBOOK

COMPLIANCE AGREEMENT

The Key National Contractor Program Manager has read and understands the contents of the *Contractor's ESH Handbook*. Contractor agrees while performing work on Lockheed Martin-owned or Lockheed Martin-controlled premises, that the Contractor shall require its employees and subcontractors at any tier to comply with the contents of this *Contractor's ESH Handbook* and the job specific HASP. A copy of the HASP shall be maintained at the job site and made readily available to contractor and subcontractor employees for their information. All contractor employees and subcontractors shall read and certify that they have read and understand the job specific health and safety plan (HASP). The certification forms shall be electronically sent to the Lockheed Martin Project Lead.

I further understand that this handbook and the rules and regulations it contains do not in any way relieve the Contractor (employer) of its responsibility to comply with the applicable environmental safety and health (ESH) regulations and its obligation to implement and enforce its own written ESH programs while working on this project.

Company: _____

Name: _____

Signature: _____

Title: _____

Date: _____

COMPLETE, SIGN AND RETURN THIS CERTIFICATE TO THE LOCKHEED MARTIN ESH MANAGER.

ATTACHMENT II

INCIDENT REPORT FORM

TETRA TECH, INC.
Safety Excellence

Tetra Tech, Inc.
Incident Report

Report Date	Report Prepared By	Incident Report Number

INSTRUCTIONS:

All incidents (including those involving subcontractors under direct supervision of Tetra Tech personnel) must be documented on the IR Form.

Complete any additional parts to this form as indicated below for the type of incident selected.

TYPE OF INCIDENT (Check all that apply)		Additional Form(s) Required for this type of incident
Near Miss (No losses, but could have resulted in injury, illness, or damage)	☐	Complete IR Form Only
Injury or Illness	☐	Complete Form IR-A; Injury or Illness
Property or Equipment Damage, Fire, Spill or Release	☐	Complete Form IR-B; Damage, Fire, Spill or Release
Motor Vehicle	☐	Complete Form IR-C; Motor Vehicle

INFORMATION ABOUT THE INCIDENT

Description of Incident

_____

_____

_____

Date of Incident	Time of Incident
	_____ AM ☐ PM ☐ *OR* Cannot be determined ☐
Weather conditions at the time of the incident	**Was there adequate lighting?**
_____	_____ Yes ☐ No ☐

Location of Incident

_____ Was location of incident within the employer's work environment? Yes ☐ No ☐

Street Address	City, State, Zip Code and Country
Project Name	**Client:**
Tt Supervisor or Project Manager	**Was supervisor on the scene?**
	Yes ☐ No ☐

WITNESS INFORMATION (attach additional sheets if necessary)

Name	Company
Street Address	**City, State and Zip Code**
Telephone Number(s)	

CORRECTIVE ACTIONS

Corrective action(s) immediately taken by unit reporting the incident:

_____

_____

_____

Corrective action(s) still to be taken (by whom and when):

_____

_____

_____

ROOT CAUSE ANALYSIS LEVEL REQUIRED

Root Cause Analysis Level Required: Level - 1 ☐ Level - 2 ☐ None ☐

Root Cause Analysis Level Definitions

Level - 1	**Definition:** A Level 1 RCA is conducted by an individual(s) with experience or training in root cause analysis techniques and will conduct or direct documentation reviews, site investigation, witness and affected employee interviews, and identify corrective actions. Activating a Level 1 RCA and identifying RCA team members will be at the discretion of the Corporate Administration office. The following events may trigger a Level 1 RCA: ▪ Work related fatality ▪ Hospitalization of one or more employee where injuries result in total or partial permanent disability ▪ Property damage in excess of $75,000 ▪ When requested by senior management
Level - 2	**Definition:** A Level 2 RCA is self performed within the operating unit by supervisory personnel with assistance of the operating unit HSR. Level 2 RCA will utilize the 5 Why RCA methodology and document the findings on the tools provided. The following events will require a Level 2 RCA: ▪ OSHA recordable lost time incident ▪ Near miss incident that could have triggered a Level 1 RCA ▪ When requested by senior management

Complete the Root Cause Analysis Worksheet and Corrective Action form. Identify a corrective action(s) for each root cause identified within each area of inquiry.

NOTIFICATIONS

Title	Printed Name	Signature	Telephone Number	Date
Project Manager or Supervisor				
Site Safety Coordinator or Office H&S Representative				
Operating Unit H&S Representative				
Other: _____				

The signatures provided above indicate that appropriate personnel have been notified of the incident.

_____

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT FORM IR-A

INSTRUCTIONS:

Complete all sections below for incidents involving injury or illness.
Do NOT leave any blanks.
Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)

EMPLOYEE INFORMATION

Company Affiliation

Tetra Tech Employee? ☐ TetraTech subcontractor employee (directly supervised by Tt personnel)? ☐

Full Name	**Company (if not Tt employee)**

Street Address, City, State and Zip Code	**Address Type**
_____	Home address (for Tt employees) ☐
_____	Business address (for subcontractors) ☐

Telephone Numbers

Work: _____	Home: _____	Cell: _____

Occupation (regular job title)	**Department**

Was the individual performing regular job duties?	**Time individual began work**
Yes ☐ No ☐	_____ AM ☐ PM ☐ *OR* Cannot be determined ☐

Safety equipment

Provided? Yes ☐ No ☐

Used? Yes ☐ No ☐ If no, explain why

_____

_____

_____

Type(s) provided:
☐ Hard hat ☐ Protective clothing
☐ Gloves ☐ High visibility vest
☐ Eye protection ☐ Fall protection
☐ Safety shoes ☐ Machine guarding
☐ Respirator ☐ Other (list)

_____

NOTIFICATIONS

Name of Tt employee to whom the injury or illness was first reported	**Was H&S notified within one hour of injury or illness?**
	Yes ☐ No ☐
Date of report	**H&S Personnel Notified**
Time of report	**Time of Report**

If subcontractor injury, did subcontractor's firm perform their own incident investigation?

Yes ☐ No ☐ If yes, request a copy of their completed investigation form/report and attach it to this report.

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT FORM IR-A

INJURY / ILLNESS DETAILS

What was the individual doing just before the incident occurred? Describe the activity as well as the tools, equipment, or material the individual was using. Be specific. Examples: "Climbing a ladder while carrying roofing materials"; "Spraying chlorine from a hand sprayer"; "Daily computer key-entry"

_____

_____

_____

What Happened? Describe how the injury occurred. Examples: "When ladder slipped on wet floor and worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; Worker developed soreness in wrist over time"

_____

_____

_____

_____

Describe the object or substance that directly harmed the individual: Examples: "Concrete floor"; "Chlorine"; "Radial Arm Saw". If this question does not apply to the incident, write "Not Applicable".

_____

_____

MEDICAL CARE PROVIDED

Was first aid provided at the site: Yes ☐ No ☐ If yes, describe the type of first aid administered and by whom?

_____

Was treatment provided away from the site: Yes ☐ No ☐ If yes, provide the information below.

Name of physician or health care professional	**Facility Name**
Street Address, City State and Zip Code	**Type of Care?**
_____ _____	Was individual treated in emergency room? Yes ☐ No ☐ Was individual hospitalized overnight as an in-patient? Yes ☐ No ☐ Did the individual die? Yes ☐ No ☐ If yes, date: _____ Will a worker's compensation claim be filed? Yes ☐ No ☐
Telephone Number	

NOTE: Attach any police reports or related diagrams to this report.

SIGNATURES

I have reviewed this report and agree that all the supplied information is accurate

Affected individual (print)	**Affected individual (signature)**	**Telephone Number**	**Date**

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT FORM IR-B

INSTRUCTIONS:

Complete all sections below for incidents involving property/equipment damage, fire, spill or release.
Do NOT leave any blanks.
Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)

TYPE OF INCIDENT (Check all that apply)

Property Damage ☐ Equipment Damage ☐ Fire or Explosion ☐ Spill or Release ☐

INCIDENT DETAILS

Results of Incident: Fully describe damages, losses, etc.

_____

_____

_____

Response Actions Taken:

_____

_____

_____

Responding Agency(s) (i.e. police, fire department, etc.)	Agency(s) Contact Name(s)

DAMAGED ITEMS (List all damaged items, extent of damage and estimated repair cost)

Item:	Extent of damage:	Estimated repair cost

SPILLS / RELEASES (Provide information for spilled/released materials)

Substance	Estimated quantity and duration	Specify Reportable Quantity (RQ)
		_____ Exceeded? Yes ☐ No ☐ NA ☐

FIRES / EXPLOSIONS (Provide information related to fires/explosions)

Fire fighting equipment used? Yes ☐ No ☐ If yes, type of equipment: _____

NOTIFICATIONS

Required notifications	Name of person notified	By whom	Date / Time
Client: _____ Yes ☐ No ☐			
Agency: _____ Yes ☐ No ☐			
Other: _____ Yes ☐ No ☐			

Who is responsible for reporting incident to outside agency(s)? Tt ☐ Client ☐ Other ☐ Name: _____

Was an additional written report on this incident generated? Yes ☐ No ☐ If yes, place in project file.

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT FORM IR-C

INSTRUCTIONS:

Complete all sections below for incidents involving motor vehicle accidents. Do NOT leave any blanks. Attach this form to the IR FORM completed for this incident.

Incident Report Number: (From the IR Form)	

INCIDENT DETAILS

Name of road, street, highway or location where accident occurred	**Name of intersecting road, street or highway if applicable**

County	**City**	**State**

Did police respond to the accident?	**Did ambulance respond to the accident?**
Yes ☐ No ☐	Yes ☐ No ☐
Name and location of responding police department	**Ambulance company name and location**

Officer's name/badge #	

Did police complete an incident report? Yes ☐ No ☐ If yes, police report number: _____
Request a copy of completed investigation report and attach to this form.

VEHICLE INFORMATION

How many vehicles were involved in the accident? _____ (Attach additional sheets as applicable for accidents involving more than 2 vehicles.)

Vehicle Number 1 – Tetra Tech Vehicle		**Vehicle Number 2 – Other Vehicle**	
Vehicle Owner / Contact Information		**Vehicle Owner / Contact Information**	
Color		**Color**	
Make		**Make**	
Model		**Model**	
Year		**Year**	
License Plate #		**License Plate #**	
Identification #		**Identification #**	
Describe damage to vehicle number 1		**Describe damage to vehicle number 2**	
Insurance Company Name and Address		**Insurance Company Name and Address**	
Agent Name **Agent Phone No.**		**Agent Name** **Agent Phone No.**	
Policy Number		**Policy Number**	

TETRA TECH, INC.
Safety Excellence

TETRA TECH, INC.
INCIDENT FORM IR-C

DRIVER INFORMATION

Vehicle Number 1 – Tetra Tech Vehicle		Vehicle Number 2 – Other Vehicle	
Driver's Name		**Driver's Name**	
Driver's Address		**Driver's Address**	
Phone Number		**Phone Number**	
Date of Birth		**Date of Birth**	
Driver's License #		**Driver's License #**	
Licensing State		**Licensing State**	
Gender	Male ☐ Female ☐	**Gender**	Male ☐ Female ☐
Was traffic citation issued to Tetra Tech driver? Yes ☐ No ☐		Was traffic citation issued to driver of other vehicle? Yes ☐ No ☐	
Citation #		**Citation #**	
Citation Description		**Citation Description**	

PASSENGERS IN VEHICLES (NON-INJURED)

List all non-injured passengers (excluding driver) in each vehicle.
Driver information is captured in the preceding section.
Information related to persons injured in the accident (non-Tt employees) is captured in the section below on this form.
Injured Tt employee information is captured on FORM IR-A

Vehicle Number 1 – Tetra Tech Vehicle		Vehicle Number 2 – Other Vehicle	
How many passengers (excluding driver) in the vehicle? ____		How many passengers (excluding driver) in the vehicle? ____	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	
Non-Injured Passenger Name and Address		**Non-Injured Passenger Name and Address**	

INJURIES TO NON-TETRATECH EMPLOYEES

Name of injured person 1				Address of injured person 1		
Age	**Gender**	**Car No.**	**Location in Car**	**Seat Belt Used?**	**Ejected from car?**	**Injury or Fatality?**
	Male ☐ Female ☐			Yes ☐ No ☐	Yes ☐ No ☐	Injured ☐ Died ☐
Name of injured person 2				**Address of injured person 2**		
Age	**Gender**	**Car No.**	**Location in Car**	**Seat Belt Used?**	**Ejected from car?**	**Injury or Fatality?**
	Male ☐ Female ☐			Yes ☐ No ☐	Yes ☐ No ☐	Injured ☐ Died ☐

OTHER PROPERTY DAMAGE

Describe damage to property other than motor vehicles	
Property Owner's Name	**Property Owner's Address**

COMPLETE AND SUBMIT DIAGRAM DEPICTING WHAT HAPPENED

ATTACHMENT III

MEDICAL DATA SHEET

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Person to notify in the event of an emergency: Name: _____

Phone: _____

Drug or other Allergies: _____

Particular Sensitivities : _____

Do You Wear Contacts? _____

What medications are you presently using? _____

_____

Name, Address, and Phone Number of personal physician: _____

_____

_____

Note: Health Insurance Portability and Accountability Act (HIPAA) Requirements

HIPAA took effect April 14, 2003. Loosely interpreted, HIPAA regulates the disclosure of Protected Health Information (PHI) by the entity collecting that information. PHI is any information about health status (such as that you may report on this Medical Data Sheet), provision of health care, or other information. HIPAA also requires Tetra Tech to ensure the confidentiality of PHI. This Act can affect the ability of the Medical Data Sheet to contain and convey information you would want a Doctor to know if you were incapacitated. So before you complete the Medical Data Sheet understand that this form will not be maintained in a secure location. It will be maintained in a file box or binder accessible to other members of the field crew so that they can accompany an injured party to the hospital.

DO NOT include information that you do not wish others to know, only information that may be pertinent in an emergency situation or treatment.

_____ _____ _____

Name (Print clearly) Signature Date

ATTACHMENT IV

SAFE WORK PERMITS

SAFE WORK PERMIT
SITE MOBILIZATION AND DEMOBILIZATION ACTIVITIES
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Mobilization and demobilization activities

II. Primary Hazards: Lifting; slips, trips and falls; vehicular and foot traffic; insect/animal bites and stings; poisonous plants; inclement weather.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, or coveralls, safety, glasses and safety footwear. Hard hats and hearing protection will be worn when working near operating equipment.

VI.

Chemicals of Concern	**Hazard Monitoring / Action Level(s)**	**Response Measures**
None anticipated	None	None

Primary Route(s) of Exposure/Hazard: NA

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☒ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☒ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type – Work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☒ No
Steel toe work shoes/boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☐ No
High visibility vest	☐ Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Tyvek coverall to protect against natural hazards (e.g., ticks) if working/walking through areas of high grass. Use insect repellants containing at least 10% DEET and tape up in such areas. Follow manufacturer's recommendations for proper application and reapplication. Hard hat when overhead hazards exist. Safety glasses when near eye hazards. Hearing protection when in high noise areas.

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Review PPE needs based on activities being performed and the associated hazards. Use safe lifting procedures and obtain assistance when handling heavy or awkward objects. Suspend site activities in the event of inclement weather. Observe site workers for signs and symptoms of heat/cold stress. Use sun block (SPF > 15) to prevent sunburn if necessary.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
SITE CONCRETE CORING OPERATIONS
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Concrete coring will take place in some areas of the complex. This activity uses an electrical coring machine with water supplied cooling and dust suppression. This activity will also include: Installation of soil gas monitoring points, coring borehole restoration and protective casing installation.

II. Primary Hazards: Potential hazards associated with this task: heavy equipment hazards; elevated noise; energized systems/utilities; electrical shock; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; flying projectiles.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: _____

VI. Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
Dust (Concrete)	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Airborne concentrations of VOCs are not anticipated during this activity. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash shield	☐ Yes ☒ No	Barricades	☒ Yes ☐ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type – nitrile/work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☒ No
Steel toe work shoes or boots	☒Yes ☐ No	Chemical resistant boot covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☒ No
First Aid Kit	☒Yes ☐ No	Fire extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Coveralls if the potential for soiling work clothing exists. Other PPE may be specified by the SSO based on conditions (rain gear, rubber boots, etc.)

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 (Excavation/Penetration Permit is Required)

X. Special instructions, precautions: Ensure all equipment is powered through a GFCI to prevent possible electrocution hazards. Ensure the coring unit is stable and secured to prevent movement during operation. Keep water collected using a shop vac or similar device for wet applications. This device should also be routed through the GFCI. Inspect the unit before use Ensure wiring, casing, and guards are not damaged and the unit is suitable for use. As this activity may occur at night Ensure lighting within the work area is adequate. Use barricades, signs, temporary diking to control water spread during coring operations. Place signs and barricades to warn foot traffic of potential wet areas. Do not leave any core holes open and unattended. Ensure all protective casings that are installed are flat and level with existing grade. Heavy Equipment Inspection Checklist must be completed prior to beginning work.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
SITE GEOPHYSICAL/GEOGRAPHIC LAND SURVEYING
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. **Work limited to the following (description, area, equipment used):** Surveying activities both geophysical and geographical.

II. **Primary Hazards:** Potential hazards associated with this task: slip, trip and fall; vehicular and foot traffic; temperature extremes; inclement weather; insect /animal bites or stings, poisonous plants, etc.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: _____

VI. **Chemicals of Concern** | **Hazard Monitoring** | **Action Level(s)** | **Response Measures**

Chemicals of Concern	Hazard Monitoring	Action Level(s)	Response Measures
None expected during this task	NA	NA	NA

Primary Route(s) of Exposure/Hazard: _____

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes ☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☒ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☒ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type – Work)	☐ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility vest	☐ Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☒ No
Safety Shower/Eyewash	☐ Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Tape up, use insect repellents. Follow manufacturer's label directions for application and re-application of these products. Wear snake chaps in any high grass or brush areas.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.) ☐ Yes ☒ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend activities in the event of inclement weather.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
VEGETATION MANAGEMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Vegetative clearing

II. Primary Hazards: heavy equipment hazards; energized systems; noise; vehicular and equipment traffic; strain from heavy lifting; slips, trips and falls; cuts, abrasions and lacerations; loading trucks; and inclement weather,

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☐

Modifications/Exceptions: _____

VI. Chemicals of Concern	**Hazard Monitoring**	**Action Level(s)**	**Response Measures**
None expected during this task	NA	NA	NA

Primary Route(s) of Exposure/Hazard: _____

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes	☐ No	Hearing protection (plugs/muffs)	☒ Yes	☐ No
Safety glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☒ No	Radio/cellular phone	☐ Yes	☐ No
Splash shield	☐ Yes	☒ No	Barricades	☐ Yes	☐ No
Coveralls	☒ Yes	☐ No	Gloves (type – cotton/leather)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No
Steel toe work shoes/boots	☒ Yes	☐ No	Chemical resistant boot covers	☐ Yes	☐ No
High visibility vest	☒ Yes	☐ No	Tape up/use insect repellent	☐ Yes	☐ No
First aid kit	☐ Yes	☐ No	Fire extinguisher	☐ Yes	☐ No
Safety shower/eyewash	☐ Yes	☐ No	Other	☐ Yes	☐ No

Modifications/Exceptions: Tyvek coverall and boot covers if there is a potential for soiling work clothes or contacting potentially contaminated media (soils, shed debris, etc.). PVC or PE coated Tyvek if saturation of work clothes may occur

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: Use dust suppression (area wetting) methods as needed. This will reduce dust emissions when handling dry materials which have a tendency to become airborne much more easily than wet or moist materials. Suspend site activities in the event of inclement weather. Employ proper lifting techniques..

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
BLOCK E GRASS CUTTING AND VEGETATION MANAGEMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Vegetative clearing and grass cutting Block E only.

II. Primary Hazards: heavy equipment hazards; energized systems; noise; vehicular and equipment traffic; strain from heavy lifting; slips, trips and falls; cuts, abrasions and lacerations; loading trucks; and inclement weather

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☐

Modifications/Exceptions: _____

VI. Chemicals of Concern	**Hazard Monitoring**	**Action Level(s)**	**Response Measures**
Possible PCB exposure	Visual	Visible dust	Area wetting

Primary Route(s) of Exposure/Hazard: _____

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☒ No	Hearing protection (plugs/muffs)	☒ Yes	☐ No
Safety glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☒ Yes	☐ No	Radio/cellular phone	☐ Yes	☐ No
Splash shield	☐ Yes	☒ No	Barricades	☐ Yes	☐ No
Coveralls	☒ Yes	☐ No	Gloves (type – cotton/leather)	☒ Yes	☐ No
Impermeable apron	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No
Steel toe work shoes/boots	☒ Yes	☐ No	Chemical resistant boot covers	☒ Yes	☐ No
High visibility vest	☒ Yes	☐ No	Tape up/use insect repellent	☒ Yes	☐ No
First aid kit	☐ Yes	☐ No	Fire extinguisher	☐ Yes	☐ No
Safety shower/eyewash	☐ Yes	☐ No	Other (Cool Vests)	☒ Yes	☐ No

Modifications/Exceptions: Blue or Green colored Tyvek coverall and boot covers. If significant dust is generated that obscures vision a ½ face Air Puifying Respirator will be used in accordiance with the Respiratory Protection Program in Attachment XII of this HASP.

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: Use dust suppression (area wetting) methods as needed. This will reduce dust emissions when handling dry materials which have a tendency to become airborne much more easily than wet or moist materials. Suspend site activities in the event of inclement weather. Employ proper lifting techniques

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
BLOCK D SOIL BORING AND MONITORING/DEEP WELL INSTALLATION
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ **Date:** _____ **Time: From** _____ **to** _____

I. Work limited to the following (description, area, equipment used): Soil boring and monitoring well installation. Soil boring will generally be performed using DPT and HSA Rigs, while the monitoring wells will be installed via HSA. This task includes well development and the installation of vapor monitoring points and installation of membrane interface probes.

II. Primary Hazards: Contact and transfer of site contaminants; heavy equipment hazards; elevated noise; energized systems/utilities; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; flying projectiles; insect/animal bites and stings, poisonous plants, inclement weather, drowning.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions: _____

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>1.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type – nitrile/work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☒Yes ☐ No	Chemical resistant boot covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐Yes ☐ No	Fire extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Coveralls if the potential for soiling work clothing exists. Other PPE is possible based on conditions (rain gear, rubber boots, etc.)

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 (Excavation Permit is Required)

X. Special instructions, precautions: Any sustained VOC readings in worker BZs indicate an unanticipated condition requiring that site activities be suspended. Use safe lifting/carrying techniques. Inspect equipment prior to use. Ensure emergency stop devices are functional and test daily. Minimize contact with potentially contaminated media and assume soils/groundwater are contaminated. Use waterless hand cleaner products or disinfecting wipes on boat after sampling until access to proper hands washing facilities on shore can be reached. Heavy Equipment Inspection Checklist must be completed prior to beginning work.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
BLOCK E AND G SOIL BORING AND MONITORING/DEEP WELL INSTALLATION
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. Date: Time: From to

I. Work limited to the following (description, area, equipment used): Soil boring and monitoring well installation. Soil boring will generally be performed using DPT and HSA Rigs, while the monitoring wells will be installed via HSA. This task includes well development and the installation of vapor monitoring points and installation of membrane interface probes.

II. Primary Hazards: Contact and transfer of site contaminants; heavy equipment hazards; elevated noise; energized systems/utilities; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; flying projectiles; insect/animal bites and stings, poisonous plants, inclement weather, drowning.

III. Field Crew:

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions:

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>7.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type – nitrile/work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☒Yes ☐ No	Chemical resistant boot covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐Yes ☐ No	Fire extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Coveralls if the potential for soiling work clothing exists. Other PPE is possible based on conditions (rain gear, rubber boots, etc.)

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 (Excavation Permit is Required)

X. Special instructions, precautions: Any sustained VOC readings in worker BZs indicate an unanticipated condition requiring that site activities be suspended. Use safe lifting/carrying techniques. Inspect equipment prior to use. Ensure emergency stop devices are functional and test daily. Minimize contact with potentially contaminated media and assume soils/groundwater are contaminated. Use waterless hand cleaner products or disinfecting wipes on boat after sampling until access to proper hands washing facilities on shore can be reached. Heavy Equipment Inspection Checklist must be completed prior to beginning work.

Permit Issued by: Permit Accepted by:

SAFE WORK PERMIT
BLOCK E, G AND I LACTOIL INSITU TREATMENT SYSTEM INSTALLATION
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. Date: Time: From to

I. Work limited to the following (description, area, equipment used): Soil boring and injection well installation. Soil boring will generally be performed using DPT and HSA Rigs. This task includes well development and the excavation of trenches for pipeline installation.

II. Primary Hazards: Contact and transfer of site contaminants; heavy equipment hazards; elevated noise; energized systems/utilities; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; flying projectiles; insect/animal bites and stings, poisonous plants, inclement weather, drowning.

III. Field Crew:

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions:

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>7.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☒ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☒ Yes ☐ No	Gloves (Type – nitrile/work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☒Yes ☐ No	Chemical resistant boot covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐Yes ☐ No	Fire extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Coveralls if the potential for soiling work clothing exists. Other PPE is possible based on conditions (rain gear, rubber boots, etc.)

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 (Excavation Permit is Required)

X. Special instructions, precautions: Any sustained VOC readings in worker BZs indicate an unanticipated condition requiring that site activities be suspended. Use safe lifting/carrying techniques. Inspect equipment prior to use. Ensure emergency stop devices are functional and test daily. Minimize contact with lactoil by wearing splash shield, apron and nitrile gloves to avoid contact with lactoil solution. Also assume soils/groundwater are contaminated and avoid contact with contaminated media. Use waterless hand cleaner products or disinfecting wipes after sampling until access to proper hands washing facilities can be reached. Heavy Equipment Inspection Checklist must be completed prior to beginning work.

Permit Issued by: Permit Accepted by:

SAFE WORK PERMIT
SOIL EXCAVATION TRANSPORTATION AND PUMP STATION PLACEMENT ACTIVITIES
LOCKHEED MARTIN, MIDDLE RIVER COMPLEX

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): This activity includes the excavation and removal of contaminated soils; Direct loading and dewatering and loading will be conducted. Back filling, compaction; site restoration will be included in this activity. This activity includes: initial site surveys including identifying, eliminating or barricading hazards in the work area; establishing traffic patterns for the site including truck staging, loading position as well as hauling in back fill. Removal, lift and placement of preconstructed pump stations. Heavy equipment includes tracked excavator, loader and back-hoe and crane.

II. Primary Hazards: Physical/natural hazards - Lifting; slips, trips and falls; vehicular and foot traffic; struck by; inclement weather.

III. Field Crew: _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☒ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, or coveralls, safety, glasses and safety footwear. Hard hats, hearing protection, and High Visibility Vests will be worn when working near operating equipment. Chemical resistant over boots will be worn during muddy conditions.

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>7.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, and dizziness); extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☒ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☒ Yes ☐ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type – Work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☒ No
Steel toe work shoes/boots	☒Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☒Yes ☐ No	Fire Extinguisher	☒ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Hard hat, safety glasses, steel toed work booted will be worn in all cases as minimum PPE. Equipment operators and truck drivers are not required to wear hard hats as long as they remain in the cab. Hearing protection (>25dB NRR) for activities generating high noise levels. High Visibility Vests when working along traffic patterns or near operating equipment.

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.).☒ Yes ☐ No

If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 – Utility locating Excavation Clearance Permit and Ticket will be applied for from the Local One-Call

X. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Suspend site activities in the event of inclement weather. Establish Site Control boundaries as well as Free Space of Travel along vehicle patterns. For this activity the clearance exists around the excavator and crane (fully extended boom length + 5-feet and maintain at least 4-feet from

excavation edge and pump station removal. Cut excavation in shallow intervals. Ground personnel will use passive methods to evaluate the next cut depth (6-inch intervals). The excavator should be equipped with a sand bar to avoid snagging subsurface utilities. Ground personnel will also direct truck movement and loading activities. Confirm utility clearance status. Call those who have not responded to One Call request, confirm utility absence. Utilities within 5-feet of the subsurface investigation point will be potholed (hand dug) to confirm location. Excavation activities will be conducted in accordance with 29 CFR 1926.650-.652. concerning sloping, shoring, storage, and movement on or over excavations. Equipment, personnel, and machinery will be kept away from the edges of open excavations (> 3 feet). Personnel will not be permitted to enter an excavation greater than 4 feet deep with out the use of shoring, benching or trench boxes. Excavations which cross sidewalks or streets will provide crossovers of adequate construction for anticipated traffic loads. Flag persons and traffic control barricades and signs will be used where excavation encroaches streets and passageways. Excavation activities will be supported by a "Competent Person". Do not overload transport vehicles. Calculate weight based on bucket capacity and the number of buckets loaded into each truck or roll off. Typical weight for wet earthen soils is 100lbs per cubic foot or 2700 lbs per cubic yard. The use of a spotter/ground man during excavation activities and motor vehicle/heavy equipment use will be employed.

Permit Issued by:_____ Permit Accepted by:_____

SAFE WORK PERMIT
BLOCK F SOIL BORING AND MONITORING/DEEP WELL INSTALLATION
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. Date: Time: From to

I. Work limited to the following (description, area, equipment used): Soil boring and monitoring well installation. Soil boring will generally be performed using DPT and HSA Rigs, while the monitoring wells will be installed via HSA. This task includes well development and the installation of vapor monitoring points and installation of membrane interface probes.

II. Primary Hazards: Contact and transfer of site contaminants; heavy equipment hazards; elevated noise; energized systems/utilities; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; flying projectiles; insect/animal bites and stings, poisonous plants, inclement weather, drowning.

III. Field Crew:

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions:

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>1,000 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type – nitrile/work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☒Yes ☐ No	Chemical resistant boot covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐Yes ☐ No	Fire extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Coveralls if the potential for soiling work clothing exists. Other PPE is possible based on conditions (rain gear, rubber boots, etc.)

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No

If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 (Excavation Permit is Required)

X. Special instructions, precautions: Any sustained VOC readings in worker BZs indicate an unanticipated condition requiring that site activities be suspended. Use safe lifting/carrying techniques. Inspect equipment prior to use. Ensure emergency stop devices are functional and test daily. Minimize contact with potentially contaminated media and assume soils/groundwater are contaminated. Use waterless hand cleaner products or disinfecting wipes on boat after sampling until access to proper hands washing facilities on shore can be reached. Heavy Equipment Inspection Checklist must be completed prior to beginning work.

Permit Issued by: Permit Accepted by:

SAFE WORK PERMIT
Block H SOIL BORING AND MONITORING/DEEP WELL INSTALLATION
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Soil boring and monitoring well installation. Soil boring will generally be performed using DPT and HSA Rigs, while the monitoring wells will be installed via HSA. This task includes well development and the installation of vapor monitoring points and installation of membrane interface probes.

II. Primary Hazards: Contact and transfer of site contaminants; heavy equipment hazards; elevated noise; energized systems/utilities; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; flying projectiles; insect/animal bites and stings, poisonous plants, inclement weather, drowning.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions: _____

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>10.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☐ No	Gloves (Type – nitrile/work)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☒Yes ☐ No	Chemical resistant boot covers	☐ Yes ☐ No
High visibility vest	☐Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐Yes ☐ No	Fire extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Coveralls if the potential for soiling work clothing exists. Other PPE is possible based on conditions (rain gear, rubber boots, etc.)

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090 (Excavation Permit is Required)

X. Special instructions, precautions: Any sustained VOC readings in worker BZs indicate an unanticipated condition requiring that site activities be suspended. Use safe lifting/carrying techniques. Inspect equipment prior to use. Ensure emergency stop devices are functional and test daily. Minimize contact with potentially contaminated media and assume soils/groundwater are contaminated. Use waterless hand cleaner products or disinfecting wipes on boat after sampling until access to proper hands washing facilities on shore can be reached. Heavy Equipment Inspection Checklist must be completed prior to beginning work.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
Block E, G AND I SOIL REMOVAL AND REPLACEMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Excavation activities using heavy equipment to remove contaminated soil and replace with clean soil. Excavations will be limited to 2 foot depths.

II. Primary Hazards: Potential hazards associated with this task include: heavy equipment hazards, heavy lifting, pinches and compressions, slip, trips and falls, vehicular and foot traffic, insect/animal bites and stings, poisonous plants, inclement weather and limited contact with potential contaminants of concern.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ TtNUS
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ TtNUS

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, or coveralls, safety, glasses hard hats, hearing protection and safety footwear. Nitrile gloves will be worn whenever the potential for coming into direct contact with potentially contaminated groundwater or soil exists or whenever handling grout mixtures.

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>7.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☒ No
Splash Shield	☐ Yes ☒ No	Barricades	☒ Yes ☒ No
Splash suits/coveralls	☒ Yes ☐ No	Gloves (Type – Work and nitrile)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☒ No
Steel toe Work shoes or boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility vest	☒ Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Tyvek coverall to protect against soil contact and natrual hazards (e.g., ticks) if working/walking through areas of high grass. Use insect repellants containing at least 10% DEET. Follow manufacturer's recommendations for proper application and reapplication. If working in areas where snakes are a threat, wear snake chaps to protect against bites.

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required. Utility Clearance/Dig Permit ☒ Yes ☐ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: Stay clear of operating equipment (minimum of 30 feet) and stay in the field of vision of the operator. Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Review PPE needs based on activities being performed and the associated hazards. Use safe lifting procedures and obtain assistance when handling heavy or awkward objects. Suspend site activities in the event of inclement weather. Observe site workers for signs and symptoms of heat stress. Use sun block (SPF > 15) to prevent sunburn.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
MARINE OPERATIONS (FROM WATER VESSEL)
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Collection of surface water and sediment samples. These sampling activities will be conducted from a small boat. Deep well installation via Rotosonic drill rig from a barge will be part of this activity.

II. Primary Hazards: Drowning. Suspend activities in the event of inclement weather (i.e., high winds, heavy rains, or electrical storms). Other hazards could include, small cuts/abrasions, and injury form slip, trip and fall events

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: Coast Guard approved personal floatation device (pfd).

VI. VI. Chemicals of Concern (COCs) and Actions

COC's	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>1.75 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Stop site activity until background levels return to normal.

Primary Route(s) of Exposure/Hazard: incidental ingestion, direct contact with contaminated media.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☒ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☐ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☒ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type – Work/nitrile)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel toe work shoes or boots	☐ Yes ☒ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility vest	☐ Yes ☒ No	Tape up/use insect repellent	☐ Yes ☒ No
First Aid Kit	☒ Yes ☐ No	Fire Extinguisher	☒ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☒ No	Other	☒ Yes ☐ No

Modifications/Exceptions: Each person on the boat must be wearing a USCG-approved pfd, and the boat must be equipped with a tethered, throwable life saver device. Footwear equipped with slip-resistant soles. Hats and sunscreen for protection from UV rays.

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☒
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☒ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: Minimize contact with potentially contaminated media and sampling devices. Wash hands before performing any hand-to-mouth activities. Use waterless hand cleaner products or disinfecting wipes on boat after sampling until access to proper hands washing facilities on shore can be reached. Fire extinguisher and first aid kit to be maintained on boat at all times. The boat employed will meet the minimum safe vessel requirements including PFDs, fire extinguishers, and visual distress signals. Complete Boating Safety Checklist prior to beginning work. See Attachment VI for Tetra Tech Procedure for Working over or near Water.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
Block D MULTI MEDIA SAMPLING AND WELL DEVELOPMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Multimedia sampling including surface and subsurface soils, groundwater, storm water, IDW. This task also includes soil vapor sampling and indoor air quality sampling.

II. Primary Hazards: Contact with site contaminants; transfer of contamination; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; insect/animal bites and stings, poisonous plants, inclement weather.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions: _____

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>1.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Dust components may include metals, PCBs, PAHs, sand, grout. Encountering airborne concentrations above background levels in the breathing zone (BZ) during this activity is not anticipated based on historical source concentrations. SSO to take and record background levels at least daily.

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety Belt/Harness	☐ Yes ☒ No
Chemical/Splash Goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash Suits/Coveralls	☐ Yes ☐ No	Gloves (Type – Nitrile)	☒ Yes ☐ No
Impermeable Apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel Toe Work Shoes or Boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility Vest	☐ Yes ☐ No	Tape/Insect Repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: _____

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: VOCs are most likely to be present at REC 1, 11, and 12. Any sustained readings in worker breathing zones will suggest an unanticipated condition that will require that site activities be suspended until the source of elevated readings is determined. Use safe lifting/carrying techniques. Assume media is contaminated and avoid contact through the use of safe work practices, PPE and decontamination. As this activity may occur at night Ensure lighting within the work area are at least 5 foot candles. Prior to placing Summa Canisters ventilate indoor area if elevated readings (>10 ppm) are encountered upon entering building to achieve readings less than 10 ppm.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
BLOCK E AND G MULTI MEDIA SAMPLING AND WELL DEVELOPMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Multimedia sampling including surface and subsurface soils, groundwater, storm water, IDW. This task also includes soil vapor sampling and indoor air quality sampling.

II. Primary Hazards: Contact with site contaminants; transfer of contamination; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; insect/animal bites and stings, poisonous plants, inclement weather.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions: _____

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>7.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes
Benzene	Draeger Tube 0.5/a	Up to 5 ppm/sustained 10 minutes/4 times/day	Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Dust components may include metals, PCBs, PAHs, sand, grout. Encountering airborne concentrations above background levels in the breathing zone (BZ) during this activity is not anticipated based on historical source concentrations. SSO to take and record background levels at least daily.

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety Belt/Harness	☐ Yes ☒ No
Chemical/Splash Goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash Suits/Coveralls	☐ Yes ☐ No	Gloves (Type – Nitrile)	☒ Yes ☐ No
Impermeable Apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel Toe Work Shoes or Boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility Vest	☐ Yes ☐ No	Tape/Insect Repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions:

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: VOCs are most likely to be present at REC 1, 11, and 12. Any sustained readings in worker breathing zones will suggest an unanticipated condition that will require that site activities be suspended until the source of elevated readings is determined. Use safe lifting/carrying techniques. Assume media is contaminated and avoid contact through the use of safe work practices, PPE and decontamination. As this activity may occur at night Ensure lighting within the work area are at least 5 foot candles. Prior to placing Summa Canisters ventilate indoor area if elevated readings (>10 ppm) are encountered upon entering building to achieve readings less than 10 ppm.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
BLOCK F MULTI MEDIA SAMPLING AND WELL DEVELOPMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Multimedia sampling including surface and subsurface soils, groundwater, storm water, IDW. This task also includes soil vapor sampling and indoor air quality sampling.

II. Primary Hazards: Contact with site contaminants; transfer of contamination; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; insect/animal bites and stings, poisonous plants, inclement weather.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: _____

VI. Chemicals of Concern (COCs) and Actions

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>1,000 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Dust components may include metals, PCBs, PAHs, sand, grout. Encountering airborne concentrations above background levels in the breathing zone (BZ) during this activity is not anticipated based on historical source concentrations. SSO to take and record background levels at least daily.

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety Belt/Harness	☐ Yes ☒ No
Chemical/Splash Goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash Suits/Coveralls	☐ Yes ☐ No	Gloves (Type – Nitrile)	☒ Yes ☐ No
Impermeable Apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel Toe Work Shoes or Boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility Vest	☐ Yes ☐ No	Tape/Insect Repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: _____

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: VOCs are most likely to be present at REC 1, 11, and 12. Any sustained readings in worker breathing zones will suggest an unanticipated condition that will require that site activities be suspended until the source of elevated readings is determined. Use safe lifting/carrying techniques. Assume media is contaminated and avoid contact through the use of safe work practices, PPE and decontamination. As this activity may occur at night Ensure lighting within the work area are at least 5 foot candles. Prior to placing Summa Canisters ventilate indoor area if elevated readings (>10 ppm) are encountered upon entering building to achieve readings less than 10 ppm.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
BLOCK H MULTI MEDIA SAMPLING AND WELL DEVELOPMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. **Work limited to the following (description, area, equipment used):** Multimedia sampling including surface and subsurface soils, groundwater, storm water, IDW. This task also includes soil vapor sampling and indoor air quality sampling.

II. **Primary Hazards:** Contact with site contaminants; transfer of contamination; heavy lifting; slip, trip and fall; cuts and lacerations; vehicular and foot traffic; ambient temperature extremes; insect/animal bites and stings, poisonous plants, inclement weather.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Modifications/Exceptions: _____

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

VI. **Chemicals of Concern (COCs) and Actions**

COCs	Hazard Monitoring	Action Level(s)	Response Measures
VOCs	PID (except on boat/barge)	>10.00 ppm in BZ sustained 4 exp of 5 minutes	Screen BZ with Draeger tubes Evacuate site till background levels return
Dust	Visual –Visible dust	>2 mg/m3	Employ dust suppression –Wet it down

Dust components may include metals, PCBs, PAHs, sand, grout. Encountering airborne concentrations above background levels in the breathing zone (BZ) during this activity is not anticipated based on historical source concentrations. SSO to take and record background levels at least daily.

Primary Route(s) of Exposure/Hazard: Inhalation, ingestion and skin contact. Controls include monitoring instrument use, dust control, use of PPE, and following safe work practices. VOCs – irritating at all points of contact; CNS effects (blurred vision, narcotic effects, dizziness); Extremely high concentrations may result in Irregular heartbeats, possible cardiac arrest. Sand, bentonite, grout may cause mechanical irritation (eyes) as well as potential alkali burns; respiratory, eye, and mucous membrane irritation.

(Note to FOL and/or SSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☐ No
Safety Glasses	☒ Yes ☐ No	Safety Belt/Harness	☐ Yes ☒ No
Chemical/Splash Goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash Suits/Coveralls	☐ Yes ☐ No	Gloves (Type – Nitrile)	☒ Yes ☐ No
Impermeable Apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☐ No
Steel Toe Work Shoes or Boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High Visibility Vest	☐ Yes ☐ No	Tape/Insect Repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: _____

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.) ☒ Yes ☐ No
If yes, SSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** VOCs are most likely to be present at REC 1, 11, and 12. Any sustained readings in worker breathing zones will suggest an unanticipated condition that will require that site activities be suspended until the source of elevated readings is determined. Use safe lifting/carrying techniques. Assume media is contaminated and avoid contact through the use of safe work practices, PPE and decontamination. As this activity may occur at night Ensure lighting within the work area are at least 5 foot candles. Prior to placing Summa Canisters ventilate indoor area if elevated readings (>10 ppm) are encountered upon entering building to achieve readings less than 10 ppm.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
SITE IDW MANAGEMENT
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. **Work limited to the following (description, area, equipment used):** IDW management activities includes containerization, staging, monitoring for leaks of IDW accumulated wastes. Wastes types include soil cutting, purge and decontamination wash waters.

II. **Primary Hazards:** Lifting, pinches and compressions; flying projectiles; slips, trips, and falls and chemical contamination.

III. **Field Crew:** _____

IV. **On-site Inspection conducted** ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☒ No Initials of Inspector _____Tetra Tech

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. **Protective equipment required**
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ See Reverse
No ☒

Modifications/Exceptions: None anticipated

VI. **Chemicals of Concern**: None anticipated
Hazard Monitoring /Action Level(s): N/A
Response Measures: N/A

Primary Route of Exposure/Hazard: inhalation, dermal, ingestion

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes or No)

VII. **Additional Safety Equipment/Procedures**

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☒ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☐ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes ☐ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type – Leather/Cotton)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☒ No	Work/rest regimen	☐ Yes ☒ No
Steel toe work shoes/boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☒ No
High visibility vest	☐ Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☒ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☒ No	Other	☐ Yes ☐ No

Modifications/Exceptions: If using pneumatic/electric power to open drums – Safety glasses are required. If power equipment is used to move drums or you are working near operating equipment hard hats will be worn. Tyvek coverall to protect against natural hazards (e.g., ticks) if working/walking through areas of high grass. Use insect repellants containing at least 10% DEET if necessary. Follow manufacturer's recommendations for proper application and reapplication. If working in areas where snakes are a threat, wear snake chaps to protect against bites. High visibility vest if near active traffic areas.

VIII. **Site Preparation**

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. **Additional Permits required** (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. **Special instructions, precautions:** Suspend site activities in the event of inclement weather. Employ proper lifting techniques. When/where possible use heavy equipment to move and place containers. When placing drums – Place the label and retention ring nut on the outside where it is readily visible. Place 4-drums to a pallet. Maintain a minimum distance of 4-feet between pallet rows. An IDW inventory shall be generated to provide the number of drums, contents, and volumes. This inventory should be provided to the facility contact. Inspect equipment prior to use.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT
SITE DECONTAMINATION ACTIVITIES
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

I. Work limited to the following (description, area, equipment used): Decontamination of sampling equipment (i.e., reusable stainless steel trowels, etc.). Brushes and spray bottles will be used to decontaminate small sampling equipment.

II. Primary Hazards: Chemical exposure, transfer of contamination, inclement weather, noise.

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____ Tetra Tech

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐

Respiratory equipment required
Yes ☐ Specify on the reverse
No ☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety glasses, safety footwear, and nitrile gloves. Impermeable aprons are preferred protection against soiling work clothes when lifting auger flights because of the need to carry close to the body. If it (impermeable apron) does not offer adequate protection, PVC rain suits or PE or PVC coated Tyvek should be employed. Chemical resistant boot covers if excessive liquids are generated or to protected footwear. PID with 10.6eV lamp [Note: This instrument will be used to determine if any volatile contaminants have been removed. It will not be used for purposes of monitoring exposure.

VI. Chemicals of Concern | **Hazard Monitoring / Action Level(s)** | **Response Measures**
Decontamination Fluids | Refer to MSDS | refer to MSDS

Primary Route(s) of Exposure/Hazard: Inhalation and direct contact and ingestion

(Note to FOL and/or SHSO: Each item in Sections VII, VIII, and IX must be checked Yes, No, or NA)

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes ☒ No
Safety Glasses	☒ Yes ☐ No	Safety belt/harness	☐ Yes ☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio/Cellular Phone	☐ Yes ☒ No
Splash Shield	☒ Yes ☐ No	Barricades	☐ Yes ☒ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type – Nitrile)	☒ Yes ☐ No
Impermeable apron	☐ Yes ☐ No	Work/rest regimen	☐ Yes ☒ No
Steel toe Work shoes or boots	☒ Yes ☐ No	Chemical Resistant Boot Covers	☐ Yes ☐ No
High Visibility vest	☐ Yes ☐ No	Tape up/use insect repellent	☐ Yes ☐ No
First Aid Kit	☐ Yes ☐ No	Fire Extinguisher	☐ Yes ☐ No
Safety Shower/Eyewash	☐ Yes ☐ No	Other	☐ Yes ☐ No

Modifications/Exceptions: Chemical resistant boot covers if excessive liquids are generated or to protect footwear.

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Established/Traffic Control Barricades/Signs in Place	☐	☐	☐
Physical Hazards Identified and Isolated (Splash and containment barriers)	☐	☐	☐
Emergency Equipment Staged (Spill control, fire extinguishers, first aid kits, etc).	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, SHSO to complete or contact Health Sciences, Pittsburgh Office (412)921-7090

X. Special instructions, precautions: Suspend site activities in the event of inclement weather. Employ proper lifting techniques. When/where possible use heavy equipment to move and place containers.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
BLOCK E FORMER BUILDING D MULTI-MEDIA SAMPLING / RADIOLOGICAL SURVEYING
LOCKHEED MARTIN MIDDLE RIVER COMPLEX
MIDDLE RIVER, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Radiological survey activities and soil sampling at Sites 10 and 14.

II. Required Monitoring Instrument(s): beta/gamma detectors (Micro R meter and frisker such as the Ludlum Model 19)

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____Tetra Tech
Equipment Inspection required ☐ Yes ☐ No Initials of Inspector _____Tetra Tech

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: None anticipated

VI. Chemicals of Concern	Action Level(s)	Response Measures
Alpha, Beta, Gamma Radiation	Dose rates above 50 μR/hr	Exit work area and evaluate control measures

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☒ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type – Surgical Style)	☒ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Gloves required during sampling activities or whenever contact with potentially contaminated media exists.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, Complete Permit Required or Contact Health Sciences, Pittsburgh Office (412)921-7090

XI. Special Instructions, Precautions: It is anticipated that remedial action activities have resulted in the removal of contaminated soils. This sampling effort is being conducted to evaluate the effectiveness of the remediation effort. However, contact with potentially contaminated media will be minimized through the use of avoidance practices and the use of ppe. Site workers must wash hands and face before performing any hand to mouth activities. Avoid inhalation of any airborne dusts, however, soil sampling activities are unlikely to generate dusts. First aid kits will be available at all remote sampling locations. Avoid insect/animal nesting areas. Sampling areas may be tick, gnat, wasp, and mosquito infested. Maintain a means to contact emergency services (cell phone) and verify they are functional.

Permit Issued by: _____ Permit Accepted by: _____

ATTACHMENT V
EQUIPMENT INSPECTION CHECKLIST
FOR DRILL/DPT RIGS

Equipment Inspection Checklist for Drill/DPT Rigs

Company: _____ **Unit/Serial No#:** _____

Inspection Date: ____/____/____ **Time:** ____:____ **Equipment Type:** _____
(e.g., Drill Rigs Hollow Stem, Mud Rotary, Direct Push, HDD)

Project Name: _____ **Project No#:** _____

Yes	No	NA	Requirement	Comments
			Emergency Stop Devices	
☐	☐	☐	• Emergency Stop Devices (At points of operation)	
☐	☐	☐	• Have all emergency shut offs identified been communicated to the field crew?	
☐	☐	☐	• Has a person been designated as the Emergency Stop Device Operator?	
			Highway Use	
☐	☐	☐	• Cab, mirrors, safety glass?	
☐	☐	☐	• Turn signals, lights, brake lights, etc. (front/rear) for equipment approved for highway use?	
☐	☐	☐	• Seat Belts?	
☐	☐	☐	• Is the equipment equipped with audible back-up alarms and back-up lights?	
☐	☐	☐	• Horn and gauges	
☐	☐	☐	• Brake condition (dynamic, park, etc.)	
☐	☐	☐	• Tires (Tread) or tracks	
☐	☐	☐	• Windshield wipers	
☐	☐	☐	• Exhaust system	
☐	☐	☐	• Steering (standard and emergency)	
☐	☐	☐	• Wheel Chocks?	
☐	☐	☐	• Are tools and material secured to prevent movement during transport? Especially those within the cab?	
☐	☐	☐	• Are there flammables or solvents or other prohibited substances stored within the cab?	
☐	☐	☐	• Are tools or debris in the cab that may adversely influence operation of the vehicle (in and around brakes, clutch, gas pedals)	

Unit/Serial No#:_____ **Inspection Date:** ____/____/____

Yes	No	NA	Requirement	Comments
			Fluid Levels:	
☐	☐	☐	• Engine oil	
☐	☐	☐	• Transmission fluid	
☐	☐	☐	• Brake fluid	
☐	☐	☐	• Cooling system fluid	
☐	☐	☐	• Hoses and belts	
☐	☐	☐	• Hydraulic oil	
			High Pressure Hydraulic Lines	
☐	☐	☐	• Obvious damage	
☐	☐	☐	• Operator protected from accidental release	
☐	☐	☐	• Coupling devices, connectors, retention cables/pins are in good condition and in place	
			Mast Condition	
☐	☐	☐	• Structural components/tubing	
☐	☐	☐	• Connection points	
☐	☐	☐	• Pins	
☐	☐	☐	• Welds	
☐	☐	☐	• Outriggers	
☐	☐	☐	• Operational	
☐	☐	☐	• Plumb (when raised)	
			Hooks	
☐	☐	☐	• Are the hooks equipped with Safety Latches?	
☐	☐	☐	• Does it appear that the hook is showing signs of wear in excess of 10% original dimension?	
☐	☐	☐	• Is there a bend or twist exceeding 10% from the plane of an unbent hook?	
☐	☐	☐	• Increase in throat opening exceeding 15% from new condition	
☐	☐	☐	• Excessive nicks and/or gouges	
☐	☐	☐	• Clips	
☐	☐	☐	• Number of U-Type (Crosby) Clips (cable size 5/16 – 5/8 = 3 clips minimum) (cable size 3/4 – 1 inch = 4 clips minimum) (cable size 1 1/8 – 1 3/8 inch = 5 clips minimum)	

Unit/Serial No#:_____ **Inspection Date:** ____/____/____

Yes	No	NA	Requirement	Comments
☐	☐	☐	Power cable and/or hoist cable • Reduction in Rope diameter π (5/16 wire rope>1/64 reduction nominal size -replace) (3/8 to 1/2 wire rope>1/32 reduction nominal size-replace) (9/16 to 3/4 wire rope>3/64 reduction nominal size-replace)	
☐	☐	☐	• Number of broken wires (6 randomly broken wires in one rope lay) (3 broken wires in one strand)	
☐	☐	☐	• Number of wire rope wraps left on the Running Drum at nominal use (≥3 required)	
☐	☐	☐	- Lead (primary) sheave is centered on the running drum	
☐	☐	☐	• Lubrication of wire rope (adequate?)	
☐	☐	☐	• Kinks, bends – Flattened to > 50% diameter	
☐	☐	☐	Hemp/Fiber rope (Cathead/Split Spoon Hammer) • Minimum ¾; maximum 1 inch rope diameter (Inspect for physical damage)	
☐	☐	☐	• Rope to hammer is securely fastened	
☐	☐	☐	Safety Guards – • Around rotating apparatus (belts, pulleys, sprockets, spindles, drums, flywheels, chains) all points of operations protected from accidental contact?	
☐	☐	☐	• Hot pipes and surfaces exposed to accidental contact?	
☐	☐	☐	• High pressure lines	
☐	☐	☐	• Nip/pinch points	
☐	☐	☐	Operator Qualifications • Does the operator have proper licensing where applicable, (e.g., CDL)?	
☐	☐	☐	• Does the operator, understand the equipment's operating instructions?	
☐	☐	☐	• Is the operator experienced with this equipment?	
☐	☐	☐	• Is the operator 21 years of age or more?	

Unit/Serial No#:_____ **Inspection Date:** ____/____/____

Yes	No	NA	Requirement	Comments
☐	☐	☐	PPE Required for Drill Rig Exclusion Zone • Hardhat	
☐	☐	☐	• Safety glasses	
☐	☐	☐	• Work gloves	
☐	☐	☐	• Chemical resistant gloves_____	
☐	☐	☐	• Steel toed Work Boots	
☐	☐	☐	• Chemical resistant Boot Covers	
☐	☐	☐	• Apron	
☐	☐	☐	• Coveralls Tyvek, Saranex, cotton)_____	
☐	☐	☐	Other Hazards • Excessive Noise Levels? _____dBA	
☐	☐	☐	• Chemical hazards (Drilling supplies - Sand, bentonite, grout, fuel, etc.)	
☐	☐	☐	- MSDSs available?	
☐	☐	☐	• Will On-site fueling occur	
☐	☐	☐	- Safety cans available?	
☐	☐	☐	- Fire extinguisher (Type/Rating -_____ _)	

Approved for Use ☐ Yes ☐ No ☐ See Comments

_____ _____

Site Health and Safety Officer Operator

ATTACHMENT VI

TETRA TECH SWP 5-6 SAFE WORKING PRACTICES FOR WORKING OVER OR NEAR WATER

The following sections discuss general procedures for working over or near water, underwater work, and cold water procedures.

1.0 SCOPE

This safe work practice (SWP) provides guidelines for all Tetra Tech employees and subcontractors who work over or near bodies of water three (3) or more feet deep or swiftly moving water. This SWP was developed in accordance with the Occupational Safety and Health Administration (OSHA) standard specified in Title 29 of the *Code of Federal Regulations* (CFR), Part 1926.106, "Working Over or Near Water."

2.0 RESPONSIBILITIES

The project manager (PM) is responsible for identifying all health and safety requirements of each project, including all tasks that may involve worker exposure to hazards or working in or near bodies of water. The PM will appoint a site safety coordinator (SSC) to ensure that this SWP is followed in the field. Workers will follow this SWP whenever working near or in any body of water that is over three (3) feet deep or swiftly moving.

3.0 GENERAL PROCEDURES

When working over or near water, the following precautions will be taken:

- All staff and team members must wear a personal flotation device (PFD) when working within 15 feet of a water body. Personnel will be provided with U.S. Coast Guard (USCG)-approved life jackets or work vests. The PFD should be Class III, which will support the head of an unconscious person above water.
- Life jackets and work vests will be inspected before and after each use.
- Ring buoys with at least 90 feet of line shall be provided and readily available for employee rescue operations.
- The distance between ring buoys shall not exceed 200 feet.

- A USCG-approved life-saving skiff will be available.
- Under no circumstances will team members enter water bodies without protective clothing such as rubber boots or waders.
- At least one person will remain on shore as a look-out.

If a team member falls into the water, a ring buoy, branch, paddle, pole, or other floating object should be extended to the person in the water. Resist the impulse to dive in; employees should not attempt a deep water rescue unless they have been trained in water lifesaving skills. When the person in the water grabs the extended item, the worker should be pulled toward the shore or boat. If the person is unconscious, the PFD, clothing, or hair should be hooked to pull the person toward the shore or boat. Once the person has been safely retrieved, necessary emergency medical procedures should be performed by qualified personnel. If none are necessary, the retrieved team member should change into dry clothing as soon as possible after any necessary personal decontamination.

4.0 UNDERWATER WORK

Underwater work should be performed in accordance with the procedures and guidelines of the Diving Safety Program (Document Control No. 2-15).

5.0 COLD WATER PROCEDURES

When the water temperature is below 45 °F, hypothermia is a serious risk. A person can loose feeling in the extremities within 5 minutes. Additional protective equipment such as cold water immersion suits may be required. All field staff members should be familiar with cold water survival techniques or should receive training from an American Red Cross-certified swimming instructor in cold water survival techniques when site conditions warrant such knowledge. Cold water safe work practices must be addressed in site specific safety documents.

After a person has been rescued from cold water, he or she should change into dry clothes as soon as possible. If the person who has fallen into the water displays hypothermia symptoms, he or she should be treated immediately and taken to a medical facility. Under no circumstances should the hypothermia victim be given hot liquids because this could

accelerate shock. Drinks no warmer than normal body temperature are acceptable. If symptoms are severe and evacuation to a medical facility cannot be quickly conducted, any wet clothing should be removed, the victim should be placed in blankets or sleeping bags in a sheltered location, and the rescuer should climb into the blankets or sleeping bag with victim to provide additional warmth. The victim should also be treated continuously for shock, elevating feet and monitoring the victim's pulse and breathing rate.

If a team member falls into cold water, he or she should not remove any clothing while in the water because clothing provides additional insulation. Although clothing creates an added drag while swimming, the insulation outweighs the disadvantage of the additional drag. Each team member should carry a wool hat to place on his or her head in case he or she falls into the water. A wool hat, even when wet, provides good insulation for the head, where a large amount of body heat is lost.

Revision Date	Document Authorizer	Revision Details
10/1/2008	Chris McClain	Update from 1998 format

ATTACHMENT VII

BOAT SAFETY CHECKLIST

TETRA TECH, INC.

SAFE BOATING CHECKLIST

Owner/Operator Name:_____

Registration Number_____

Location _____ County: _____State: _____HIN:_____

Length of Boat: <16 ❑ 16-25 ❑ 26-39 ❑ 40-65 ❑ > 65 ❑

Area of Operations: Inland ❑ Coastal ❑

Powered by: Gas ❑ Diesel ❑ Sail ❑ Other ❑

Type: PWC ❑ Open ❑ Cabin ❑ Other ❑

VESSEL SAFETY CHECK REQUIREMENTS					**RECOMMENDED AND DISCUSSION ITEMS**			
Item	Yes	No	NA		*Item*	Yes	No	NA
1. Display of Numbers					**(While encouraged, items below are not requirements)**			
2. Registration / Documentation					**I.** Marine Radio			
3. Personal Flotation Devices (PFD)					**II.** Dewatering Device & Backup			
4. Visual Distress Signals (VDS)					**III.** Mounted Fire Extinguishers			
5. Fire Extinguishers					**IV.** Anchor & Line for Area			
6. Ventilation					**V.** First Aid and PIW Kits (**over)			
7. Backfire Flame Control					**VI.** Inland Visual Distress Signals			
8. Sound Producing Devices / Bell					**VII.** Capacity / Cert. of Compliance			
9. Navigation Lights					**VIII.** Discussion Items: (as applies)			
10. Pollution Placard					a. Accident reporting / owner responsibility			
11. MARPOL Trash Placard					b. Offshore operations			
12. Marine Sanitation Devices					c. Nautical charts / navigation aids			
13. Navigation Rules					d. Survival tips / first Aid			
14. State and/ or Local Requirements					e. Fueling / fuel management			
15. Overall Vessel Condition: (as applies)					f. Float plan / weather & sea conditions			
a. Deck free of hazards / clean bilge					g. Insurance considerations			
b. Electrical / fuel systems					h. Boating check list			
c. Galley / heating systems					i. Safe boating classes			

This checklist has been modified for use from the United States Coast Guard Auxiliary Vessel Safety Check (VSC) Program. USCG AUX. Form 204 (7-2000)

Explanation of Required Items

- ❑ **1. NUMBERING:** The boat's registration number must be permanently attached to each side of the forward half of the boat. Characters must be plain, vertical, block style, not less than three (3) inches high, and in a color contrasting with the background. A space or hyphen must separate the letters from the numbers.

- ❑ **2. REGISTRATION / DOCUMENTATION:** Registration or Documentation papers must be on board and available. Documentation numbers must be permanently marked on a visible part of the interior structure. The documented boat's name and hailing port must be displayed on the exterior hull in letters not less than 4 inches in height.

- ❑ **3. PERSONAL FLOTATION DEVICES (PFDs):** Acceptable PFDs (also known as Life Jackets) must be U.S. Coast Guard approved and in good, serviceable condition. A wearable PFD of suitable size is required for the each person on the boat. Wearable PFDs shall be *"readily accessible*." Boats 16 Feet or longer, must also have one Type IV (throwable) device, which shall be " *immediately available*." PFDs shall NOT be stored in unopened plastic packaging.

- ❑ **4. VISUAL DISTRESS SIGNALS:** Boats 16 feet and over are required to carry a minimum of either:
  1) three day and three night pyrotechnic devices
  2) one day non-pyrotechnic device (flag) and one night non-pyrotechnic device (auto SOS light)
  3) a combination of 1) and 2).

  Boats less than 16 feet need only carry night visual distress signals when operating from sunset to sunrise. It is recommended, but not required, that boats operating on inland waters should have some means of making a suitable day and night distress signal. The number and type of signals is best judged by considering conditions under which the boat will be operating.

- ❑ **5. FIRE EXTINGUISHERS:** Fire extinguishers are required if one of the following conditions exists:
  1) Inboard engine(s)
  2) Double bottom hulls not completely sealed or not completely filled with flotation materials
  3) Closed living space
  4) Closed stowage compartments that contain flammable materials or
  5) Permanently installed fuel tanks. Boats less than 26 feet, and propelled by outboard motors are NOT required to have fire extinguishers unless one or more of the conditions (2-5) listed above applies.

Coast Guard Classification of Fire Extinguishers		
Classification (type size)	**B-I**	**B-II**
Foam (minimum gallons)	1.25	2.5
Carbon Dioxide (minimum lbs.)	4	15
Dry Chemical (minimum lbs.)	2	10
Halon (minimum lbs.)	2.5	10

NOTE: Fire extinguishers must be readily accessible and verified as serviceable.

Minimum Number of Extinguishers Required		
Boat Length	*No Fixed System*	*With Fixed System*
Less than 26'	one B-1	0
26' to less than 40'	two B-1 or one B-2	one B-1
40' to 65'	three B-1 or one B-1 & one B-2	two B-1 or one B-2

- ❑ **6. VENTILATION:** Boats with gasoline engines in closed compartments, built after 1 August 1980 must have a powered ventilation system. Those built prior to that date must have natural or powered ventilation. Boats with closed fuel tank compartments built after 1 August 1978 must

meet requirements by displaying a "certificate of compliance." Boats built before that date must have either natural or powered ventilation in the fuel tank compartment.

- ❑ **7. BACKFIRE FLAME ARRESTER:** Gasoline powered inboard/outboard or inboard motor boats must be equipped with an approved backfire flame control device.

- ❑ **8. SOUND PRODUCING DEVICES:** To comply with Navigation Rules and for distress signaling purposes boats must carry a sound producing device (whistle, horn, siren, etc.) capable of a 4-second blast audible for ½ mile. Boats larger than 39.4 ft. are also required to have a bell (see Navigation Rules.)

- ❑ **9. NAVIGATION LIGHTS: B**oats must be able to display navigation lights between sunset and sunrise and in conditions of reduced visibility. Boats 16 feet or more in length must have properly installed, working navigation lights and an all-around anchor light capable of being lit independently from the red/green/white "running" lights.

- ❑ **10. POLLUTION PLACARD:** Boats 26 feet and over with a machinery compartment must display an oily waste "pollution" placard.

- ❑ **11. MARPOL TRASH PLACARD:** Boats 26 feet and over in length, operating in U.S. navigable waters, must display a "MARPOL" trash placard. Oceangoing boats 40 feet and over must also have a written trash disposal plan available onboard.

- ❑ **12. MARINE SANITATION DEVICE:** Any installed toilet must be a Coast Guard approved device. Overboard discharge outlets must be capable of being sealed.

- ❑ **13. NAVIGATION RULES:** Boats 39.4 feet and over must have on board a current copy of the Navigation Rules.

- ❑ **14. STATE AND LOCAL REQUIREMENTS:** A boat must meet the requirements of the state in which it is being examined.

- ❑ **15. OVERALL BOAT CONDITION: As it applies to this Vessel. Including, but not limited to:**

    a. **Deck free of hazards and clean bilge -** The boat must be free from fire hazards, in good overall condition, with bilges reasonably clean and visible hull structure generally sound. The use of automobile parts on boat engines is not acceptable. The engine horsepower must not exceed that shown on the capacity plate.

    b. **Electrical and Fuel Systems:** The electrical system must be protected by fuses or manual reset circuit breakers. Switches and fuse panels must be protected from rain or water spray. Wiring must be in good condition, properly installed and with no exposed areas or deteriorated insulation. Batteries must be secured and terminals covered to prevent accidental arcing. If installed, self-circling or kill switch mechanism must be in proper working order.

    c. **Fuel Systems -** Portable fuel tanks (normally 7 gallon capacity or less) must be constructed of non-breakable material and free of corrosion and leaks. Vents must be capable of being closed. The tank must be secured and have a vapor-tight, leak-proof cap. Each permanent fuel tank must be properly ventilated.

    d. **Galley and Heating Systems -** System and fuel tanks must be properly secured with no flammable materials nearby.

ATTACHMENT VIII

TETRA TECH SWP 5-15 HEAT STRESS AND 5-26 PREVENTION OF SUN EXPOSURE

This safe work practice (SWP) describes situations where heat stress is likely to occur and provides procedures for the prevention and treatment of heat-related injuries and illnesses. Wearing personal protective equipment (PPE), especially during warm weather, puts employees at considerable risk of developing heat-related illness. Health effects from heat stress may range from transient heat fatigue or rashes to serious illness or death.

Many factors contribute to heat stress, including PPE, ambient temperature and humidity, workload, and the physical condition of the employee, as well as predisposing medical conditions. However, the primary factors are elevated ambient temperatures in combination with fluid loss. Because heat stress is one of the more common health concerns that may be encountered during field activities, employees must be familiar with the signs, symptoms, and various treatment methods of each form of heat stress. Heat stroke is the most serious heat-related illness—it is a threat to life and has a 20 percent mortality rate. Direct exposure to sun, poor air circulation, poor physical condition, and advanced age directly affect the tendency to heat stroke. Table 1 lists the most serious heat conditions, their causes, signs and symptoms, and treatment.

Training is an important component of heat stress prevention. Employees are instructed to recognize and treat heat-related illnesses during 8-hour health and safety refresher and first aid training courses. When working in hot environments, specific steps should be taken to lessen the chances of heat-related illnesses. These include the following:

- Ensuring that all employees drink plenty of fluids (Gatorade® or its equivalent)
- Ensuring that frequent breaks are scheduled so overheating does not occur
- Revising work schedules, when necessary, to take advantage of the cooler parts of the day (such as working from 5:00 a.m. to 11:00 a.m. and 6:00 p.m. to nightfall).

When PPE must be worn (especially Levels A and B), suggested guidelines relating to ambient temperature and maximum wearing time per excursion are as shown in Table 2.

TABLE 1
HEAT STRESS CONDITIONS

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles • Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness • Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of cool liquid or Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot, and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 105 or 106 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions

TABLE 2
SUGGESTED GUIDELINES WHEN WEARING PPE

Ambient Temperature	Maximum PPE Wearing Time per Excursion
Above 90 °F	15 minutes
85 to 90 °F	30 minutes
80 to 85 °F	60 minutes
70 to 80 °F	90 minutes
60 to 70 °F	120 minutes
50 to 60 °F	180 minutes

Source: National Institute for Occupational Safety and Health (NIOSH). 1985. Memorandum Regarding Recommended Personal Protective Equipment Wearing Times at Different Temperatures. From Austin Henschel. To Sheldon Rabinovitz. June 20.

To monitor the level of an employee's heat stress, the following should be measured:

- Heart Rate: Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period; if heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next period, shorten the following work cycle by one-third.

- Oral Temperature: Use a clinical thermometer (3 minutes under the tongue) to measure the oral temperature at the end of the work period. If oral temperature exceeds 99.6 °F (37.6 °C), shorten the next work cycle by one-third without changing the rest period. If oral temperature still exceeds 99.6 °F at the beginning of the next rest period, shorten the following work cycle by one-third. Do not permit a worker to wear impermeable PPE when his or her oral temperature exceeds 100.6 °F (38.1 °C).

Revision Date	Document Authorizer	Revision Details
10/1/2008	Chris McClain	Update from 1998 format

By far, the most common cause of skin cancer is overexposure to the sun. Ninety percent of all skin cancers occur on parts of the body that not usually covered by clothing. People who sunburn easily, and those with fair skin and red or blond hair are more prone to develop skin cancer. The amount of time spent in the sun also affects a person's risk of skin cancer. Premature aging of the skin also occurs with prolonged sun exposure. Tetra Tech encourages personnel to avoid prolonged exposure to the sun, and recommends the following:

- Sunburn can occur during any time of the year. To avoid sunburn, wear hats with wide brims.
- Use sunscreen with a Sun Protective Factor (SPF) rating of 15 or higher.
- To prevent skin cancer:
  - Cover up with a wide brimmed hat and a bandanna for your neck. Wear long-sleeved shirts and pants which the sun cannot penetrate.
  - Use sunscreens to help prevent skin cancer as well as premature aging of your skin. Use a Sun Protective Factor (SPF) rating of 15 or higher.
  - Apply sunscreen at least an hour before going into the sun and again after swimming or perspiring a lot.
  - Do not use indoor sun lamps, tanning salons/parlors, or tanning pills.
- You can still get burned on a cloudy day. Try to stay out of the direct sun at midday, because sun rays are their strongest between 10 a.m. and 3 p.m. Beware of high altitudes - where there is less atmosphere to filter out the ultraviolet rays. Skiers should remember that snow reflects the sun's rays, too.
- Know your skin. Whatever your skin type, do a monthly self-examination of your skin to note any moles, blemishes or birthmarks. Check them once a month and if you notice any changes in size, shape or color, or if a sore does not heal, see your physician without delay.

Revision Date	Document Authorizer	Revision Details
10/1/2008	Chris McClain	NEW

ATTACHMENT IX
TETRA TECH DECONTAMINATION OF FIELD EQUIPMENT AND WASTE HANDLING STANDARD OPERATING PROCEDURE

TETRA TECH NUS, INC.	STANDARD OPERATING PROCEDURES	Number SA-7.1	Page 1 of 8
		Effective Date 09/03	Revision 3
		Applicability Tetra Tech NUS, Inc.	
		Prepared Earth Sciences Department	
Subject DECONTAMINATION OF FIELD EQUIPMENT		Approved D. Senovich	

TABLE OF CONTENTS

1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The objective/purpose of this SOP is intended to protect site personnel, general public, and the sample integrity through the prevention of cross contamination onto unaffected persons or areas. It is further intended through this procedure to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, monitoring well materials, chemical sampling equipment and field analytical equipment.

2.0 SCOPE

This procedure applies to all equipment including drilling equipment, heavy equipment, monitoring well materials, as well as chemical sampling and field analytical equipment decontamination that may be used to provide access/acquire environmental samples. Where technologically and economically feasible, single use sealed disposable equipment will be employed to minimize the potential for cross contamination. This procedure also provides general reference information on the control of contaminated materials.

3.0 GLOSSARY

Acid - For decontamination of equipment when sampling for trace levels of inorganics, a 10% solution of nitric acid in deionized water should be used. Due to the leaching ability of nitric acid, it should not be used on stainless steel.

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Decontamination Solution - Is a solution selected/identified within the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

Deionized Water (DI) - Deionized water is tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet CAP and NCCLS specifications for reagent grade, Type I water.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Pressure Washing - Employs high pressure pumps and nozzle configuration to create a high pressure spray of potable water. High pressure spray is employed to remove solids.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Use of other solvents (methanol, acetone, pesticide-grade hexane, or petroleum ether) may be required for particular projects or for a particular purpose (e.g. for the removal of concentrated waste) and must be justified in the project planning documents. As an example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

Steam Pressure Washing - This method employs a high pressure spray of heated potable water. This method through the application of heat provides for the removal of various organic/inorganic compounds.

4.0 RESPONSIBILITIES

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved Standards Operating Procedures or as otherwise dictated by the approved project plan(s).

Site Health and Safety Officer (SHSO) - The SHSO exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on-site (as part of the equipment inspection), leaving the site, moving between locations are required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Failure to meet these objectives are sufficient to restrict equipment from entering the site/exiting the site/ or moving to a new location on the site until the objectives are successfully completed.

5.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or the isolation of contaminants. In order to accomplish this activity a level of preparation is required. This includes site preparation, equipment selection, and evaluation of the process. Site contaminant types, concentrations, media types, are primary drivers in the selection of the types of decontamination as well as where it will be conducted. For purposes of this SOP discussion will be provided concerning general environmental investigation procedures.

The decontamination processes are typically employed at:

- Temporary Decontamination Pads/Facilities
- Sample Locations
- Centralized Decontamination Pad/Facilities
- Combination of some or all of the above

The following discussion represents recommended site preparation in support of the decontamination process.

5.1 Decontamination Design/Constructions Considerations

5.1.1 Temporary Decontamination Pads

Temporary decontamination pads are constructed at satellite locations in support of temporary work sites. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soils generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations

- Site Location – The site selected should be within a reasonable distance from the work site but should avoid:

  - Pedestrian/Vehicle thoroughfares
  - Areas where control/custody cannot be maintained
  - Areas where a potential releases may be compounded through access to storm water transport systems, streams or other potentially sensitive areas.
  - Areas potentially contaminated.

- Pad – The pad should be constructed to provide the following characteristics

  - Size – The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination.

  - Slope – An adequate slope will be constructed to permit the collection of the water and potentially contaminated soils within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks.

  - Sidewalls – The sidewalls should be a minimum of 6-inches in height to provide adequate containment for wash waters and soils. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls maybe constructed of wood, inflatables, sand bags, etc. to permit containment.

  - Liner – Depending on the types of equipment and the decontamination method the liner should be of sufficient thickness to provide a puncture resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. Achieving the desired thickness maybe achieved through layering lighter constructed materials. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner a light coating of sand maybe applied to provide traction as necessary.

  - Wash/drying Racks – Auger flights, drill/drive rods require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process. A minimum ground clearance of 2-feet is recommended.

  - Maintenance – The work area should be periodically cleared of standing water, soils, and debris. This action will aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross contamination. Hoses should be gathered when not in use to eliminate potential tripping hazards.

5.1.2 Decontamination Activities at Drill Rigs/DPT Units

During subsurface sampling activities including drilling and direct push activities decontamination of drive rods, Macro Core Samplers, split spoons, etc. are typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.

Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected media. Drying racks will be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/re-use.

5.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations sampling devices such as trowels, pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition.

5.2 Equipment Decontamination Procedures

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

5.2.1 Monitoring Well Sampling Equipment

5.2.1.1 Groundwater sampling pumps – This includes pumps inserted into the monitoring well such as Bladder pumps, Whale pumps, Redi-Flo, reusable bailers, etc.

1) Evacuate to the extent possible, any purge water within the pump.

2) Scrub using soap and water and/or steam clean the outside of the pump and tubing, where applicable.

3) Insert the pump and tubing into a clean container of soapy water. Pump a sufficient amount of soapy water through the pump to flush any residual purge water. Once flushed, circulate soapy water through the pump to ensure the internal components are thoroughly flushed.

4) Remove the pump and tubing from the container, rinse external components using tap water. Insert the pump and tubing into a clean container of tap water. Pump a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).

5) Rinse equipment with pesticide grade isopropanol

6) Repeat item #4 using deionized water through the hose to flush out the tap water and solvent residue as applicable*.

7) Drain residual deionized water to the extent possible, allow components to air dry.

8) Wrap pump in aluminum foil or a clear clean plastic bag for storage.

5.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing with the extracted tape and probe with deionized water and wiping the surface of the extracted tape is acceptable. However, periodic full decontamination should be conducted as indicated below.

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* - The solvent should be employed when samples contain oil, grease, PAHs, PCBs, and other hard to remove materials. If these are not of primary concern, the solvent step may be omitted. In addition, do not rinse PE, PVC, and associated tubing with solvents.

1) Wash with soap and water
2) Rinse with tap water
3) Rinse with deionized water

Note: In situations where oil, grease, free product, other hard to remove materials are encountered probes and exposed tapes should be washed in hot soapy water.

5.2.1.3 Miscellaneous Equipment

Miscellaneous equipment including analytical equipment (water quality testing equipment) should be cleaned per manufacturer's instructions. This generally includes wiping down the sensor housing and rinsing with tap and deionized water.

Coolers/Shipping Containers employed to ship samples are received from the lab in a variety of conditions from marginal to extremely poor. Coolers should be evaluated prior to use for

- Structural integrity – Coolers missing handles or having breaks within the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples will not be attempted and request a replacement unit.

- Cleanliness – As per protocol only volatile organic samples are accompanied by a trip blank. If a cooler's cleanliness is in question (visibly dirty/stained) or associated with noticeable odors it should be decontaminated prior to use.

  1) Wash with soap and water
  2) Rinse with tap water
  3) Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and notify the laboratory to provide a replacement unit.

5.2.2 Down-Hole Drilling Equipment

This includes any portion of the drill rig that is over the borehole including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. This procedure is to be employed prior to initiating the drilling/sampling activity, then between locations.

1) Remove all soils to the extent possible using shovels, scrapers, etc. to remove loose soils.
2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.
3) Rinse with tap water.
4) Rinse equipment with pesticide grade isopropanol
5) To the extent possible allow components to air dry.
6) Wrap or cover equipment in clear plastic until it is time to be used.

5.2.3 Soil/Sediment Sampling Equipment

This consists of soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.

1) Remove all soils to the extent possible.

2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.

3) Rinse with tap water.

4) Rinse equipment with pesticide grade isopropanol

5) Rinse with deionized water

6) To the extent possible allow components to air dry.

7) If the device is to be used immediately, screen with a PID/FID to insure all solvents (if they were used) and trace contaminants have been adequately removed.

8) Once these devices have been dried wrap in aluminum foil for storage until it is time to be used.

5.3 Contact Waste/Materials

During the course of field investigations disposable/single use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.) broken sample containers.

With the exception of the broken glass, single use articles should be cleaned (washed and rinsed) of visible materials and disposed of as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned should be containerized for disposal in accordance with applicable federal state and local regulations.

5.3.1 Decontamination Solutions

All waste decontamination solutions and rinses must be assumed to contain the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. The waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. These containers must be appropriately labeled.

5.4 Decontamination Evaluation

Determining the effectiveness of the decontamination process will be accomplished in the following manner

- Visual Evaluation – A visual evaluation will be conducted to insure the removal of particulate matter. This will be done to insure that the washing/rinsing process is working as intended.

- Instrument Screening – A PID and/or an FID should be used to evaluate the presence of the contaminants or solvents used in the cleaning process. The air intake of the instrument should be passed over the article to be evaluated. A positive detection requires a repeat the decontamination process. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instruments capabilities.

- Rinsate Blanks – It is recommended that Rinsate samples be collected to

  - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.

  - Single use disposable equipment – The number of samples should represent different types of equipment as well as different Lot Numbers of single use articles.

The collection and the frequency of collection of rinsate samples are as follows:

- Per decontamination method
- Per disposable article/Batch number of disposable articles

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and in an effort to avoid using a contaminated batch of single use articles. It is recommended that a follow up sample be collected during the execution of the project to insure those conditions do not change. Lastly, rinsate samples collection may be driven by types of and/or contaminant levels. Hard to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.

ATTACHMENT X

TETRA TECH SAFE WORK PROCEDURE

DCN5-37 CRITICAL LIFT SAFE PRACTICES AND CRITICAL LIFT PLAN MASTER CHECKLIST

1.0 PURPOSE

The purpose of this procedure is to identify minimum requirements and provide a means to ensure that critical lift operations are planned, reviewed, and conducted with specific documented instructions that identify appropriate additional, special, and/or unusual precautions, methods, and/or safety requirements that must be accounted for before or during any lifting operation.

2.0 SCOPE

This procedure applies to all Tetra Tech (Tt) projects that include a construction O&M, and/or UXO component, including remediation construction, that involve critical lifts, as defined in Section 3.1, Definitions. This procedure applies to lifting operations performed by Tt's personnel and to lifting operations performed using crane operators provided with rented or leased cranes or other material handling equipment. This procedure may be applicable to work performed by subcontractors; however, the applicability shall be addressed in the subcontract agreement terms and conditions.

3.0 MINIMUM REQUIREMENTS

3.1 Definitions

3.1.1 Competent Person

One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them, OSHA 29 CFR 1926 Subpart CC – Cranes and Derricks in Construction.

3.1.2 Crane and Lifting Equipment

The terms "crane" and "lifting equipment" are used throughout this procedure. It shall be understood that these terms are inclusive of any equipment or tools utilized for lifting operations, including, but not limited to, crawler cranes and truck mounted cranes, including those with lattice booms or telescoping booms; forklifts; backhoes; excavators; loaders; derricks; chain falls; tuggers; and come-alongs. It is the intent that the requirements or guidance set forth in this procedure are to be applied to any device used for lifting activities, with appropriate adjustment to the instructions as required to address the specific situation. (For example, when using a chain fall for a lift or more than 75% of its rated capacity, the Critical Lift Plan checklist entry for "Foundation Support Checked" would require checking the structural integrity for the supporting member to which the chain fall is attached).

3.1.3 Crane Operator Aids

Devices which are used to assist a crane operator in the safe operation of a crane, including: two-block warning devices, two-block prevention devices, load and load moment indicator devices, boom angle and radius indicators, boom and jib stops, boom hoist disengaging devices, limit switches, drum rotation indicators, power line proximity devices, etc.

3.1.4 Critical Lift

A non-routine lift requiring additional detailed planning and additional or more than normal safety precautions. Critical lifts include lifts made when the load weight is 75% or more of the rated capacity of the lifting equipment at a specific configuration (boom angle, lift radius, swing, etc.); lifts which require the load to be lifted, swung, or placed out of the operator's view; lifts made with more than one piece of lifting equipment; lifts involving non-routine or technically difficult rigging arrangement(s); hoisting of personnel with a crane or derrick; or any lift which the lifting equipment operator believes should be considered critical.

Any lift of 30,000 pounds or more should be considered a critical lift, regardless of the crane capacity. The 30,000 pound criteria should be evaluated by the Project Manager and the Site Safety Coordinator (SSC) for the advisability of lowering the criteria based on project-specific factors such as capacity of the lifting equipment to be employed on the project, frequency and nature of the lifting activities, and availability of experienced personnel, among other factors. Establishment of project-specific criteria for determination of critical lifts should be documented by the Project Manager.

3.1.5 Critical Lift Plan

A plan prepared by the Crane Operator, Lift Supervisor, Project Engineer (or designee), and rigger, as applicable, prior to making a critical lift. The Critical Lift Plan shall be documented, and shall be reviewed and signed by all personnel involved with the lift.

3.1.6 Failure Mode

There are two generally recognized modes of failure of cranes when the rated capacity is exceeded, depending on the crane configuration: a structural failure occurs when the boom, jib, or other component of the crane suddenly fails (there is usually no advance warning of an impending structural failure); an overturning failure occurs when the crane is pulled over by the weight of the load (there may be advance warning of an impending overturning failure as weight is transferred from the outboard tires, crawler track, or outriggers, causing these to rise as the back side of the crane becomes "light").

3.1.7 Lift Supervisor

A competent person who has extensive knowledge and experience in lifting operations.

3.1.8 Qualified Operator

An operator who is qualified to operate the crane in accordance with the standards promulgated in 29 CFR 1926.1427, who is licensed or certified to operate the crane, or who has extensive knowledge and experience, and who has successfully demonstrated the ability to operate the equipment and to solve or resolve problems related to operation of the equipment.

3.1.9 Qualified Person

One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project. OSHA 29 CFR 1926 Subpart CC – Cranes and Derricks in Construction.

3.1.10 Tailing Crane Lift

A procedure sometimes used in erecting large vessels or structural elements in which one crane (lead crane) lifts the top of the load and a second crane (tail crane), rigged to the bottom of the load, either secures the bottom of the load from movement or assists in the horizontal positioning of the load. (USACE Safety and Health Requirements Manual, Publication EM 385-1-1).

3.1.11 Tandem Crane Lift

The use of two or more cranes to lift a load. (USACE Safety and Health Requirements Manual, Publication EM 385-1-1).

3.1.12 Terms

The terms "should, may, and might" as used in statements in this procedure are intended to denote a discretionary consideration; the terms "shall and must" are intended to impose a mandatory requirement. The terms "is, are and will" as used in statements in this procedure are intended to denote discretionary or mandatory requirements that are addressed in other department/disciplines' procedures. However, nothing contained herein should be interpreted as to prohibit development and approval of project-specific procedures or plans that take exception to mandatory direction presented in this procedure provided that the appropriate level of approval (Executive Vice President of Construction, Business Line Executive Vice

President, or the Vice President ESQ Services as appropriate) is obtained for deviations from such requirements.

3.1.13 Two-blocking

A condition which occurs when the lower load block or hook assembly comes in contact with the upper load block, or when the load block comes in contact with the boom tip. (USACE Safety and Health Requirements Manual, Publication EM 385-1-1).

3.2 Roles & Responsibilities

3.2.1 Executive Vice President of Construction

The Executive Vice President of Construction is responsible for providing qualified personnel to support the project as requested by the Project Manager.

3.2.2 Project Manager

The Project Manager is responsible for ensuring that a qualified Lift Supervisor and Project Engineer are assigned to the project for the performance of critical lifts. The Project Engineer may delegate authority to perform functions relative to critical lifts to a qualified Field Engineer but should maintain oversight of activities.

The Project Manager is responsible for communicating to the Site Superintendent and the Lift Supervisor that the Lift Supervisor is to be assigned the authority to take any actions, including but not limited to exercising Stop Work Authority, required for the safe execution of this critical lift.

3.2.3 Site Superintendent

The Site Superintendent is responsible for ensuring that no critical lifts are performed without the completion and approval of a Critical Lift Plan in accordance with this procedure, that no critical lifts are scheduled without the knowledge of the Lift Supervisor, and that the Lift Supervisor is assigned the authority discussed in Section 3.2.4 below.

3.2.4 Lift Supervisor

The Lift Supervisor is responsible for the execution of critical lifts, including selection of appropriate equipment of sufficient capacity, selection of qualified operators, and direct supervision of the critical lift operation and all personnel involved in the critical lift, including

the operator, rigger, and signalperson. The Lift Supervisor is responsible for ensuring that all personnel associated with the critical lift are aware of their responsibilities as addressed in this procedure, any applicable project procedure(s), and/or the Critical Lift Plan.

The Lift Supervisor is responsible for the selection of rigging slings, spreaders, shackles, and miscellaneous rigging materials in accordance with the requirements of the Critical Lift Plan. The Lift Supervisor is responsible for the arrangement and configuration of the rigging, and the attachment of the rigging to the load and to the lifting hook in accordance with safe rigging practices and the Critical Lift Plan.

The Lift Supervisor shall be responsible for determining the applicable qualification requirements for the crane operator in accordance with this procedure, state and local licensing agency requirements, OSHA 29 CFR 1926 Subpart CC – Cranes and Derricks in Construction, ANSI/ASME B30 standards, client requirements, or equipment manufacturer's recommendations. The U.S. Army Corps of Engineers (USACE), for example, requires proficiency qualification of operators, which includes a written examination and a physical examination, on USACE projects. Assistance in determining state and local licensing agency requirements may be obtained from a Tt Regulatory Specialist.

3.2.5 Crane Operator

The crane operator is responsible for the performance of the pre-operational inspections prior to each use of a crane, safe operation of the crane, and the performance of the critical lift in accordance with the requirements of the Critical Lift Plan and the instructions of the Lift Supervisor. The crane operator is responsible for ensuring that the following documents are with the crane at all times, and that the documents are completed as required:

- A copy of the operating manual developed by the manufacturer for the specific make and model of crane.
- A copy of the operating manual for any crane operator aids with which the crane is equipped.
- The load rating chart for the crane.
- A copy of the crane log book which records all operating hours as well as all inspections, tests, maintenance, and repair.
- The US Army Corps of Engineers (USACE) Safety and Health Requirements Manual, EM 385-1-1, requires the following information to be included on the load rating chart for lifting equipment to be used on a USACE project:

- The crane make and model, serial number and year of manufacture;
- Load ratings for all crane operating configurations, including optional equipment;
- Wire rope type, size and reeving; line pull, line speed and drum capacity; and
- Operating limits in windy or cold weather conditions.

When circumstances are encountered where all of the required information listed above is not included on the load rating chart for lifting equipment to be used on a USACE project, the USACE's project representative shall be requested to provide direction. For lifting equipment to be used on projects where the requirements of EM 385-1-1 do not apply, the Lifting Supervisor should determine the project's requirements concerning the information listed above.

The crane's log book shall be updated daily as the crane is used and shall be signed by the operator and supervisor. Service mechanics shall sign the log after conducting maintenance and repairs on the crane.

3.2.6 Signalperson

The signalperson is responsible for familiarity with the proper use of hand signals, radio communications, or other signal devices as appropriate for the Critical Lift Plan.

3.2.7 Subcontractors/Vendors

Roles and responsibilities of Tt personnel for lifting activities performed by subcontractors, vendors and suppliers shall be as established in the subcontract agreement terms and conditions and site-specific procedures.

3.3 Qualifications

3.3.1 Lift Supervisor Qualifications

The Lift Supervisor shall have the capability of determining the total weight and center of gravity of the load; selecting the appropriate lifting equipment and rigging materials rated for the load and the particular lifting configuration; evaluating the lifting configuration and conditions affecting the lift; and evaluating the condition of the equipment and rigging.

The Lift Supervisor shall have demonstrated the ability to solve or resolve problems related to lifting operations through experience, certification, or other means to the satisfaction of the Executive Vice President of Construction and the Project Manager.

3.3.2 Crane Operator Qualifications

Individual states and/or municipalities may have licensing requirements for crane operators. Where there are no licensing requirements, a certification of competency is recommended. Requirements for competency certification shall be included in subcontracts or purchase orders if this is to be a requirement of the project. The Project Manager should coordinate with the Tt Labor Relations Representative for the project to ensure inclusion of the competency certification requirement in the Project Labor Agreement as appropriate.

Crane operators shall be physically, mentally, medically, and emotionally qualified for performing the duties required of the position. Some factors to be considered in determining qualifications of crane operators are strength, endurance, agility, coordination, and visual and hearing acuity.

Tetra Tech crane operators shall be required to demonstrate to the satisfaction of the Lift Supervisor their knowledge of the following:

- Responsibilities of the operator, rigger, signalpersons, and lift supervisor;
- Knowledge of crane safety requirements (such as required safety equipment, clearance from power lines, overhead lifts, etc.) and the crane's operator manual;
- Ability to determine the crane configuration, to determine the weight and center of gravity of loads, and to determine the crane's capacity using the load chart;
- Ability to determine whether the crane would be in either the structural and overturning failure mode for the crane's configuration and the lift radius, using the crane's load chart;
- Use and limitations of the crane operator aids;
- Crane inspection, testing and maintenance requirements;
- Determination of ground conditions and outrigger matting requirements;
- Crane set-up, assembly, dismantling, and demobilization procedures;
- Signaling and communication procedures; and
- Factors which reduce rated capacity.

Tetra Tech crane operators shall pass a practical operating examination, conducted by the Lift Supervisor, which demonstrates their ability to perform the following:

- Inspecting the crane (refer to Construction Tools and Equipment, Attachment 2, for a Daily Equipment Inspection checklist);
- Establishing a stable foundation and leveling the crane;
- Raising, lowering, extending, retracting and swinging the boom;
- Raising and lowering the load line;
- Attaching the load, holding the load, and moving the load;
- Reading and understanding the signs, load charts, signals and operating instructions in use; and
- Reading the load, boom angle, and other indicating devices.

During the practical examination the crane operators should demonstrate the ability to operate the crane smoothly, with no sudden starts, stops or impact loading.

Results of crane operators' qualification examinations should be documented by the Lift Supervisor in the cranes' log books and/or other appropriate on-site project file.

3.3.3 Rigger Qualifications

The rigger shall demonstrate, to the satisfaction of the Lift Supervisor, a knowledge of safe rigging practices and the abilities to select the proper rigging hardware, slings and accessories of adequate capacity; to inspect the rigging and determine its condition, acceptability for use and load capacity; and to position the load in the lifting devices, assuring that the load is well secured, stable and balanced.

3.3.4 Signal Person Qualifications

The signalperson shall demonstrate, to the satisfaction of the Lift Supervisor, the ability to communicate, verbally and through the use of standard signals, with the crane operator, other workers, and the Lift Supervisor. The signalperson shall possess the visual and hearing acuity required for the performance of the duties associated with the position. The signalperson shall demonstrate a knowledge of the operation of any radio or other communication devices required for the lifting operation.

3.4 Planning the Lift

3.4.1 Critical Lift Plan Preparation, Review and Approval

Prior to commencing any lift meeting, the requirements of a critical lift, as defined in Section 3.4 of this procedure, the Site Superintendent shall ensure that a Critical Lift Plan is prepared, reviewed and approved. The Critical Lift Plan shall be prepared with appropriate input from the Lift Supervisor, Project Engineer (or designee), crane operator, rigger and the Site Safety Coordinator (SSC). The Critical Lift Plan shall be approved by the Project Manager or designee, and shall be signed by all personnel involved in the lift.

The Project Manager shall ensure that personnel performing calculations for total lift weight, determination of center of gravity, and capacity of the crane at the operating radius, as well as all other calculations required for the critical lift, possess the necessary qualifications. The Project Engineer may establish requirements for the performance of calculation reviews by a checker, and an independent verification of calculations, in accordance with the Tt Engineering Procedures. State and/or federal regulations may require a Professional Engineer to stamp the calculations for the Critical Lift Plan. Assistance in determining specific regulations applicable to a project may be obtained from a Regulatory Specialist.

Attachment 1, Critical Lift Plan Forms, provides a standard form which may be utilized to document the Critical Lift Plan. Other forms or project generated formats may be utilized provided that they address all of the areas required by this procedure.

After completion of the Critical Lift Plan, and immediately before the lift, the Lift Supervisor shall hold a meeting to be attended by all personnel involved in the lift. The purpose of the meeting is to communicate the roles, authorities, and responsibilities of all personnel, in particular the role of the Lift Supervisor as the person with the overall responsibility for the lift and the authority to direct the actions of all personnel involved in the lift; and to review the lift equipment and rigging selection, lift configuration, lift operation sequence, and all hazards involved in the lift. The pre-lift meeting shall be documented in the crane's log book.

For multiple, repetitive lifts with the same basic crane configuration and only minor variations in load weight, lift radius, or other variables, as determined by the Lift Supervisor, the Project Manager or designee may authorize the use of a single Critical Lift Plan to document all of the involved lifts. In those cases, the Lift Supervisor shall analyze the various lifts and ensure that the Critical Lift Plan adequately addresses the worst case combination of all of the variables involved.

For multiple, repetitive lifts utilizing one Critical Lift Plan, and conducted during the same work shift, The Project Manager or designee may determine that only one pre-lift meeting is required. Waiver of the pre-lift meeting should be documented in the crane's log book. Critical

lifts performed on separate shifts or workdays should require additional, documented pre-lift meetings as described above.

3.4.2 Critical Lift Plan Content

The Critical Lift Plan shall:

- Specify the exact size and weight of the load to be lifted as well as all crane and rigging components which add to the weight. Calculations required for determination of total weight, lift radius, % of crane's capacity, and center of gravity shall be included in or attached to the Critical Lift Plan. Documentation of any required calculation checks and independent verifications shall also be attached to the Critical Lift Plan,

- Specify the lift geometry and procedures, including the crane position, height of the lift, the load radius or boom angle, and the boom length, for the entire range of the lift. Sketches may be used when appropriate to adequately describe the layout,

- Designate the Crane Operator, Lift Supervisor, and Rigger. The Lift Supervisor shall be designated as the person in charge of the lift,

- Include a rigging plan which shows the lift points and forces and describes the rigging procedures and the hardware requirements. Sketches may be used when required to adequately describe the configuration and attachment points to the load,

- Include the sequence of the lift operation's activities, including verification of preparation activities (setup, inspections, testing),

- Describe the ground conditions, outrigger or crawler track requirements, and, if necessary, the design of cribbing or mats, necessary to achieve a level, stable foundation of sufficient bearing capacity for the lift for ground based lift equipment and the operating base (platform) condition for floating lift equipment,

- List the environmental conditions (rain, snow, ice, lightning, reduced visibility, etc.) under which the lift operations shall be conducted and/or curtailed or stopped,

- Specify the coordination and communication requirements for and during all lift operations, and

- Specify the make and model of the cranes, the line, boom and swing speeds, and requirements for an equalizer beam for tandem or tailing lift equipment.

3.4.3 Crane Supported Work Platforms (Manbaskets)

Crane supported work platforms shall be used only when the erection, use, and dismantling of conventional means of reaching a work site, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold would be more hazardous or is not possible because of structural design or work site conditions. (See SWP 5-37 Manbasket Form).

3.4.4 Special Considerations for Critical Lifts

When two or more cranes are used to lift a load, the responsibility of the Lift Supervisor as the person in charge of the lift shall be emphasized to all personnel involved in the lift. If the Lift Supervisor delegates any authority to a crane operator, this delegation shall be clearly communicated to all personnel involved in the lift.

When two or more cranes are used in a lift, unless approved otherwise, the capacity of each crane shall be at least equal to or greater than the total weight to be lifted including the load, lifting beams, rigging, hooks and attachments. Particular attention shall be given to the distribution of the load between the cranes to eliminate the overloading of a crane due to unbalanced load distribution and forces. The Lift Supervisor shall consider the rigging configuration to ensure that there is no possibility of an unacceptable load transfer between cranes, Such a load transfer may overload a crane.

Consideration shall be given to the possibility that the load may not be successfully placed in its intended location due to unanticipated occurrences (wind, obstacles, etc.). The Critical Lift Plan shall address contingency plans to return the load to its original or an alternate location. Refer to Section 3.4.4 of this procedure for additional discussion on this subject.

Consideration shall be given to the performance of a test lift to demonstrate the ability to safely perform a lift when, in the judgment of the Project Manager or the Lift Supervisor, there is a significant risk of a loss occurring during the actual lift. In evaluating the need for a test lift, consideration should be given to the complexity of the lifting operation, the value of the component being lifted, the potential impact to other installations, and potential schedule impacts, among other factors.

3.4.5 General Considerations for All Lifts

The Project Engineer or designee shall review and approve the strength and stability of the foundation or supports to receive any load. Cranes should be positioned as near as possible to the load, maintaining a safe operating distance from any foreign objects that might contact the boom and outriggers, and, if possible with a clear line of sight of the complete lift operation with consideration for minimizing the swing and the setting radii. The operator shall verify that

the load line is vertical and over the load's center of gravity prior to lifting the load to ensure that the load does not drift when lifted.

The immediate area of the lift should be checked for any electrical wires. A minimum safe distance of 10 feet shall be maintained from power lines rated 50 kV or less. The USACE Safety and Health Requirements Manual, Publication EM 385-1-1 shall be consulted for minimum safe distances from electric lines with a higher system voltage. Alternately, the minimum safe distance may be calculated as follows: minimum safe distance = 10 ft + 0.4 in for each 1 kV of lines rated over 50 kV; or twice the length of the line insulator (but never less than 10 feet). Refer to ANSI/ASME B30.5a for specific guidance concerning the operation of cranes in proximity to electrical transmission lines. Special precautions including de-energizing and grounding the lines may be required depending on the proximity and possibility of the crane, the load line, or the load becoming a conductive path.

The required bearing capacity for the ground or foundation supporting the crane should be calculated, and the actual bearing capacity should be verified to be sufficient to support the crane and the load being lifted.

3.4.6 The Lift Supervisor should always ensure that:

- The swing area of the crane is barricaded to protect personnel in the immediate area;
- Loads are not lifted over personnel;
- All loose load objects are secured or removed;
- Tag lines are used to control loads except where their use will create a hazard;
- The crane is not subjected to sudden lifting, stopping or impact loading;
- Riding on loads, hooks, buckets, material hoists, or other material hoisting equipment not meant for personnel use is absolutely prohibited;
- Rigging attachment points are as specified by the equipment vendor, if applicable, or as specified in the Critical Lift Plan;
- Softeners are used at contact points between rigging and load as necessary to avoid damage to the load or the rigging;
- Environmental conditions under which lifting operations should not be performed, such as wind, precipitation, reduced visibility, etc., have been established and

communicated to project personnel through the Work Plan, Health, and Safety Plan (HASP), and by verbal instructions, and

- Consideration is given towards developing a contingency plan should conditions prohibit the load from being placed in it's intended position. Contingency plans could include placement back in its original position or an alternate temporary location, and should include ensuring that adequate cribbing, dunnage, or tie downs are provided for the alternate location.

The Lift Supervisor shall determine that the foundation or supports to receive any load have been reviewed for stability and strength prior to any lift operation. This may be considered as a risk sensitive item, and if so, calculations performed shall be checked and independently verified prior to use in accordance with CP-11, Field Engineering. Temporary supports such as dunnage, cribbing, tie downs, and false work shall be reviewed with consideration given to the load's weight, center of gravity, and resistance to overturning forces. Stability and bearing capacity of soils to support loads shall be verified. Review and approval of permanent foundations or supports is performed as part of the design, however, there may be instances where a load is to be placed in it's final, designed location prior to completion of all construction associated with support of that load. (Examples: Backfill may not have been placed against foundations, concrete may not have achieved full design strength, or structural steel framing may not be complete.) These instances require review and approval by the Project Engineer prior to any load being placed.

Prior to placement of any load in storage or otherwise temporarily staged prior to placement in its final, designed location, consideration shall be given to any future access requirements, needed maintenance activities, the ability to perform future lifting or handling, and any construction activities expected to be performed in the vicinity of the stored or staged load.

3.4.7 Rigging Requirements

Certification of all lift accessories, including the results of proof tests for custom designed accessories, shall be available at the on-site project offices and maintained in a file as part of the project filing system. Certifications for load testing shall only be required if specified in the contract documents.

The total weight of the load to be lifted must include all lifting beams, rigging, hooks and attachments before any lift can be planned or executed.

The determination of the exact location of the center of gravity of the load is critical in ensuring that the load is rigged in a stable configuration. The location of the attachments of the rigging to the load should be above the center of gravity whenever and wherever possible. Where the location of attachments is below the center of gravity, extreme care must be taken to ensure

stability of the load and to guard against overturning of the load. Special precautions shall be taken in the selection of sling lengths and attachment configurations to ensure that the load is stable. Rigging of loads in this configuration should only be performed by personnel with extensive experience in rigging and after all plans have been reviewed and approved by competent and qualified personnel.

Consideration shall be given in any lifting operation to the possibility of a load becoming unstable during lifts intended only to reposition a load, such as up righting or turning a load over. The center of gravity shall be calculated for the load in all positions anticipated in order to ensure stability.

The load shall be safely rigged within the rated capacity of all rigging equipment.

Sling capacities shall be determined based on sling configuration (vertical, choker or basket hitch) and sling leg angle.

Custom designed grabs, hooks, clamps, or other lifting accessories shall be marked to indicate the safe working loads and shall have been proof-tested prior to use to 125% of their load rating.

3.4.8 Crane Inspections

Inspection Classification: Crane inspections are divided into two classifications by the ANSI/ASME B30 standards:

- Initial Inspection: Prior to initial use, all new and altered cranes shall be inspected by a qualified person to verify compliance with the applicable provisions of the ANSI/ASME B30 standards.

- Regular Inspection: The inspection procedure for cranes in regular service is further divided into two general classifications based on the intervals at which inspections should be performed. The intervals are dependent in turn on the nature of the critical components of the crane and the degree of their exposure to wear, deterioration, or malfunction. The two general classifications of regular inspections are designated as “frequent” and “periodic”, with respective intervals between inspections defined as:

- Frequent Inspection - intervals from one to thirty days, performed by a person designated by the Lift Supervisor; and

- Periodic Inspection - intervals from one to twelve months (or as specifically recommended by the manufacturer or by a qualified person), performed by a qualified person.

Specific guidelines and requirements for all of the above inspections are included in the ANSI/ASME B30 standards.

Implementation of the inspection requirements listed above for Tt projects shall be in accordance with the following:

- Prior to initial use, all new and altered cranes to be used by Tt shall be inspected (initial inspection) by a certified crane inspector to ensure compliance with the applicable portions of the ANSI/ASME B30 standards, or the Power Crane and Shovel Association Standard #4 for draglines.

- Cranes to be used by Tt shall receive pre-operational inspections (frequent inspections) performed by the crane operator daily, prior to every use. Refer to the USACE Safety and Health Requirements Manual, Publication EM 385-1-1, Appendix H, Crane and Derrick Inspection, for a checklist of items to be inspected. Pre-operational inspections of rented or leased cranes, performed by a Tt employee (e.g. either a certified crane inspector, the Lift Supervisor, or the crane operator) should not be documented or used in place of a periodic inspection.

- Cranes to be used by Tt shall receive periodic inspections conducted by a qualified person on an annual basis, or more frequently if recommended by the manufacturer or if subjected to extensive use. Because of liability considerations, the vendor renting or leasing the crane shall be responsible for performing and documenting the periodic inspections.

- Cranes which have been idle for a period of more than one month but less than six months shall be given a pre-operational inspection, conforming to the requirements for frequent crane inspections and frequent wire rope inspections, by a qualified person before being placed into service.

- Cranes which have been idle for a period of more than six months shall be given a complete inspection, conforming to the requirements for frequent and periodic crane inspections and for frequent and periodic wire rope inspections, by a qualified person prior to being placed into service.

3.4.9 Crane Performance Load Tests

Cranes to be used by Tt shall receive performance load tests by a qualified person in accordance with USACE Safety and Health Requirements Manual EM 385-1-1 Appendix I under the following circumstances:

- Prior to initial use of cranes when load sustaining parts have been altered, replaced, or repaired (excluding replacement of load line wire rope);

- Every time it is reconfigured or reassembled after disassembly or is moved and set up in a unsimilar configuration; and

- Every four years.

Under the first 2 bullet statements a selective operational performance test (testing only components that have or may have been affected by the alteration, replacement, repair, reconfiguration, or reassembly) may be performed.

A crane boom stop field test shall be conducted to verify the proper setup of the boom stops and functioning of the boom hoist disengaging device. This test shall be conducted, and deficiencies noted shall be corrected, prior to initiating the load performance test. Refer to the USACE Safety and Health Requirements Manual, Publication EM 385-1-1, Appendix I, for a checklist for the crane boom stop field test.

Performance load tests shall be conducted in accordance with the manufacturer's recommendations. Test loads shall not exceed 100% of the manufacturer's load rating capacity chart for any configuration of the test, except where a specific requirement exists.

Written reports of the load test, showing test procedures and confirming the adequacy of repairs or alterations, shall be maintained in the crane log book and in project equipment records.

3.4.10 Applicability to Subcontractors

Subcontractors performing work on Tt projects shall be required to comply with the minimum requirements of the Tt Safety Plan(s) or to develop and implement a Site Safety Plan of their own which includes Tt requirements in accordance with DCN 2-11 Health and Safety Qualifications for Subcontractors.

This critical lift procedure in and of itself is not directly applicable to subcontractors unless specifically addressed in the subcontract terms and conditions. The Project Manager may provide copies of this procedure to subcontractors for their use in developing their own Critical Lift Plans; however, this should only be done with the understanding and express, written agreement that Tt has no responsibility or liability for the acceptability and/or implementation of this procedure in the subcontractors' plans.

4.0 GUIDANCE

None Required

5.0 REFERENCES

1. American National Standards Institute, ANSI/ASME B30 Standards, B30.1 through B30.25, including the B20.5-1995 Addenda to ASME B30.5-1994
2. OSHA 29 CFR 1926 Subpart CC – Cranes and Derricks in Construction
3. Power Crane and Shovel Association Standard #4
4. USACE Safety & Health Requirements Manual, Publication EM-385-1-1, October 1992 or latest edition

6.0 ATTACHMENTS

1. Attachment 1 - Critical Lift Plan and Attachment "A"
2. Attachment 2 - Personnel Platform (Manbasket) Inspection/Verification Form

ATTACHMENT XI

TETRA TECH SAFE WORK PROCEDURE SWP 5-38 SAFE LOAD SECURING GUIDELINES

1.0 Loads

Loads are secure and do not exceed manufacturer's specifications and legal limits for the vehicle.

Vehicles will be equipped with only necessary equipment, laid out or positioned in the safest configuration. Loads, equipment and other items shall be tied down or secured before commencing motion, and total weight shall never exceed the weight limitations of the vehicle.

2.0 Guidance

Loads, equipment and other items transported external to the driving compartment or on a trailer shall be:

- Secured in such a manner to prevent against the loss of the load via leaking, spilling, blowing off or falling from the motor vehicle.
- Contained, immobilized or secured in such a manner to prevent shifting.
- If likely to roll, restrained by chocks, wedges, a cradle or other equivalent means to prevent rolling.
- If considered top heavy and capable of tipping, secured in such a manner to prevent tipping.
- If placed beside each other and secured by transverse tie-downs, either placed in direct contact with each other or prevented from shifting towards each other while in transit.

Securing devices and systems shall be capable of withstanding the following three forces, applied separately:

- Deceleration in the forward direction.
- Acceleration in the reverse direction.
- Acceleration in a lateral direction.

The manufacturer shall apply any tie-down points added to a vehicle, or the tie-down points shall meet manufacturer's specifications.

Loads, equipment and other items transported under a pickup truck bed-covering device shall be considered secured.

The driver shall verify that loads, equipment and other items transported inside a vehicle's driving compartment are secure and/or positioned to eliminate or minimize safety risks to the occupants. When loading these items, the driver shall consider:

- Transporting them in the trunk of a car (e.g., a suitcase or computer bag).
- Stowing them under or behind a seat, glove box or armrest console.
- Covering them with netting or holding them in the seats with seatbelts or similar devices.

Revision Date	Document Authorizer		Revision Details
	Name	Approval Date	
4/21/2012	Chris McClain		

ATTACHMENT XII

TETRA TECH RESPIRATORY PROTECTION PROGRAM

TETRA TECH INC.
RESPIRATORY PROTECTION PROGRAM
For
Lockheed Martin
Middle River Complex
Block E

April 2013

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Respiratory Protection Program

1.0 INTRODUCTION

1.1 Mission

Tetra Tech ensures the safe and healthful work environment for employees performing field work. To accomplish this mission Tetra Tech evaluates all work sites provides the proper protective equipment to insure that all employees are properly protected.

1.2 Vision

Tetra Tech is committed to being the premier environmental engineering and consultation firm, dedicated to providing our clients with the best possible service to ensure regulatory compliance in all aspects of environmental work.

2.0 PURPOSE

Tetra Tech, Inc has determined that certain employees may be potentially exposed to respiratory hazards during grass cutting operations on Block E of the Middle River Complex from PCB contamination. If significant dust is generated that obscures vision this program and respiratory protective equipment will be used. The purpose of this program is to ensure that all Tetra Tech, Inc. employees are protected from exposure to possible respiratory hazards from PCB exposure.

Engineering controls, such as ventilation and isolation, are not appropriate for grass cutting operations at this site. Since Tetra Tech, Inc. cannot control exposure at this site. Respirators and other protective equipment may be used if dust is generated.

3.0 SCOPE AND APPLICATION

This program applies to employees who may be required to wear respirators during grass cutting operations at Block E.

Any employee who wears a respirator is subject to medical evaluation, cleaning, maintenance, and storage elements of this program, and must be provided with certain information specified in this section of the program.

Employees participating in the respiratory protection program do so at no cost to them. The expense associated with training, medical evaluations and respiratory protection equipment will be borne by Tetra Tech, Inc.

4.0 RESPONSIBILITIES

4.1 Program Administrator

The Program Administrator is responsible for administering the respiratory protection program. Duties of the program administrator include:

- Identifying work areas, processes or tasks that require workers to wear respirators, and evaluating hazards.
- Selection of respiratory protection options.

- Monitoring respirator use to ensure that respirators are used in accordance with their certifications.
- Arranging for and/or conducting training.
- Ensuring proper storage and maintenance of respiratory protection equipment.
- Conducting qualitative fit testing.
- Administering the medical surveillance program.
- Maintaining records required by the program.
- Evaluating the program.
- Updating written program, as needed.

The Program Administrator is Clyde Snyder Tetra Tech, Inc.

4.2 Supervisors

Supervisors are responsible for ensuring that the respiratory protection program is implemented in their particular areas. In addition to being knowledgeable about the program requirements for their own protection, supervisors must also ensure that the program is understood and followed by the employees in their charge. Duties of the supervisor include:

- Ensuring that employees under their supervision (including new hires) have received appropriate training, fit testing and annual medical evaluation.
- Ensuring the availability of appropriate respirators and accessories.
- Being aware of tasks requiring the use of respiratory protection.
- Enforcing the proper use of respiratory protection when necessary.
- Ensuring that respirators are properly cleaned, maintained, and stored according to the respiratory protection program.
- Ensuring that respirators fit well and do not cause discomfort.
- Continually monitoring work areas and operations to identify respiratory hazards.
- Coordinating with the Program Administrator on how to address respiratory hazards or other concerns regarding the program.

4.3 Employees

Each employee has the responsibility to wear his or her respirator when and where required and in the manner in which they were trained. Employees must also:

- Care for and maintain their respirators as instructed, and store them in a clean sanitary location.
- Inform their supervisor if the respirator no longer fits well, and request a new one that fits properly.
- Inform their supervisor or the Program Administrator of any respiratory hazards that they feel are not adequately addressed in the workplace and of any other concerns that they have regarding the program.

5.0 PROGRAM ELEMENTS

5.1 Selection Procedures

The Program Administrator has selected a respirator to be used for Tetra Tech, Inc. personnel. This selection is based on the hazard (PCB's) to which workers are exposed it is also in accordance with

OSHA standards. The Program Administrator conducted a hazard evaluation for the anticipated operation, and the work area (Block E) where the airborne contaminant may be present. The hazard evaluation has limited the exposure potential to particulates which PCB's are attached.

- Particulate contaminants are classified according to physical and chemical characteristics and the physiological effect of the body. The particulates are measured in diameter in microns (1 micron = 1/25,400 of an inch). Particulates below 10 microns have a greater chance to enter the respiratory system, and particles below 5 microns in diameter are more likely to reach the deep lung or alveolar spaces. In healthy lungs, particles from 5 to 10 microns are naturally removed by the human body. With excessive "dust" exposure or someone who has a diseased respiratory system the efficiency of the cleaning action is significantly reduced.

- Prior to performing grass cutting and trimming where there is an atmospheric hazard, Tetra Tech, Inc. personnel must ensure the following:

    - Review the work area and required tasks to be performed.

    - Determine where potential exposures to hazardous substances may occur.

    - This review shall be conducted by surveying the site, reviewing current and historical records, and talking with TETRA TECH, INC management and Health and Safety personnel.

    - Monitoring will not be performed due to Tetra Techs and Lockheed Martins knowledge of site contaminants (PCB's) levels encountered will only occur during dry conditions when dust is created. Based on previous data contaminants levels are within the visible range making monitoring instruments unnecessary.

5.1.1 Updating the Hazard Assessment

The Program Administrator must revise and update the hazard assessment as needed (i.e., any time the work process changes or new information is obtained that could potentially affect exposure). If an employee feels that respiratory protection is needed during a other activities, he/she is to contact his or her supervisor or the Program Administrator. The Program Administrator will evaluate the potential hazard, arranging for outside assistance as necessary. The Program Administrator will then communicate the results of that assessment back to the employee. If it is determined that respiratory protection is necessary, all other elements of this program will be in effect for those tasks and this program will be updated accordingly.

5.1.2 NIOSH Certification

All respirators must be certified by the National Institute for Occupational Safety and Health (NIOSH) and shall be used in accordance with the terms of that certification. Also, all filters, cartridges, and canisters must be labeled with the appropriate NIOSH approval label. The label must not be removed or defaced while it is in use.

5.2 Medical Evaluation

Employees who wear respirators must pass a medical exam before being permitted to wear a respirator on the job. Employees are not permitted to wear respirators until a physician has

determined that they are medically able to do so. Any employee refusing the medical evaluation will not be allowed to work in an area requiring respirator use.

Workcare has been chosen by Tetra Tech to provide this service will provide the medical evaluations. Medical evaluation procedures are as follows:

- The medical evaluation will be conducted using the questionnaire provided in Appendix C of the respiratory protection standard. The Program Administrator will provide a copy of this questionnaire to all employees requiring medical evaluations.

- To the extent feasible, Tetra Tech, Inc. will assist employees who are unable to read the questionnaire (by providing help in reading the questionnaire). When this is not possible, the employee will be sent directly to the physician for medical evaluation.

- Follow-up medical exams will be granted to employees as required by the standard, and/or as deemed necessary by the WorkCare clinic physician.

- All employees will be granted the opportunity to speak with the physician about their medical evaluation, if they so request.

- The Program Administrator has provided the occupational medicine physician (Workcare) with a copy of this program, a copy of the Respiratory Protection Standard, the list of potential hazardous substances, and for each employee requiring evaluation: his or her work area or job title, proposed respirator type and weight, length of time required to wear respirator, expected physical work load (light, moderate, or heavy), potential temperature and humidity extremes, and any additional protective clothing required.

- Any employee required for medical reasons to wear a positive pressure air purifying respirator will be provided with a powered air purifying respirator.

- After an employee has received clearance and begun to wear his or her respirator, additional medical evaluations will be provided under the following circumstances:

    - Employee reports signs and/or symptoms related to their ability to use a respirator, such as shortness of breath, dizziness, chest pains, or wheezing.

    - The WorkCare clinic physician or supervisor informs the Program Administrator that the employee needs to be reevaluated;

    - Information from this program, including observations made during fit testing and program evaluation, indicates a need for reevaluation;

    - A change occurs in workplace conditions that may result in an increased physiological burden on the employee.

All examinations are to remain confidential between the employee and the physician.

5.3 Fit Testing

Fit testing is required for employees wearing half-facepiece APRs for exposure to suspended particulates in the atmosphere.

Employees required to wear half-face piece APRs during grass cutting operations will be fit tested:

- Prior to being allowed to wear any respirator with a tight fitting face piece

- Annually
- When there are changes in the employee's physical condition that could affect respiratory fit (e.g., obvious change in body weight, facial scarring, etc.)

Employees will be fit tested with the make, model, and size of respirator that they will actually wear. Employees will be provided with several sizes of respirators so that they may find an optimal fit.

The Program Administrator will conduct fit tests following the OSHA approved QNFT Protocol in Appendix B (B4) of the Respiratory Protection standard.

5.4 Respirator Use

Participation in the Respiratory Protection Program at Tetra Tech, Inc. is mandatory. Only individuals who are in the program will be issued respirators. Others will refrain from entering atmospheres where respiratory protection is required.

5.4.1 General Use Procedures

- Employees will use their respirators under conditions specified by this program, and in accordance with the training they receive on the use of each particular model. In addition, the respirator shall not be used in a manner for which it is not certified by NIOSH or by its manufacturer.

- All employees shall conduct user seal checks each time that they wear their respirator. Employees shall use either the positive or negative pressure check (depending on which test works best for them) specified in Appendix B-1 of the Respiratory Protection Standard.

- Employees are not permitted to wear tight-fitting respirators if they have any condition, such as facial scars, facial hair, or missing dentures, that prevents them from achieving a good seal. Employees are not permitted to wear headphones, jewelry, or other articles that may interfere with the facepiece-to-face seal.

- Air Purifying filters provides respiratory protection against aerosols by removing dusts, mists, fumes, fibers, and other particles. Filters do not remove gases or vapors, or correct for oxygen deficiency. P100 Particulate Filter provides a 99.97% Minimum Filter Efficiency. Typical applications include but are not limited to asbestos or mold and lead.

- Employees wearing respirators must be clean shaven with no stuble.

- End of service life for filters is normally determined by the increase in breathing resistance sensed by the user. When it becomes difficult to breathe comfortably, the filters should be replaced.

5.4.2 Half Mask Air Purifying Respirator

550030M Half Mask shown with 7580P100 Cartridges

The North 5500 Series is a comfortable and efficiently designed half mask respirator. It was chosen because of its convenience, low maintenance and it is disposable. However, all parts are replaceable, which will extend the useful life of the respirator.

Features and benefits:

- Made of an extremely soft non-allergenic elastomer for comfort and fit. Contoured sealing flange eliminates discomfort caused by pressure points on facial nerves. The design of nose area provides excellent comfort and fit

- Low dead air space improves worker comfort by limiting re-breathing of exhaled air
- Direct cartridge to facepiece seal minimizes replacement parts and simplifies maintenance
- Three overlapping sizes comfortably fit most users
- North 5500 Series half masks are compatible with all North cartridges, filters and accessories

5.4.3 Emergency Procedures

If during grass cutting operations, Tetra Tech, Inc. employees must ensure that a procedure is in place to evacuate the site. If a site alarm sounds, employees must immediately exit the area and report to the designated location.

5.4.4 Respirator Malfunction

For any malfunction of an APR (e.g., such as breakthrough, facepiece leakage, or improperly working valve), the respirator wearer should immediately leave the site and inform his or her supervisor that the respirator no longer functions as intended, and go to the designated safe area to maintain the respirator. The supervisor must ensure that the employee receives the needed parts to repair the respirator, or is provided with a new respirator.

5.4.5 Immediately Dangerous to Life and Health (IDLH) Procedures

Respirators will only be worn in areas declared to be free of IDLH situations.

5.5 Air Quality

This work is being conducted in the open air, air quality should not be an issue. The only air quality issue that could arise is dust generated during grass cutting operations. Prior to commencing grass cutting personnel will determine the site conditions if dry conditions exist conduct area wetting to suppress dust.

5.6 Cleaning, Maintenance, Change Schedules and Storage

5.6.1 Cleaning

Respirators are to be regularly inspected, cleaned and disinfected if necessary.

The following procedure is to be used when cleaning and disinfecting respirators:

- Disassemble respirator, removing any filters, canisters, or cartridges.
- Wash the face piece and associated parts in a mild detergent with warm water. Do not use organic solvents.
- Rinse completely in clean warm water.
- Wipe the respirator with disinfectant wipes (70% Isopropyl Alcohol) to kill germs.
- Air dry in a clean area.
- Reassemble the respirator and replace any defective parts.

- Place in a clean, dry plastic bag or other air tight container.

Note: The Program Administrator will ensure an adequate supply of appropriate cleaning and disinfection material. If supplies are low, employees should contact their supervisor, who will inform the Program Administrator.

5.6.2 Maintenance

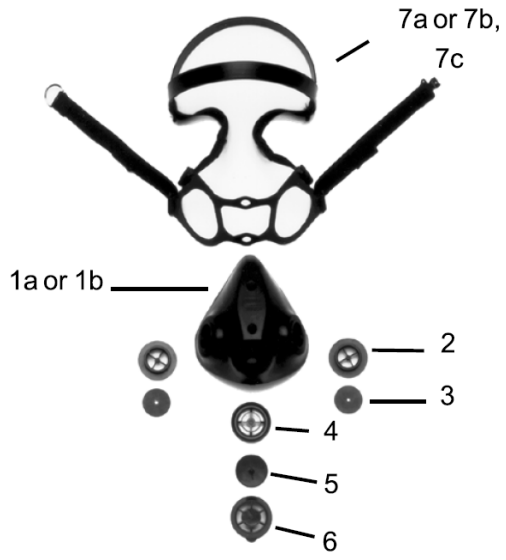
Respirators are to be properly maintained at all times in order to ensure that they function properly and adequately protect the employee. Maintenance involves a thorough visual inspection for cleanliness and defects. Worn or deteriorated parts will be replaced prior to use. No components will be replaced or repairs made beyond those recommended by the manufacturer.

The following checklist will be used when inspecting respirators:

- Facepiece: cracks, tears, or holes facemask distortion
- Headstraps: breaks or tears broken clasps
- Valves: residue or dirt, cracks or tears in valve material
- Filters/Cartridges: approval designation on cartridge, gaskets, cracks in housing and proper cartridge for hazard

The following Figure shows the “exploded” view of the North N5500 face piece. Replacement part numbers are also listed.

7700 & 5500 Series Facepiece Replacement Parts



	Cat. #	*Description*
1a	770011 L, M, S	Basic Facepiece for 7700
1b	550011 L, M, S	Basic Facepiece for 5500
2	770016	Cartridge Connector
3	770017	Inhalation Valve
4	770019	Exhalation Valve Seat
5	770018	Exhalation Valve
6	770020	Exhalation Valve Guard
7a	770092	Cradle Suspension System for 7700
7b	550092	Cradle Suspension System for 5500
7c	770092P	Cradle Suspension System with Slides for 7700

5.6.3 Change Schedules

Employees wearing APRs shall change the cartridges on their respirators when they first begin to experience difficulty breathing (i.e., resistance) while wearing their masks.

5.6.4 Storage

Respirators must be stored in a clean, dry area, and in accordance with the manufacturer's recommendations. Each employee will clean and inspect their own air-purifying respirator in accordance with the provisions of this program and will store their respirator in a plastic bag in their own locker. Each employee will have his/her name on the bag and that bag will only be used to store that employee's respirator.

The Program Administrator will store Tetra Tech, Inc.'s supply of respirators and respirator components in their original manufacturer's packaging in the equipment storage room.

5.6.5 Defective Respirators

Respirators that are defective or have defective parts shall be taken out of service immediately. If, during an inspection, an employee discovers a defect in a respirator, he/she is to bring the defect to the attention of his or her supervisor. Supervisors will give all defective respirators to the Program Administrator. The Program Administrator will decide whether to:

- Temporarily take the respirator out of service until it can be repaired.
- Perform a simple fix on the spot such as replacing a headstrap.
- Dispose of the respirator due to an irreparable problem or defect.

5.7 Training

The Program Administrator will provide training to respirator users and their supervisors on the contents of the TETRA TECH, INC Respiratory Protection Program and their responsibilities under it, and on the OSHA Respiratory Protection standard. Workers will be trained prior to using a respirator in the workplace. Supervisors will also be trained prior to using a respirator in the workplace or prior to supervising employees that must wear respirators.

The training course will cover the following topics:

- TETRA TECH, INC Respiratory Protection Program
- OSHA Respiratory Protection standard
- Respiratory hazards encountered at Lockheed Martin and their health effects
- Proper selection and use of respirators
- Limitations of respirators
- Respirator donning and user seal (fit) checks
- Fit testing
- Emergency use procedures
- Maintenance and storage
- Medical signs and symptoms limiting the effective use of respirators

Employees will be retrained annually or as needed (e.g., if they change departments and need to use a different respirator). Employees must demonstrate their understanding of the topics covered in the training through hands-on exercises and a written test. Respirator training will be documented by the Program Administrator and the documentation will include the type, model, and size of respirator for which each employee has been trained and fit tested.

6.0 PROGRAM EVALUATION

The Program Administrator or designee will conduct periodic evaluations to ensure that the provisions of this program are being implemented. The evaluations will include regular consultations with employees who use respirators and their supervisors, site inspections, air monitoring and a review of records.

Problems identified will be noted in an inspection log and addressed by the Program Administrator. These findings will be reported to Tetra Tech, Inc. Program Administrator and the report will list plans to correct deficiencies in the respirator program and target dates for the implementation of those corrections.

7.0 DOCUMENTATION AND RECORDKEEPING

A written copy of this program and the OSHA standard is kept in the site office and is available to all employees who wish to review it.

Also maintained in the Program Administrator's office are copies of training and fit test records. These records will be updated as new employees are trained, as existing employees receive refresher training, and as new fit tests are conducted.

The Program Administrator will also maintain copies of the medical records for all employees covered under the respirator program. The completed medical questionnaire and the physician's documented findings are confidential and will remain at WorkCare Clinic. Tetra Tech, Inc. will only retain the physician's written recommendation regarding each employee's ability to wear a respirator.

8.0 DEFINITIONS

Approved: Respirators tested and listed as satisfactory by the National Institute for Occupational Safety and Health (NIOSH), or U.S. Department of Labor Mine Safety and Health Administration (MSHA) to provide adequate respiratory protection against a particular hazard for which it is designed.

Aerosol: A suspension of fine solid or liquid particles or fibers in air, such as dust, fog, fume, mist, smoke, or sprays.

Contaminant: A harmful, irritating, or nuisance material in concentrations exceeding those normally found in the ambient air.

Disinfection: The destruction of pathogenic organisms, especially by means of chemical substances.

Dust: Solid particles, mechanically produced, with a size ranging from submicroscopic to microscopic.

Elastomer: Materials with the ability to be stretched to twice their original length and to retract (rapidly) to their original length.

End-Of-Service-Life Indicator (ESLI): A system that warns the respirator user of the approach of the end of adequate respiratory protection; for example, that the sorbent is approaching saturation or is no longer effective.

Fog: A heavy concentration of a mist that can obscure vision.

Fumes: Solid particles generated by condensation from the gaseous state, generally after volatilization from molten metals, with a size usually less than one micron in diameter.

Gases: Substances that are gaseous at ordinary temperatures and pressures.

High-Efficiency Particulate Air (HEPA) Filter: A filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Immediately Dangerous to Life or Health (IDLH): Environmental conditions which contain less than 19.5% oxygen or contaminants of high toxicity which even for short periods of exposure (at the proper concentrations) pose an immediate threat to life or health of employees.

Mists: Suspended liquid droplets generated by condensation or by breaking up of liquid with a size ranging from submicroscopic to microscopic.

Oxygen-Deficient Atmosphere: An atmosphere containing 19.5% or less of oxygen by volume.

Respirator: A device designed to provide the wearer protection against inhalation of airborne contaminants; and, for some devices, protection against oxygen-deficient atmospheres.

Respiratory Protective Equipment (RPE): Approved equipment that provides uncontaminated respirable air to the user.

Sanitize: The process of cleaning and removing potentially harmful bacteria, viruses, etc. by using disinfectant cleaning materials or immersion in hot water or a combination of the two processes.

Smoke: Particles generated by the incomplete combustion of an organic substance. Colors vary (e.g., thick black--hydrocarbon; gray--wood, paper).

Spray: Liquid particles suspended in air. This usually occurs by mechanical means, such as a leaking pipe.

Vapor: The gaseous state of a substance that is a solid or liquid at ordinary temperature and pressure.

ATTACHMENT XIII

OSHA POSTER

Job Safety and Health

It's the law!

OSHA

Occupational Safety and Health Administration
U.S. Department of Labor

EMPLOYEES:

- You have the right to notify your employer or OSHA about workplace hazards. You may ask OSHA to keep your name confidential.
- You have the right to request an OSHA inspection if you believe that there are unsafe and unhealthful conditions in your workplace. You or your representative may participate in that inspection.
- You can file a complaint with OSHA within 30 days of retaliation or discrimination by your employer for making safety and health complaints or for exercising your rights under the *OSH Act*.
- You have the right to see OSHA citations issued to your employer. Your employer must post the citations at or near the place of the alleged violations.
- Your employer must correct workplace hazards by the date indicated on the citation and must certify that these hazards have been reduced or eliminated.
- You have the right to copies of your medical records and records of your exposures to toxic and harmful substances or conditions.
- Your employer must post this notice in your workplace.
- You must comply with all occupational safety and health standards issued under the *OSH Act* that apply to your own actions and conduct on the job.

EMPLOYERS:

- You must furnish your employees a place of employment free from recognized hazards.
- You must comply with the occupational safety and health standards issued under the *OSH Act*.

This free poster available from OSHA –
The Best Resource for Safety and Health

Free assistance in identifying and correcting hazards or complying with standards is available to employers, without citation or penalty, through OSHA-supported consultation programs in each state.

1-800-321-OSHA
www.osha.gov

OSHA 3165-12-06R

APPENDIX B – WASTE MANAGEMENT PLAN

Waste Management Plan
Middle River Complex
Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

April 2012

Michael Martin, P.G.
Regional Manager

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

ACRONYMS

CFR	*Code of Federal Regulations*
COMAR	Code of Maryland Regulation
EESH	Energy, Environment, Safety, and Health
HAZWOPER	hazardous waste operations
IDW	Investigation-derived waste
LMCPI	Lockheed Martin Corporation Properties, Inc.
Lockheed Martin	Lockheed Martin Corporation
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MRC	Middle River Complex
OERR	Office of Emergency Remedial Response
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
Tetra Tech	Tetra Tech, Inc.
TSD	treatment, storage, and disposal
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency

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Section 1
Purpose

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared this *Waste Management Plan* to address management of the potentially contaminated nature of the waste that will be generated as part of field investigations at the Lockheed Martin Middle River Complex (MRC) (Figure 1-1). Both solid- and liquid-waste will be generated and handled as investigation-derived waste (IDW). Following proper IDW procedures, the IDW generated will be collected in U.S. Department of Transportation- (USDOT)-approved steel drums, stored at a designated on-site location (considered a temporary satellite accumulation area), sampled for waste profiling and characterization and, once characterized, disposed of off-site at a Lockheed Martin-approved facility. The IDW generated during these field investigations will include but is not limited to soil, sediment, and water (surface, groundwater, purge and/or decontamination water).

A Tetra Tech geologist will be on-site for all MRC field activities. All work by any subcontractor will be directed by the Tetra Tech geologist and will fully comply with Maryland Department of Transportation (MDOT) and other local, state, and federal regulations, including the federal Resource Conservation Recovery Act, Toxic Substances Control Act, Occupational Safety and Health Administration (OSHA) regulation 1910.120, and Lockheed Martin's EROP-03 procedure. In addition, IDW will be handled in accordance with the U.S. Environmental Protection Agency (USEPA) guidance *Management of Investigation-Derived Wastes During Site Inspections* [USEPA Office of Emergency Remedial Response (OERR) directive 9345.3-02, May 1991].

This plan is organized as follows:

Section 2—Responsibilities and Training Requirements: Presents the requirements and responsibilities of Tetra Tech and their appointed subcontractor,

Section 3—Hazardous Waste Determinations: Briefly describes how the determination of waste characterization is completed, and

Section 4—Shipping Requirements: Details pre-shipment, shipping, and post-shipping requirements.

Section 5—Reporting Requirements: Details biennial reporting and waste minimization requirements.

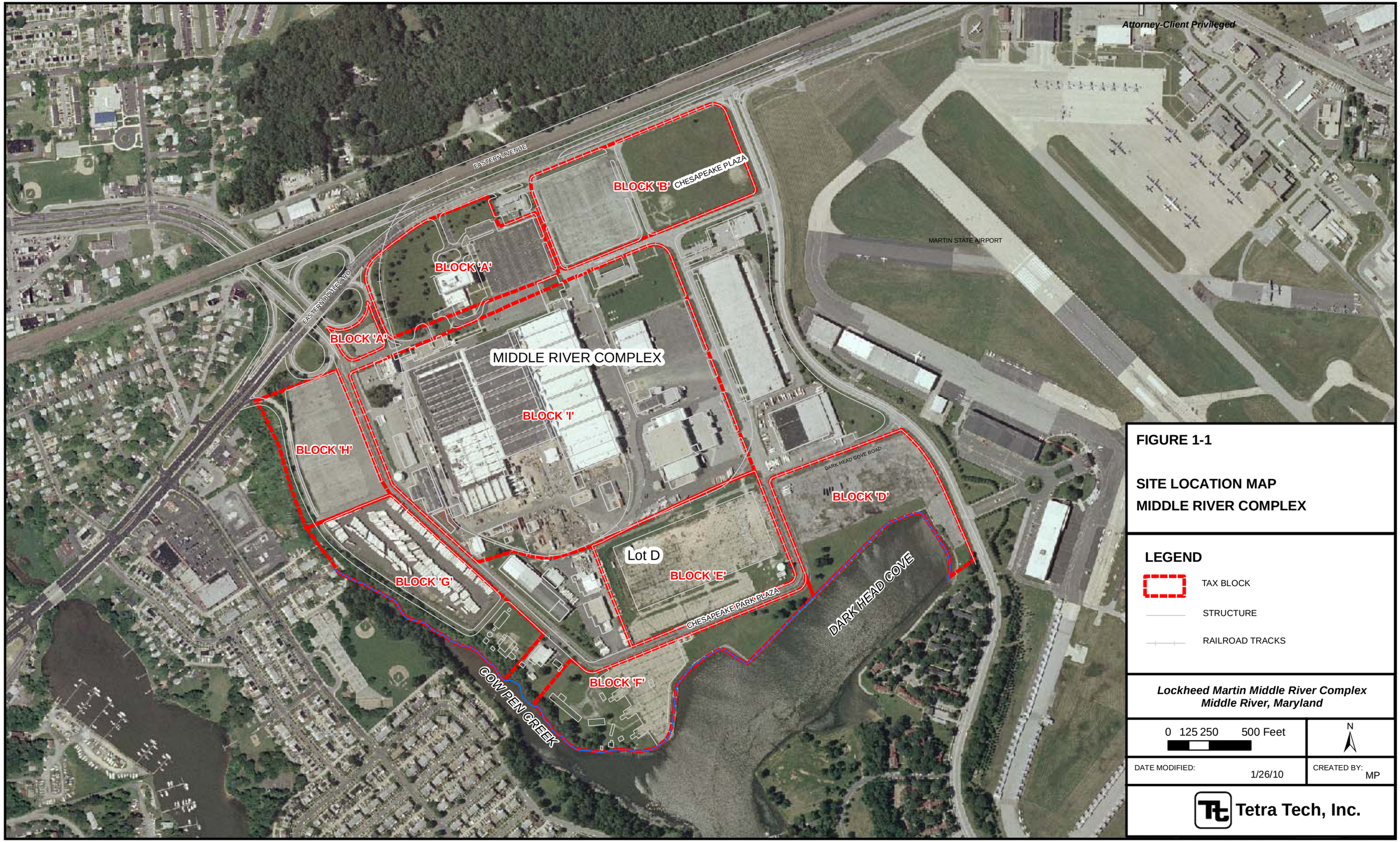

FIGURE 1-1

SITE LOCATION MAP
MIDDLE RIVER COMPLEX

LEGEND

- TAX BLOCK
- STRUCTURE
- RAILROAD TRACKS

Lockheed Martin Middle River Complex
Middle River, Maryland

0 125 250 500 Feet

N

DATE MODIFIED: 1/26/10

CREATED BY: MP

Tetra Tech, Inc.

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Section 2
Responsibilities and Training Requirements

All Tetra Tech personnel and subcontractors must be trained in accordance with all state and federal protocols. All personnel will complete the appropriate OSHA hazardous waste operations (HAZWOPER) training and annual refresher training, as specified in 29 *Code of Federal Regulations* (CFR) §1910.120. All subcontractor training certifications shall be provided electronically to the Lockheed Martin project lead. Certificates for Tetra Tech personnel are maintained internally and can be provided to Lockheed Martin upon request.

U.S. Department of Transportation HAZMAT Employee training is required for anyone involved in the shipment, preparation, offering for transport, and transportation of hazardous waste, including signing hazardous waste manifests (see 49 CFR 172, Subpart H). The waste management subcontractor will have completed HAZMAT employee training and will renew the training as necessary to meet USDOT requirements for transporting hazardous waste. Facilities that generate more than 1,000 kilograms per month of hazardous waste must comply with the emergency preparedness and personnel training requirements outlined in 40 CFR §265.16 (see 40 CFR §262.34(a)(4)). This training is intended for the waste generator's (i.e., Lockheed Martin) contractors (i.e., Tetra Tech) and includes training by a person qualified in hazardous waste management and emergency response procedures.

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Section 3
Hazardous Waste Determination and Process

Hazardous waste determinations shall be made in accordance with 40 CFR 262.11, combining process knowledge and/or analytical evaluation of waste samples. Hazardous waste determinations shall be reevaluated whenever any of the following occurs:

- the process that produces the waste changes (e.g. a new chemical constituent is discovered, the treatment process changes)
- the treatment media changes (e.g., new media vendor or media type)
- waste was tainted by inadvertent mixing with another waste
- a change occurs in the hazardous waste regulations

Waste generated during field investigations will include, but is not limited to, soil, sediment, water (surface, groundwater, purge, and/or decontamination water), and/or disposable personal protective equipment (PPE). PPE IDW will be brushed off, placed in trash bags, and disposed of in a facility trash receptacle designated by MRC personnel. IDW generated during field activities will be segregated into drums based upon historical data (as applicable), labeled to indicate the wells and/or locations from which the waste was generated, and the generation date. IDW generated during this activity will be further characterized and disposed of in accordance with the state regulations, unless state requirements are less stringent than federal requirements, in which case the federal requirements will apply.

When available, analytical data obtained during the investigations will be provided to the subcontractor for IDW classification (i.e., non-hazardous versus hazardous). IDW materials that will be generated at the MRC during future sampling events are not expected to be characterized as hazardous, since IDW generated during previous sampling events was classified as non-hazardous. All analytical data shall be presented to the IDW subcontractor for them to classify

the IDW generated from the field project. Based on the analytical data, the IDW subcontractor will determine whether additional IDW sampling is required to complete the waste profiles. If additional sampling is required for waste characterization parameters, Tetra Tech will schedule a site visit and oversee the sampling conducted by the IDW subcontractor.

Following receipt of the approved analytical data, the IDW subcontractor shall develop a waste profile. Waste profiles are to be sent to the Tetra Tech project manager for initial review. The Tetra Tech project manager will review them and forward the waste profile forms to the appropriate site contact. All forms related to IDW from the MRC will be signed and approved by Mr. Mike Musheno of Lockheed Martin Corporation Properties, Inc. (LMCPI) at the MRC.

The Waste Listing Assessment form is presented in Appendix A. The Tetra Tech project manager will complete this form as the first step in IDW classification/removal process. This form is the first notification and is presented to the managing contractor for review. The form presents pertinent information such as the project name, waste description, generation date, type, and classification information.

Lockheed Martin may choose to issue a Lockheed Martin Hazardous Waste Manifest Signatory Authorization Form (see Appendix B). This form authorizes a Lockheed Martin subcontractor to sign for the IDW. The authorization certifies that the representative signing on behalf of Lockheed Martin has completed the appropriate USDOT training (as delineated at 49 CFR Part 172, *et seq.*) to sign hazardous waste manifests and is in compliance with all state and federal requirements for hazardous waste manifesting. Lockheed Martin shall remain responsible and liable for the hazardous waste being disposed of, regardless of the signatory authorization on the form.

After Lockheed Martin or an authorized representative signs the waste profile forms, the IDW is scheduled for removal from the site. The Tetra Tech project manager will coordinate the IDW removal with the appropriate Lockheed Martin site contact. The Lockheed Martin site contact (or their authorized representative) shall be on-site to sign bills of lading (for non-hazardous IDW) or hazardous waste manifests (for hazardous IDW). Signed copies of the returned bills of lading and hazardous waste manifests will be kept on file for a minimum of three years. The signed documentation for transporting the waste off-site will be properly filed and available for review upon request.

Before IDW leaves the site, the Lockheed Martin site contact or their authorized representative will complete a waste shipment checklist. The Hazardous Material/Waste Shipment Checklist is presented in Appendix C for reference. Completion of the checklist assures that all protocols, standards, and requirements have been adhered to and the waste can be properly removed from the site. The checklist covers various items to ensure the truck is fitted with the proper waste placards, is properly constructed with double walled containment, and the waste manifests and bills of lading contain the proper information. IDW is removed from the site subsequent to the Lockheed Martin representative completing the checklist. Both the Lockheed Martin representative and the Tetra Tech geologist then receive a copy of the associated paperwork. Tetra Tech will record the drums on a master Drum Inventory form for each site (see Appendix D).

A Site Contact List is presented in Appendix E as a reference in case of an emergency, or if questions arise with regards to IDW disposal. The emergency contingency plan has been incorporated into the on-site health and safety plan and will comply with all current and applicable regulations and requirements including, but not limited, to OSHA 29 CFR 1903, 1904, 1910, and 1926. Lockheed Martin Corporation will be listed as the waste generator on all paperwork, including the waste profile sheets on which the generator was initially listed as “Middle River Complex.” The areas of Lockheed Martin investigations at MRC, including the “Tax Block” sites, are identified for purposes of waste disposal by USEPA ID number MDR000524413.

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Section 4
Shipping Requirements

4.1 PRE-SHIPMENT REQUIREMENTS

Waste generated during the field investigation will include, but is not limited to soil, sediment, and water (groundwater, surface, purge, and/or decontamination water). IDW generated during previous investigations has been characterized as non-hazardous. Pre-shipping requirements were discussed in detail in Section 3.0.

4.1.1 Packing

All waste materials will be collected in new or reconditioned USDOT-approved 55-gallon drums that will be sealed at the end of each day's sampling activities. Special consideration will be given to manage certain wastes (e.g., bentonite grout) separately from other IDW, to avoid increasing the volume of material that may be classified as hazardous due to elevated pH.

4.1.2 Labeling

Drums will be marked with the appropriate "Hazardous" or "Nonhazardous" labels containing the following information:

- **Site** will list the name of the site where waste was generated (i.e., Middle River Complex)
- **Location** will list the location where the waste was generated (i.e., well identification, soil boring, test pit, sediment and surface water location number)
- **Date** will include the date when waste materials accumulation began
- **Drum Number** will list the number of the drum in the series of drums from this sampling event
- **Contents** will list the waste that was generated (i.e., sediment, soil, and water)
- **Volume** will list an estimated volume not to exceed three quarters of the drum capacity and

- **Site Contact and Emergency Contact Information** will list the contact information for the designated authorized Lockheed Martin representative for the site and the telephone number of the local fire department.

4.1.3 Storing

Investigation derived waste storage areas will meet the following specifications to permit access to the drums and conduct spill/leak monitoring, sampling, and extraction (once the disposal route is determined):

- drums will be placed on a hard flat surface designated by the facility
- drum labels will be attached to each drum and will include the information presented in Section 4.1.2
- keep the retaining bolt and label readily visible on the outside of storage containers
- provide at least four feet between each row of pallets/drums to allow access to the containers for sampling, drum removal, and spill response
- maintain on-site a copy of work plans, waste disposal forms, and the IDW inventory list, and provide this information to the project manager at the end of each shift
- maintain spill response equipment at the site in case it is required
- whenever possible, use appropriate equipment for moving containers to avoid injury to the worker or damage to the container, when that is not possible, obtain help to manipulate containers
- Monitor and maintain all storage containers weekly to ensure that the containers remain in their original condition and that no leaks or spills have occurred. Weekly inspections should be documented in a dedicated field notebook and should include photographs of the containers and storage area.

The MRC's IDW drum storage area is on a flat concrete area in Lot D (Figure 4-1), inside the secured facility boundary. An alternate IDW storage area may be used to minimize transportation of drums on site, due to the dispersed nature of sampling locations throughout the MRC. MRC IDW storage areas will be determined by Lockheed Martin personnel at the start of field activities.

If any drums are classified as hazardous based on the waste characterization samples, the following additional measures will be instituted:

- A temporary spill containment system, constructed of polyethylene sheeting and 2-inch × 6-inch boards creating a bermed edge, will be placed under the drums to contain spilled or leaked materials. The dimensions of the temporary spill containment area will

depend on the number of 55-gallon drums at the site. For most jobs, the spill containment area is estimated to be 10-feet × 20-feet. Containment system integrity will be monitored periodically.

- The drums will be placed on self-containing plastic secondary containment pallets with four (or fewer) drums per pallet. Self-containing pallets will be stored on a hard flat surface covered with polyethylene sheeting. These pallets will be capable of containing the entire contents of one 55-gallon drum. All hazardous IDW drums will be stored on secondary containment until they can be removed from the site.
- Caution tape and/or temporary fencing will be placed around the drums to identify and secure the area.
- Signs will be posted in front of the IDW storage area identifying the site, location, collection date, number of drums, drum contents, volume of contents, site and emergency contact information, and the location of spill control materials for the wastes.
- Inform appropriate authorities/organizations of hazardous waste on-site and emergency response procedures. Identify the emergency coordinator and document emergency planning for the site.

Lockheed Martin has 90 days to remove the non-hazardous- and/or hazardous waste drums from the facility. Access for the subcontractor's representative and IDW transport carrier will be coordinated by Tetra Tech.

4.1.4 Material Identification and Classification

All waste materials shall be identified and classified per USDOT requirements.

4.1.5 Waste Shipment

Tetra Tech will subcontract all IDW removal to an approved vendor(s). In the event hazardous waste is encountered, Tetra Tech will ensure the use of Lockheed Martin Corporate Purchasing Agreements and the associated list of Corporate Approved Waste Management Vendors, to ensure that the waste is transported by an approved vendor to a treatment, storage, and disposal (TSD) facility listed on the Lockheed Martin Corporate Hazardous Waste Approved Vendors List. Non-hazardous waste shall be transported to an approved industrial waste disposal facility, but it does not have to be managed by corporate-approved waste management vendors. Attachment D is the Lockheed Martin Hazardous Waste Manifest Signatory Authorization Form, which must be filled out by the Lockheed Martin project lead in coordination with the Tetra Tech project manager if the IDW is hazardous.

4.1.5.1 Hazardous Waste Generator Identification Number

The Lockheed Martin USEPA identification number for hazardous waste generation at MRC is MDR000524413. All IDW will be removed from the site by a subcontractor adhering to the shipping requirements in Section 4.2.

4.2 SHIPPING REQUIREMENTS

United States Department of Transportation HAZMAT Employee training is required for anyone involved in shipment preparation, offering for transport, and transportation of hazardous waste, including signing hazardous waste manifests (see 49 CFR 172, Subpart H).

Certification and accuracy verification of the physical waste shipment against the manifested waste shipment must be provided. Non-hazardous materials do not require the signature of a USDOT HAZMAT trained individual. A bill of lading will be signed for all non-hazardous waste. A hazardous waste manifest will be signed for all hazardous waste.

For non-hazardous waste, Tetra Tech will use Lockheed Martin's Hazardous Material/Waste Shipment Checklist (see Appendix B) during the preparation and pre-transport review of waste shipments, and will submit a completed electronic copy to the Lockheed Martin project lead along with the shipping documentation. Detailed records of authorized work will be maintained by the subcontractor including:

- all manifests of waste transported to the approved off-site disposal facility
- receipts that the waste has been accepted by the approved treatment/disposal facility
- certification that the waste has been disposed of at the approved facility
- receipts that waste containers have been received by the approved disposal facility
- certification of the disposal of waste containers by the approved disposal facility
- weigh slips
- any other documentation required by local, state, or federal requirements

4.3 POST-SHIPMENT REQUIREMENTS

Records of waste characterization, chain of custody, transportation, and destruction will be scanned and electronically submitted to the Lockheed Martin project lead for records retention. This includes

profile sheets, the Hazardous Material/Waste Checklist, the generator's copy of the waste manifest, a copy of the signed TSD manifest, Land Disposal Restriction forms, and certificates of waste destruction (where applicable). All records of monitoring events will be submitted for each year's waste generation activities in the first quarter of the following year, or per the project lead's direction. The documentation noted above must be retained for three years. All documents should be properly stored and available for review upon request.

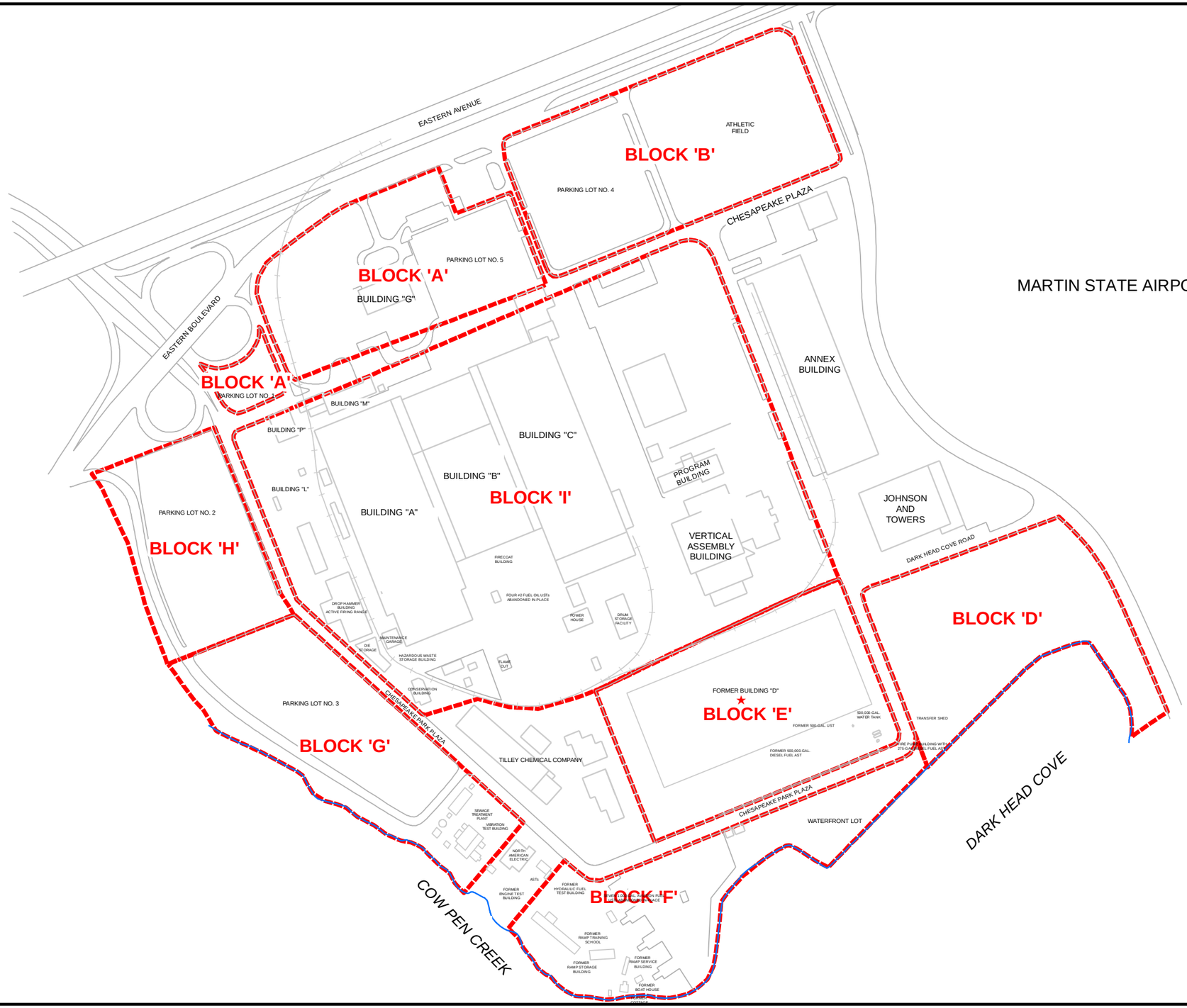

FIGURE 4-1
MIDDLE RIVER COMPLEX
INVESTIGATION DERIVED
WASTE STORAGE AREA

LEGEND

- ★ INVESTIGATION DERIVED WASTE STORAGE AREA
- TAX BLOCK
- STRUCTURE
- RAILROAD TRACKS

Lockheed Martin Middle River Complex
Middle River, Maryland

0 100 200 400 Feet

N

DATE MODIFIED: 02/17/2010

CREATED BY: BJ

Tetra Tech, Inc.

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Section 5
Reporting Requirements

5.1 BIENNIAL REPORTING REQUIREMENTS

The Code of Maryland Regulations (COMAR) 26.13.03.06B requires facilities that manage hazardous waste to file a Biennial Report once every two years which includes hazardous waste activity for the preceding calendar. Facilities are required to submit the Biennial Report, for a given site, if:

1. Either:
    a. They generate hazardous waste and ship it off-site to a facility in the United States; or
    b. They treat, store or dispose of hazardous waste on-site: and
2. They are regulated under Maryland's hazardous waste regulations by:
    a. Generating 220 pounds or more of hazardous waste, or more than 2.2 pounds of acute hazardous waste, in a calendar month; or
    b. Accumulating, art any time, more than 220 pounds of hazardous waste or more than 2.2 pounds of acute hazardous waste.

Guidance for completing the Biennial Report form is available at the Maryland Department of the Environment's (MDE) Biennial Report web page, which is available at http://www.mde.state.md.us/Programs/LandPrograms/Hazardous_Waste/home/index.asp.

The report must be completed and filed, typically by March 1 of even numbered years (e.g. 2010, 2012) with the:

Maryland Department of the Environment
Technical Services and Operations Program
1800 Washington Boulevard, Suite 610
Baltimore, Maryland 21230-1719

Before each report is filed, the Maryland hazardous waste regulations must be consulted to confirm or update regulatory thresholds.

5.2 WASTE MINIMIZATION

Hazardous waste generators, when preparing a manifest, are required to certify they have taken steps to minimize the volume and toxicity of hazardous waste generated. Waste minimization efforts are required under COMAR 26.13.03.06B(1)(d)(vi) to be reported on the Biennial Report submittal.

Efforts should be taken, to the degree economically practicable, to reduce the volume and toxicity of hazardous waste generated and a reasonable method of treatment, storage, or disposal should be selected which will minimize the present and future threat to human health and the environment.

APPENDIX A — WASTE IDENTIFICATION AND CLASSIFICATION FORM

Waste Identification and Classification Form

LMC Remediation Project		**State Generated**	
Description of Waste			
Generic Name		**Solid, Liquid, Gas**	
		Additional Info.	
Date of Waste Generation		**Ongoing (Y/N)?**	

Description of Process Generating Waste

Listed Waste ? (Y/N)		**F,K, P or U Codes, if applicable**	

Justification for Waste Classification (attach support documentation)

Completed by	
Company	
Date	

APPENDIX B — HAZARDOUS WASTE MANIFEST SIGNATURE AUTHORIZATION FORM

Lockheed Martin Hazardous Waste Manifest Signatory Authorization

This Authorization Agreement, effective for the remediation site and period of performance written below, is entered into by and between:

LOCKHEED MARTIN CORPORATION (hereinafter "Lockheed Martin"), having a business office at 6801 Rockledge Drive, Bethesda, Maryland 20817 USA, and incorporated in the State of Maryland, and

_____

(hereinafter "_____")

having a business office at_____

_____.

WHEREAS, _____ (company representative) of _____ (company) will sign Hazardous Waste Manifests on behalf of Lockheed Martin for the project and hazardous waste, as defined at 40 CFR Pt. 261 *et seq.* indicated below.

Remediation Site: _____
Site Address: _____
Period of Performance: _____
Hazardous Waste Description:
_____
_____
Hazardous Waste Disposal Facility and Location: _____
_____
_____

This Authorization Agreement certifies that the representative signing on behalf of Lockheed Martin has taken the appropriate Department of Transportation training, as delineated at 49 CFR Part 172 *t seq.* to sign Hazardous Waste Manifests and is in compliance with all state and federal requirements for hazardous waste manifesting.

Lockheed Martin shall remain responsible and liable for the hazardous waste being disposed regardless of the Signatory Authorization provided herein.

LOCKHEED MARTIN CORPORATION	_____
By:_____	By:_____
Name:_____	Name:_____
Title:_____	Title:_____
Date:_____	Date:_____

APPENDIX C —
HAZARDOUS MATERIAL/WASTE SHIPMENT CHECKLIST

Lockheed Martin Hazardous Material/Waste Shipment Checklist

Date:
Project Site Name:
Shipping Document No.:

A. DESCRIPTION

A1._____ UN/NA Identification Number, Proper Shipping Name, Hazard Class/Division Number, Packing Group
A2._____ Subsidiary hazard class(es) or division number(s), if any, in parenthesis
A3._____ Total Quantity of Material
A4._____ 24-Hour Emergency Phone Number and Response Information ERG No.: _____
A5._____ Page of Pages, *for multiple shipping papers/EPA Manifest/Air Decs.*
A6._____ Shipper's Certification, *as applicable*
A7._____ Small Quantity Exception/Dangerous Goods In Excepted Quantities/Diagnostic Specimen/Sample

B. ADDITIONAL DESCRIPTIONS - GENERAL

B1._____ Exemptions "DOT-E-*ex.#"*
B2._____ "Limited Quantity" (*not to exceed 66 lb gross weight*)
B3._____ "X" or "RQ" (if RQ, Hazardous Substance Contact @ 1-800-424-8802)
B4._____ "Waste" for RCRA regulated material
B5._____ "Mixture" or "Solution" - as appropriate.
B6._____ *(technical names), for poisons/mixtures/n.o.s./generic proper shipping names*
B7._____ "Marine Pollutant" and constituent in ( ), *for bulk shipments only*
B8._____ *(hazardous substance names) per 172.101 appendix if not contained in proper shipping name*
B9._____ *(EPA waste identification numbers)- used to identify the hazardous substance*
B10._____ "Poison" - *if not identified in proper shipping name or hazard class*
B11._____ "Poison-Inhalation Hazard" & Zone A, Zone B, Zone C, or Zone D, as appropriate*****
(*******Note Special Provisions 1-6 and 13 in Column 7 of 172.101)*

C. MARKING FOR NON-BULK PACKAGINGS

C1._____ Proper Shipping Name, UN/NA Identification Number
C2._____ (*technical name)*
C3._____ (*EPA waste identification number)*
C4._____ "RQ"
C5._____ Exemption Packagings "DOT-E-*ex.#*"
C6._____ Consignee's Name & Address
C7._____ Net or Gross quantity for non-rad Dangerous Goods (adjacent to PSN & UN#)
C8._____ Ltd. Qty - PSN only *per 172.301(a)(1) or* UN ID# placed in square-on-point border *per 172.315*
C9._____ Package Orientation Arrows, *for liquids in inner packagings*
C10._____ "Inhalation Hazard", unless these words appear on the label prescribed in *172.416* or *172.429*
C11._____ "Overpack" adjacent to proper shipping name marking [*see 173.25(a)(4)*]
C12._____ TSCA PCB Marking (*for actual or source concentration greater than or equal to 50 ppm **)
(* Note Potential Vehicle Marking Requirements in *40 CFR 761.40*)

D. MARKING FOR BULK PACKAGINGS (DUMP TRUCKS OR ROLL-OFFS)

D1._____ UN/NA Identification Number on orange panel or placard or white square-on-point display configuration as prescribed by 172.302 and 172.332

E. LABELING

E1._____ Primary Hazard Label(s): _____
E2._____ Subsidiary Hazard Label(s) with class/division: _____
E3._____ Hazardous Wastes Label(s)

F. PLACARDING

F1. 172.504 Table 1 Materials - Any Amount
F1.1._____ Dangerous When Wet (4.3)
F1.2._____ Poison (6.1, Inhalation Hazard, Zone A or B)***** (Primary or Subsidiary _____

*(*****Materials subject to the "Poison-Inhalation Hazard" notation must be placarded with a POISON INHALATION HAZARD or POISON GAS placard , as appropriate, and also placarded for any other hazard class required for that material in 172.504)*

F1.3._____ Radioactive (7, LSA/SCO Exclusive Use Shipments)

F2. 172.504 Table 2 Materials - 1,001 lb:

G. PACKAGING

G1._____ Container Type: (Inner Pkg)_____
G2._____ Container Type: (Outer Pkg)_____
G3._____ Container Type: (Bulk Pkg)_____
G4._____ Loaded and Closed As Required_____

H. PAPERWORK AND MISCELLANEOUS ITEMS

H1._____ Shipping Paper/Hazardous Waste Manifest/Bill of Lading/Airway Bill/Shipper's Declaration
H2._____ Instructions for Maintenance of Exclusive Use Shipments
H3._____ Small Quantity/Excepted Quantity Statement on Package, *for 173.4 shipments* / **DGEQ** statement per *2.7.7.2* noted on Airway Bill
H4._____ Photograph, *if applicable*
H5._____ Vehicle Inspection
H6._____ Check Driver's Qualifications
H7._____ Emergency Telephone Number Notification, if required, see 172.604(b)
H8._____ LMC Notification Instructions

I. ADDITIONAL REQUREMENTS FOR RADIOACTIVE MATERIAL SHIPMENTS

I1. SHIPPING PAPER DESCRIPTIONS
- I1.1.____ Radionuclide Symbol(s), *per 173.435*
- I1.2.____ Physical & Chemical Form, *if not special form*
- I1.3.____ Activity per Package
- I1.4 ____ Radioactive Labels
- I1.5.____ Fissile Excepted, *if applicable*
- I1.6.____ "Exclusive Use Shipment"

I2. MARKING FOR NON-BULK PACKAGINGS
- I2.1.____Gross Weight, *for radioactive material packages in excess of 110 lb*
- I2.2.____ "Radioactive"; "Radioactive – LSA" ; "Radioactive – SCO"
- I2.3.____ Package Certification Number, *for radioactive material packages, as appropriate*
- I2.4.____ IP-1, IP-2, IP-3 markings
- I2.5.____ "USA" on all IP and Type A packagings
- I2.6.____ Packaging manufacturer marking on Type A

I3. LABELING
- I3.1.____ Radioactive Labels
- I3.2.____ "EMPTY" Label
- I3.3.____ "Radioactive Material, Excepted Package" handling label

I4. PLACARDING (172.504 TABLE 1 MATERIALS - ANY AMOUNT)
- I4.1.____ Radioactive (7, LSA/SCO Exclusive Use Shipments)

I5. PAPERWORK AND MISCELLANEOUS ITEMS
- H1._____ Instructions for Maintenance of Exclusive Use Shipments
- H2._____ Radioactive Excepted Package statement per *10.8.8.3.3* on Airway Bill
- H3._____Limited Quantity Radioactive Material *for multiple hazard limited quantity Class 7*.
- H4._____Health Physics Information
- H5._____NRC Manifest #540 for radioactive waste shipment for land disposal.

Completed By: **Company:** **Date:**

APPENDIX D — DRUM INVENTORY FORM

Tetra Tech NUS, Inc.

DRUM INVENTORY

PROJECT NAME: **PROJECT NUMBER:**

CLIENT: **LOCATION:**

Tt NUS PERSONNEL: **DATE (START):**

IDW CONTRACTOR: **DATE (END):**

DRUM ID	GENERATION LOCATION	DATE GENERATED	AMOUNT (gal.)	STORAGE LOCATION	COMMENTS

COMMENTS: _____

APPENDIX E— SITE CONTACT SHEET

Site Contact List

1) Tom Ambrose: Facilities Supervisor: Office: 410-682-1308

2) Steve Thompson: Facilities Manager: Office: 410-682-1304

3) Scott Lapp: Maintenance: Office: 410-682-0365
Cell: 410-967-8745

4) Mike Musheno: ESH / Projects: Office: 484-875-2819

5) John Wells: Lead Facilities Electrician: Work: 410-682-1307

6) Tom McVickers: Facilities Electrician: Office: 410-682-1307

7) A&A Environmental / Spill Response: 1-800-404-8037

8) Tony Apanavage: Project Manager: Office: 1-301-528-3021
Cell: 1-301-233-8230

9) Michael Martin: Program Manager: Office: 1-301-528-3022
Cell: 1-410-707-5259

10) Baltimore County Police & Fire Department: 911

11) State of Maryland Emergency Response Center: (410-974-3551)

APPENDIX F— EESH REMEDIATION OPERATING PROCEDURE NO. EROP-03, EESH REMEDIATION WASTE MANAGEMENT

Subject: EESH Remediation Waste Management

Ref:
1. Code of Federal Regulations, Title 40, Parts 260, 261, 262, 264, 265, 268, 761, and 763
2. Code Federal Regulations, Title 49, Parts 100 through 180
3. Corporate Functional Procedure No: ESH-06
4. Corporate Functional Procedure No: ESH-08
4. Corporate Policy Statement 527

1.0 Purpose

This procedure establishes practices for management and transportation of solid and hazardous waste (waste in this context also refers to DOT hazardous materials) generated at remediation project sites in a manner that complies with Subtitle C of the. Resource Conservation and Recovery Act (RCRA), Department of Transportation (DOT) regulations, and similar state and/or host country waste regulations. Additionally, this procedure ensures waste disposal is managed in accordance with Corporate Functional Procedure ESH-06 and ESH-08, and records retained in accordance with Corporate Policy Statement 527.

2.0 Applicability

This procedure applies to the Energy, Environment, Safety and Health (EESH) Remediation Organization (the Organization) and to the remediation projects for which the Organization has waste management responsibility. Each member of the Organization, including IWTA, contractor staff and, where applicable, support organizations (e.g. Global Supply Chain Management), is responsible for execution of this procedure.

The materials to which this practice applies are solid wastes generated as a result of remediation project activities, including such things as investigation derived waste, environmental sampling, treatment of contaminated media, and routine operations and maintenance, unless such solid waste is exempt under applicable regulations.

3.0 Key National Agreement

Waste management requirements shall be included within the EESH Key National Agreements (KNA). The KNA establishes the requirements under which Remediation Contractors perform work for Lockheed Martin.

The KNA will stipulate that the Remediation Contractor shall comply with Lockheed Martin waste management, transportation, and disposal requirements and all applicable state, federal, and/or host country laws and regulations.

4.0 Statement of Work Requirements

4.1 Waste Management Plan

All remediation project statements of work that include the generation of solid waste, excluding office trash (e.g. food wastes, consumer packaging) that may be disposed of at a municipal solid waste facility, shall include a requirement for the waste management contractors (i.e. Remediation Contractors and/or Corporate Approved Waste Management Vendors) to submit a waste management plan to Lockheed Martin. A site specific waste management plan shall be prepared that identifies all potential solid waste streams that may reasonably be expected to be generated or discovered during project activities. The plan will address the required elements listed below; however, if the waste is determined to be non-hazardous following completion of Element A, then only the additions of Elements D and E are required.

Element A) Hazardous Waste Determination

i) Listing assessment (See Attachment #1 – Waste Listing Assessment Form)
ii) Characteristic determination

Hazardous waste determinations shall be made in accordance with 40 CFR 262.11 using a combination of process knowledge and/or analytical evaluation of waste sampling. Hazardous waste determinations shall be reevaluated whenever any of the following circumstances occur:

- A change in the process that produces the waste (e.g. a new chemical constituent is discovered, the treatment process changes);
- A change in the treatment media is made (e.g. new media vendor or media type);
- A waste was tainted by inadvertent mixing with another waste; or
- A change occurred to the hazardous waste regulations that apply to that waste.

Characteristic waste determinations based on analytical sampling shall be reevaluated at some reasonable frequency to verify the accuracy of the initial waste determination. The waste determination reevaluation frequency for ongoing remediation or treatment operations should be specified in the waste management plan and be profiled at least once a year.

Element B) Responsibilities and Training Requirements

i) Contractor staff responsibilities with regard to waste management and training requirements necessary to comply with Section 6.0 and all state, federal, and/or host country laws and regulations. Contractor training certifications shall be provided electronically to the Lockheed Martin Project Lead.

Element C) Pre-Shipment Requirements

i) Material identification and classification per DOT requirements
ii) Packaging, storage, segregation, marking, labeling, and accumulation of waste
iii) Waste shipment documentation
    (1) Hazardous Waste Generator Identification Number

iv) Hazardous Material Transportation Plan
   (1) Hazardous material transportation risk identification, prioritization, and mitigation plan
   (2) Emergency Response (material information to be provided with shipments, actions to be taken in the event of an incident, staffing the emergency response phone number)
   (3) Hazmat Security Plan (as required based on thresholds outlined in 49 CFR §172.800)
   (4) Transportation and disposal logistics

Lockheed Martin Project Leads shall ensure the use of the Lockheed Martin Corporate Purchasing Agreements and the associated Corporate Approved Waste Management Vendors (WMV) for hazardous waste management and ensure that waste is transported to a treatment, storage, and disposal (TSD) facility on the Lockheed Martin Corporate Hazardous Waste Approved Vendors List as outlined in the ESH-06. Remediation contractors can contract directly with the WMV.

Additionally, hazardous waste manifests shall be signed only by a DOT trained and qualified Lockheed Martin employee or authorized designee (See Attachment #2 – Hazardous Waste Manifest Authorization Form). In addition to completing the Authorization Form, Project Leads shall verify that the designee is DOT trained and qualified to sign manifests and has adequate DOT experience. It is preferable to have contractors designated to sign that are involved in the waste characterization and oversight. For contractor personnel handling hazardous waste, appropriate hazardous waste handling training shall be provided by the contractor as outlined in Section 6.0 and complying with all state, federal, and/or host country laws and regulations.

Non-hazardous waste is not required to be managed by Corporate Approved Waste Management Vendors but shall be transported to an approved industrial waste disposal facility as outlined in ESH-06.

Within the United States, waste shall be characterized and disposed in accordance with the state regulations where it was generated unless the state requirements are less stringent than the federal requirements. For instance, California non-RCRA hazardous waste cannot be disposed of in a non-hazardous waste facility. Within a host country, waste shall be managed in accordance with the host country regulations; however, if the host country standards are less stringent than those of the US Environmental Protection Agency (EPA), than the EPA standards shall apply.

Element D) Shipping Requirements

i) Manifest certification and accuracy verification of physical waste shipment against manifested waste shipment (for non-hazardous waste this may not be applicable)
   (1) For hazardous waste, the contractor responsible for waste shipment shall utilize the Lockheed Martin Hazardous Material/Waste Shipment Checklist (see Attachment #3) during the preparation and pre-transport review of waste shipments and submit a completed electronic copy to the Lockheed Martin Project Lead with the shipping documentation.

ii) For non-specification bulk containers (e.g. dump trucks and roll-offs), the contractor responsible for waste shipment shall adhere to the Lockheed Martin requirements for packing and closing (see Attachment #4). These requirements are meant to supplement the applicable regulations.

Element E) Post Shipment Requirements - Records

i) Waste characterization, chain of custody, transportation, and destruction records shall be scanned and electronically submitted to the Lockheed Martin Project Lead for records retention. This shall include profile sheets, the Hazardous Material/Waste Checklist, the generator copy of the waste manifest, a copy of the TSD signed waste manifest, Land Disposal Restriction forms, and certificates of waste destruction where applicable. For finite-duration remediation projects, waste transportation and disposal records shall be submitted to the project lead at the completion of the project unless submittals are required by regulatory agencies on a more frequent basis. For recurring remediation project activities such as annual groundwater monitoring or groundwater treatment, these records shall be submitted for each year's waste generation activities in the first quarter of the following year or per the Project Lead's direction.

The waste management plan shall be submitted in a phased approach. The first section of the waste management plan will provide the hazardous listing assessment and the characteristic determination methodology (addressing Element A). This section of the plan shall be submitted in a timeframe that allows for Lockheed Martin's review prior to waste generation. Upon approval to proceed, the second section will document the waste profiling results and must be signed off on by a Lockheed Martin Project Lead. Additionally, it shall outline the logistics for waste handling, transportation and disposal (addressing Elements B through E). This section of the plan shall specify a reevaluation frequency for waste generated as a result of ongoing remediation or treatment operations.

Following the approval of the second section by the Lockheed Martin Project Lead, the waste management contractor shall implement the waste management plan. This plan shall be updated when the remedial treatment system process, waste stream, media, or regulations change.

4.2 Health and Safety Plan

For remediation sites managing waste, a section shall be included in the site Safety and Health Plan to address the safety and health requirements for managing the site specific waste.

4.3 Electronics and Scrap Metal Recycling

Where applicable and feasible, electronics and scrap metals shall be recycled or refurbished to the extent possible in accordance with ESH-06.

5.0 Responsibilities

5.1 Project Lead

The Project Lead shall:

- Ensure that all remediation projects for which they have responsibility have a waste management plan as outlined in Section 4.0. Review and ensure updates are completed as necessary. Plans must also be submitted to the Records Manager for upload to the Document Management System (DMS).

- Consult with Corporate EESH Legal as needed to verify the listing determination.

- Ensure that the Contractor has outlined the applicable training requirements and provided a training plan or statement of completion within the waste management plan.

- Verify that the site has a Hazardous Waste Generator Identification Number prior to hazardous waste shipments, where applicable.

- Ensure that all hazardous waste manifests are signed and certified by a Lockheed Martin employee or authorized designee. For non-hazardous waste, there are no signatory requirements for waste manifests.

- Ensure that non-hazardous or hazardous waste is shipped to an approved facility per ESH-06 and that the Corporate Approved Waste Management Vendors are being used for hazardous waste transportation, storage, and/or disposal services.

- Ensure receipt of the waste characterization, chain of custody, transportation, and destruction records, where applicable, and submit them to the Records Manager for upload to the DMS.

- Ensure that the required regulatory and state hazardous waste reports are submitted (e.g. biennial waste reports).

5.2 Remediation Global Supply Chain Management Representative

The Global Supply Chain Representative shall:

- Ensure that the KNA includes the requirements defined in Section 3.0.

- Send the Remediation Contractors an updated version of the approved non-hazardous facility list quarterly.

- Send the Corporate Approved Waste Management Vendors an updated version of the Lockheed Martin Corporate Hazardous Waste Approved Vendors List quarterly.

5.3 Corporate EESH Legal

The Corporate EESH Legal Counsel shall:

- Provide the Project Lead with support when making listed waste determinations.
- Notify the Project Leads of regulation changes that would affect prior listing determinations.

6.0 Training Requirements

The EESH remediation staff training requirements are summarized in Table 1.

6.1 RCRA Hazardous Waste Handling and Emergency Procedures

RCRA Generator Status Facilities
Generators who generate more than 1,000 kg/month of hazardous waste (or more than 1 kg/month of acutely hazardous waste) must comply with the emergency preparedness and personnel training requirements outlined in 40 CFR §265.16 (see 40 CFR §262.34(a)(4)). This training is intended for all facility personnel including the generator's contractors and includes training by a qualified person on hazardous waste management and emergency response procedures. Personnel shall receive an annual refresher. Project Leads are responsible for ensuring this training is provided to contractor staff on remediation projects that meet this generator criterion. Contractor personnel training records must also be maintained by the Project Lead.

"Small quantity generators" who generate greater than 100 kg but less than 1000 kg/month of hazardous waste, must comply with the emergency preparedness and personnel training requirements at 40 CFR §262.34(d)(5). These generators "must ensure that all employees are thoroughly familiar with proper waste handling and emergency procedures, relevant to their responsibilities during normal facility operations and emergencies" (40 CFR §262.34 (d)(5)(iii)). Project Leads shall ensure that all contractor staff has had the appropriate hazardous waste handling and emergency procedure training on remediation projects that meet this generator criterion.

Federal training requirements do not apply to remediation projects that generate less than 100 kg/month of hazardous waste. However, Project Leads shall ensure that the contractor staff is familiar with hazardous waste handling and emergency procedure training appropriate for waste management.

RCRA Permitted or Interim Status Facilities
Permitted or interim status facilities must follow training requirements in accordance with 40 CFR §264.16 and 40 CFR §265.16, respectively (the same requirements apply as outlined in the first paragraph under Section 6.1).

Additional training may be required by state and/or host country hazardous waste regulations. Any such additional training shall be verified and implemented by the Project Lead.

6.2 Department of Transportation Training

Department of Transportation (DOT) Hazmat Employee training is required for a person involved in shipment preparation, offering for transport and transportation of hazardous waste, including signing of hazardous waste manifests (see 49 CFR 172, Subpart H). All Lockheed Martin Remediation representatives, designees, and/or waste management contractors shall complete the hazmat employee training and renew the training as necessary to meet DOT requirements for hazardous waste transportation.

6.3 OSHA HAZWOPER Training

All contractors working on Lockheed Martin remediation sites shall complete the appropriate OSHA hazardous waste operations (HAZWOPER) training and annual refresher training specified in 29 CFR §1910.120. Lockheed Martin employees managing projects where hazardous waste is generated shall complete the 24 hour OSHA HAZWOPER training and annual refresher training.

7.0 Deviations

All deviations from this procedure must have prior approval by the Director of Environmental Remediation. The approval shall be documented and uploaded to the DMS.

Table 1

EESH Remediation Staff Waste Management Training Matrix			
Function	Task	Training Required	Requirements
EESH Remediation Employees (including IWTA and managing contractor staff (where the task description matches responsibilities))	Completing / Approving Waste Determinations	RCRA Generator Training	Refresher every 5 years
	Managing Remediation Sites where Hazardous Waste is Generated	OSHA HAZWOPER 24 HR	8 hr refresher annually
	Managing Hazardous Waste Shipments	DOT HazMat Certification (see Table 2)	Refresher every 3 years

The Lockheed Martin Project Lead shall update the Remediation Waste Management Training Matrix located on the Remediation Process Asset Library once training has occurred. All training and certification documentation will reside on the Remediation DMS under Training Records.

Table 2

EESH Remediation Staff DOT Requirements for Hazmat Employees	
Requirement	**Completion Method**
General Awareness [49 CFR 172.704(a)(1)]	• Vendor (e.g. Lions) provided Hazardous Materials Transportation Workshop • DOT OJT (taught by EESH DOT SME)
Function-Specific [49 CFR 172.704(a)(2)]	• Vendor (e.g. Lions) provided Hazardous Materials Transportation Workshop • DOT OJT (taught by EESH DOT SME)
Safety [49 CFR 172.704(a)(3)]	• Vendor (e.g. Lions) provided Hazardous Materials Transportation Workshop • DOT OJT (taught by EESH DOT SME) • Hazwoper 24 Hour Training • Site specific safety training [NOTE: This element of safety training may be fulfilled through completing any one (1) of the following three (3) options which provides the required site specific safety information: 1) Site Safety Plan Review, 2) Site HazCom/ General Employee Training or 3) Site Visitor Safety Briefing/Training. The source of the training must be entered as part of the information on the test which is administered for site specific safety training.]
Security Awareness [49 CFR 172.704(a)(4)]	• Vendor (e.g. Lions) provided Hazardous Materials Transportation Workshop • DOT OJT (taught by EESH DOT SME) • Site specific security awareness training [NOTE: This element of security awareness training may be fulfilled through completing any one (1) of the following three (3) options which provides the required site specific security information: 1) Site Security Plan Review, 2) Site HazCom/General Employee Training or 3) Site Visitor Security Briefing/Training. The source of the training must be entered as part of the information on the test which is administered for site specific security training.]
In-Depth Security (Hazmat Security Plan) Only applicable when haz material/waste meets certain class and volume thresholds (reference Section 4.1, Element C, iv, 4) [49 CFR 172.704(a)(5)]	• Site Hazmat Transportation Security Plan Training

The EESH DOT SME will certify EESH Remediation staff members as DOT Hazmat Employees on behalf of Lockheed Martin once training and safety and security tests have been completed.

Attachment #1

Waste Listing Assessment Form

Waste Listing
Assessment Form

Attachment #2

Hazardous Waste Manifest Signature Authorization Form

Designee
Authorization Form

Attachment #3

Hazardous Material/Waste Shipment Checklist

Hazardous Material/
Waste Shipment Che

Attachment #4

Non-Specification Bulk Container Packing and Closing Instructions

Non-Specification
Bulk Container Packin

Waste Identification and Classification Form

LMC Remediation Project		**State Generated**	
Description of Waste			
Generic Name		**Solid, Liquid, Gas**	
		Additional Info.	
Date of Waste Generation		**Ongoing (Y/N)?**	

Description of Process Generating Waste

Listed Waste ? (Y/N)		**F,K, P or U Codes, if applicable**	

Justification for Waste Classification (attach support documentation)

Completed by	
Company	
Date	

Lockheed Martin Hazardous Waste Manifest Signatory Authorization

This Authorization Agreement, effective for the remediation site and period of performance written below, is entered into by and between:

LOCKHEED MARTIN CORPORATION (hereinafter "Lockheed Martin"), having a business office at 6801 Rockledge Drive, Bethesda, Maryland 20817 USA, and incorporated in the State of Maryland, and

_____

(hereinafter "_____")

having a business office at_____

_____.

WHEREAS, _____ (company representative) of _____ (company) will sign Hazardous Waste Manifests on behalf of Lockheed Martin for the project and hazardous waste, as defined at 40 CFR Pt. 261 *et seq.* indicated below.

Remediation Site: _____
Site Address: _____
Period of Performance: _____
Hazardous Waste Description:
_____
_____
Hazardous Waste Disposal Facility and Location: _____
_____
_____

This Authorization Agreement certifies that the representative signing on behalf of Lockheed Martin has taken the appropriate Department of Transportation training, as delineated at 49 CFR Part 172 *t seq.* to sign Hazardous Waste Manifests and is in compliance with all state and federal requirements for hazardous waste manifesting.

Lockheed Martin shall remain responsible and liable for the hazardous waste being disposed regardless of the Signatory Authorization provided herein.

LOCKHEED MARTIN CORPORATION	_____
By:_____	By:_____
Name:_____	Name:_____
Title:_____	Title:_____
Date:_____	Date:_____

Lockheed Martin Hazardous Material/Waste Shipment Checklist

Date:
Project Site Name:
Shipping Document No.:

A. DESCRIPTION

A1._____ UN/NA Identification Number, Proper Shipping Name, Hazard Class/Division Number, Packing Group
A2._____ Subsidiary hazard class(es) or division number(s), if any, in parenthesis
A3._____ Total Quantity of Material
A4._____ 24-Hour Emergency Phone Number and Response Information ERG No.: _____
A5._____ Page of Pages, *for multiple shipping papers/EPA Manifest/Air Decs.*
A6._____ Shipper's Certification, *as applicable*
A7._____ Small Quantity Exception/Dangerous Goods In Excepted Quantities/Diagnostic Specimen/Sample

B. ADDITIONAL DESCRIPTIONS - GENERAL

B1._____ Exemptions "DOT-E-*ex.#"*
B2._____ "Limited Quantity" (*not to exceed 66 lb gross weight*)
B3._____ "X" or "RQ" (if RQ, Hazardous Substance Contact @ 1-800-424-8802)
B4._____ "Waste" for RCRA regulated material
B5._____ "Mixture" or "Solution" - as appropriate.
B6._____ *(technical names), for poisons/mixtures/n.o.s./generic proper shipping names*
B7._____ "Marine Pollutant" and constituent in ( ), *for bulk shipments only*
B8._____ *(hazardous substance names) per 172.101 appendix if not contained in proper shipping name*
B9._____ *(EPA waste identification numbers)- used to identify the hazardous substance*
B10._____ "Poison" - *if not identified in proper shipping name or hazard class*
B11._____ "Poison-Inhalation Hazard" & Zone A, Zone B, Zone C, or Zone D, as appropriate*****
(*******Note Special Provisions 1-6 and 13 in Column 7 of 172.101)*

C. MARKING FOR NON-BULK PACKAGINGS

C1._____ Proper Shipping Name, UN/NA Identification Number
C2._____ (*technical name)*
C3._____ (*EPA waste identification number)*
C4._____ "RQ"
C5._____ Exemption Packagings "DOT-E-*ex.#*"
C6._____ Consignee's Name & Address
C7._____ Net or Gross quantity for non-rad Dangerous Goods (adjacent to PSN & UN#)
C8._____ Ltd. Qty - PSN only *per 172.301(a)(1) or* UN ID# placed in square-on-point border *per 172.315*
C9._____ Package Orientation Arrows, *for liquids in inner packagings*
C10._____ "Inhalation Hazard", unless these words appear on the label prescribed in *172.416* or *172.429*
C11._____ "Overpack" adjacent to proper shipping name marking [*see 173.25(a)(4)*]
C12._____ TSCA PCB Marking (*for actual or source concentration greater than or equal to 50 ppm **)
(* Note Potential Vehicle Marking Requirements in *40 CFR 761.40*)

D. MARKING FOR BULK PACKAGINGS (DUMP TRUCKS OR ROLL-OFFS)

D1._____ UN/NA Identification Number on orange panel or placard or white square-on-point display configuration as prescribed by 172.302 and 172.332

E. LABELING

E1._____ Primary Hazard Label(s): _____
E2._____ Subsidiary Hazard Label(s) with class/division: _____
E3._____ Hazardous Wastes Label(s)

F. PLACARDING

F1. 172.504 Table 1 Materials - Any Amount
F1.1._____ Dangerous When Wet (4.3)
F1.2._____ Poison (6.1, Inhalation Hazard, Zone A or B)***** (Primary or Subsidiary _____

*(*****Materials subject to the "Poison-Inhalation Hazard" notation must be placarded with a POISON INHALATION HAZARD or POISON GAS placard , as appropriate, and also placarded for any other hazard class required for that material in 172.504)*

F1.3._____ Radioactive (7, LSA/SCO Exclusive Use Shipments)

F2. 172.504 Table 2 Materials - 1,001 lb:

G. PACKAGING

G1._____ Container Type: (Inner Pkg)_____
G2._____ Container Type: (Outer Pkg)_____
G3._____ Container Type: (Bulk Pkg)_____
G4._____ Loaded and Closed As Required_____

H. PAPERWORK AND MISCELLANEOUS ITEMS

H1._____ Shipping Paper/Hazardous Waste Manifest/Bill of Lading/Airway Bill/Shipper's Declaration
H2._____ Instructions for Maintenance of Exclusive Use Shipments
H3._____ Small Quantity/Excepted Quantity Statement on Package, *for 173.4 shipments* / **DGEQ** statement per *2.7.7.2* noted on Airway Bill
H4._____ Photograph, *if applicable*
H5._____ Vehicle Inspection
H6._____ Check Driver's Qualifications
H7._____ Emergency Telephone Number Notification, if required, see 172.604(b)
H8._____ LMC Notification Instructions

I. ADDITIONAL REQUREMENTS FOR RADIOACTIVE MATERIAL SHIPMENTS

I1. SHIPPING PAPER DESCRIPTIONS
- I1.1.____ Radionuclide Symbol(s), *per 173.435*
- I1.2.____ Physical & Chemical Form, *if not special form*
- I1.3.____ Activity per Package
- I1.4 ____ Radioactive Labels
- I1.5.____ Fissile Excepted, *if applicable*
- I1.6.____ "Exclusive Use Shipment"

I2. MARKING FOR NON-BULK PACKAGINGS
- I2.1.____Gross Weight, *for radioactive material packages in excess of 110 lb*
- I2.2.____ "Radioactive"; "Radioactive – LSA" ; "Radioactive – SCO"
- I2.3.____ Package Certification Number, *for radioactive material packages, as appropriate*
- I2.4.____ IP-1, IP-2, IP-3 markings
- I2.5.____ "USA" on all IP and Type A packagings
- I2.6.____ Packaging manufacturer marking on Type A

I3. LABELING
- I3.1.____ Radioactive Labels
- I3.2.____ "EMPTY" Label
- I3.3.____ "Radioactive Material, Excepted Package" handling label

I4. PLACARDING (172.504 TABLE 1 MATERIALS - ANY AMOUNT)
- I4.1.____ Radioactive (7, LSA/SCO Exclusive Use Shipments)

I5. PAPERWORK AND MISCELLANEOUS ITEMS
- H1._____ Instructions for Maintenance of Exclusive Use Shipments
- H2._____ Radioactive Excepted Package statement per *10.8.8.3.3* on Airway Bill
- H3._____Limited Quantity Radioactive Material *for multiple hazard limited quantity Class 7*.
- H4._____Health Physics Information
- H5._____NRC Manifest #540 for radioactive waste shipment for land disposal.

Completed By: **Company:** **Date:**

PACKING AND CLOSING INSTRUCTIONS FOR NON-SPECIFICATION BULK CONTAINERS (DUMP TRUCKS AND ROLL-OFFS) 04/10/2009

PRELIMINARY TASKS

- Select the transport container based on the Department of Transportation hazard classification and the packaging requirements specified in the Hazardous Materials Table.
- Perform moisture evaluation of waste material to be loaded into transport containers to determine the potential for releasing liquid.

PREPARATION OF BULK CONTAINERS FOR LOADING

- Transport containers must be inspected for any condition that may affect their safety or performance prior to each use.
- Dump trucks and roll-offs with doors must have gaskets installed at the tailgate or doors that when the tailgate or doors are closed the gasket is compressed sealing the tailgate or doors to assure package integrity and containment of materials. The gasket must be inspected prior to each use for overall integrity including positioning, damage such as holes or tears or debris which could prevent tight closure. Any deficiencies shall require replacement prior to use.
- An absorption pad shall be placed in the truck or roll-off bed. The pad specification shall be determined utilizing the data determined in the waste material moisture evaluation and must be capable of absorbing the liquid which could be released.
- An absorption log at the rear of the transport container along the bottom of the tailgate or rear doors.
- A minimum 6 mil poly liner shall be placed over the absorption pad and absorption log prior to loading.
- Determine the amount of waste that can be loaded into the transport container. (Subtract the unladen weight of the transport vehicle from the maximum licensed weight of the transport vehicle. NOTE: Do not load the maximum permissible load determined in the mathematical calculation to allow for variance in scales that may be utilized to weigh the loaded vehicle.)

LOADING AND CLOSING BULK CONTAINERS

- Waste material shall be loaded into the transport container in such a manner that does not compromise either the liner or container integrity.
- Do not load material above the height of the sides of the transport container.
- Close the poly liner over of the waste material prior to tarping the load.
- Close the transport container by putting a heavy roll tarp over the top of the transport container and secure the tarp by utilizing tie downs on all four sides.

APPENDIX C – RADIOLOGICAL SCREENING, SAMPLING, AND PROTECTION PROCEDURES

APPENDIX C - RADIOLOGICAL SCREENING, SAMPLING, AND PROTECTION PROCEDURES
SEDIMENT REMEDY DESIGN INVESTIGATION
MIDDLE RIVER COMPLEX, MIDDLE RIVER, MARYLAND

This appendix describes the technical approach and methodology that will be used to perfromr radiological field screening during sediment sampling to be conducted as part of the 2013 sediment remedy design investigation at Middle River Complex (MRC), Middle River, Maryland. Based on the MRC history described in Section 2.0 of the MRC *Sediment Remedy Design Investigation Work Plan* (Tetra Tech, Inc., [Tetra Tech] 2013), radionuclides of concern for this scope of work are isotopic uranium and thorium.

C.1 FIELD SCREENING

Radiological field screening of personnel and equipment will be performed during sediment coring and sampling near MRC stormwater outfall 005 (at two locations) and outfall 008, which are part of storm drain systems that convey stormwater runoff to Dark Head Cove from former Building D. Isotopic uranium and thorium were used as part of past research and development activities in former Building D (Tetra Tech, 2013).

C1.1 Determination of Background Screening Levels

Prior to starting the survey, a reference background level for sediment will be established. Eight background measurements will be collected in a tidal creek separate from Dark Head Cove, Cow Pen Creek, and Dark Head Creek. The measurements will be collected from sediments with similar characteristics, in an area without a history or suspicion of radiological use or impacts. The tidal channel located east of MRC and the Hawthorne community peninsula have been selected for background determination. Sampling locations will be determined in the field. Two cores in the background area will be advanced to 52 inches below the sediment surface and four sample depths per core location will be screened. The background will be determined by holding the detector 15 centimeters (six inches) above the surface of sediment samples collected at depth intervals of 0-6 inches, 6-18 inches, 18-30 inches, and 30-52 inches (at each of two cores) and performing a 1-minute integrated count. This average background will be used in the calculation of the minimum detectable activity.

C1.2 Determination of Minimum Detectable Count Rate

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides a method for calculating the minimum count rate, above background, that is detectable by scanning with a given level of performance (United States Environmental Protection Agency [USEPA] et al., 2000). This minimum detectable count rate (MDCR) is calculated as shown below:

$$MDCR = d' \sqrt{b_i} \times \left(60 / i \right)$$

where d′ is the index of sensitivity that represents the distance between the means of the background and background plus signal, and b_i is the number of average background counts during the observation interval "*i*". Values of d′ are obtained from Table 6.5 of MARSSIM. For a performance level with 95% true positives and 20% false positives, d′ is 2.48. For typical survey speeds, an observation interval of one second is used.

When detection depends on the ability of the surveyor to recognize events above the minimum count rate, the surveyor efficiency must be taken into consideration, and the $MDCR_{surveyor}$ is calculated as follows:

$$MDCR_{surveyor} = \frac{MDCR}{\sqrt{p}}$$

where p is the surveyor efficiency. Typically, a 0.5 value for p is selected. In this study, values of 2.48 and 0.5 will be used for d′ and p, respectively.

As an example, if the average background count in the observation interval (b_i) is equal to 9433 cpm, the index of sensitivity (d′) is equal to 2.48, and the surveyor efficiency is 0.5, then:

$$9433 \text{ cpm} \div 60 \text{ seconds per minute} = 157.22 \text{ cps}$$

and

$$MDCR = 2.48 \times \sqrt{157.22} \times 60 \text{ seconds per minute} = 1866$$

then

$$MDCR \text{ surveyor} = 1866 \div \sqrt{0.5} = 2639 \text{ cpm}$$

which corresponds to a gross count rate of:

$$9433\ \text{cpm} + 2639\ \text{cpm} = 12072\ \text{cpm}$$

A gross count rate of 12,072 cpm indicates that, with a 95% true positive and 20% false positive certainty, radioactive activity is present above background.

C1.3 Survey Procedure

Sediment cores will be screened directly using a hand-held instrument that detects alpha and beta contamination. The detector will use a scan rate of approximately 0.5 meters per second, and the detector will be positioned approximately 15 centimeters (six inches) above the surface of the sediment core. . Removable contamination will be assessed using the hand-held instrument to monitor survey media (disk smears and/or large area Masslin wipes). Actions levels for alpha and beta contamination will be based on Regulatory Guide 1.86 (Atomic Energy Commission [AEC] 1974) guidance (see Table C-1) for total and removable contamination. Work areas will also be monitored for radiation using a hand-held dose rate meter, using similar methods to those described above.

Information regarding the instruments that will be used in the field is listed in Table C-2. Instruments will be checked for operability prior to use in accordance with Tetra Tech *Radiological Protection Operating Procedures* included as Attachment A of this appendix. Daily operability checks will confirm that action levels are detectable and not below MDCR for each instrument. All survey results will be documented on radiological survey forms. Any location having detector readings that exceed the appropriate action level will be marked and/or posted and documented using a global positioning system device. Anomalous readings will also be noted on the survey map, in accordance with Tetra Tech *Radiological Protection Operating Procedures* (Attachment A).

C.2 SEDIMENT SAMPLING

Background sediment samples will be collected to assess levels of naturally–occurring radioactivity present in non-impacted soils. Four sediment samples will be collected from a tidal creek separate from Dark Head Cove, Cow Pen Creek, and Dark Head Creek. The samples will be collected from sediments with similar characteristics, and in an area without a history or suspicion of radiological use or impacts. The tidal channel located east of MRC and the Hawthorne community peninsula has been selected for background determination. Static gamma

measurements will be taken at each sample location. The samples will be analyzed for the radionuclides of concern (isotopic uranium and thorium), and static measurements will be documented on a radiological survey form.

Radiological sampling of sediment will occur concurrently with non-radiological sampling activities. Samples collected for environmental analysis will be split and sent to an off-site laboratory for isotopic uranium and thorium analyses. Field screening will determine the selection of samples at depth designated for off-site analysis.

Sediment samples will be scanned in the field using the instruments listed in Table D-2. As discussed in Section 3.0 of the MRC *Sediment Remedy Design Investigation Work Plan* (Tetra Tech, 2013), sediment samples will be taken from depth intervals of 0-6 inches, 6-18 inches, 18-30 inches, and 30-52 inches for laboratory analyses. Additional biased samples may be collected along the length of the core if elevated readings are detected during scanning. Sample types, quantities and analytical methods are presented in Table 3-1 of the work plan.

Table C-1

Atomic Energy Commission Regulatory Guide 1.86
Middle River Complex, Middle River, Maryland

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

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

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

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

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

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

Acronyms and Abbreviations:

α – alpha
β – beta
γ – gamma
Ac – actinium
cm^2 – square centimeters
dpm – disintegrations per minute
I – iodine
Pa – protactinium
Ra – radium
Sr – strontium
Th – thorium
u – uranium

Table C-2

Field Radiological Instrumentation-Sediment Sampling
Middle River Complex, Middle River, Maryland

Instrument	Detector	Type of Activity Detected	Survey Type
Ludlum Model 2360 Digital Data Logger	phoswhich probe	alpha beta	contamination surveys (counts per minute [cpm])
Ludlum Model 2241 Scaler/Ratemeter	2” x 2” Ludlum Model 44-10 sodium iodide (NaI) scintillation probe	gamma	dose rate surveys (cpm)
Ludlum Model 2929	Ludlum 43-10-1 phoswhich probe	alpha beta	low-level contamination surveys (counts per minute [cpm])

ACRONYMS AND ABBREVIATIONS

α	alpha
Ac	actinium
AEC	Atomic Energy Commission
β	beta
b_i	number of average background counts during observation interval "*i*"
cm^2	square centimeters
cpm	counts per minute
cps	counts per second
d'	index of sensitivity
DOE	United States Department of Energy
dpm	disintegrations per minute
γ	gamma
HASL	Health and Safety Laboratory
I	iodine
i	observation interval
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDRC	minimum detectable count rate
µR/hr	micro Röntgen per hour
MRC	Middle River Complex
NaI	sodium iodide
NRC	Nuclear Regulatory Commission
NUREG	NRC Regulation
p	surveyor efficiency
Pa	protactinium
Sr	strontium
Tetra Tech	Tetra Tech, Inc.
Th	thorium
Tl	thallium
U	uranium
USEPA	United States Environmental Protection Agency

References

1. AEC (Atomic Energy Commission). 1974. Regulatory Guide 1.86. *Termination of Operating Licenses for Nuclear Reactors.* June.

2. Tetra Tech (Tetra Tech, Inc.), 2013. *Sediment Remedy Design Investigation Work Plan, Middle River Complex, 2323 Eastern Boulevard, Middle River, Maryland*. Work Plan prepared for Lockheed Martin Corporation, Bethesda, Maryland by Tetra Tech, Inc., Germantown, Maryland, May.

3. USEPA (United States Environmental Protection Agency) et al, 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).* NUREG-1575, Rev. 1. USEPA 402-R-97-016, Rev. 1. DOE/EH-0624, Rev. 1. August.

ATTACHMENT A – RADIOLOGICAL PROTECTION OPERATING PROCEDURES

OPERATING PROCEDURE INDEX

Procedure	Title	Rev
RP-OP-01	ALARA Reviews	0
RP-OP-02	Radiological Surveys	0
RP-OP-03	Air Sampling	0
RP-OP-04	Radiological Respiratory Protection	0
RP-OP-05	Radiological Posting, Labeling and Entry Control	0
RP-OP-06	Radiological Work Permits	0
RP-OP-08	Decontamination of Items, Material and Work Surfaces	0
RP-OP-09	Response to Radiological Incidents	0
RP-OP-10	Water Sample Analysis	0
RP-OP-11	Radiological Personnel Qualification and Training	0
RP-OP-12	Pre-Operation Checks For Portable Hand Held Survey Instruments	0
RP-OP-13	Soil Survey and Sampling Techniques	0
RP-OP-14	Internal and External Dosimetry	0
RP-OP-15	Radiological Records	0
RP-OP-16	Source Control	0
RP-OP-17	Operation of the Ludlum Model 2929 Dual Scaler	0
RP-OP-18	Air Sampler Operation	0
RP-OP-19	Analysis of Soil Samples	0
RP-OP-23	Electra Plus/Selectra Plus/Electra GM Plus Ratemeters	0
RP-OP-24	Thermo Eberline HandECount System	0
RP-OP-29	Radiological Sampling	0

TETRA TECH, INC

Procedure No: RP-OP-001 Rev 0

ALARA REVIEWS

1.0 PURPOSE

The purpose of this procedure is to provide instructions for Radiation Protection Organization (RPO) personnel in the preparation and approval of formal ALARA reviews for radiological operations.

10 CFR 20 and the Tetra Tech, Inc. (Tt) Radiation Protection Plan (RPP) require the implementation of ALARA for conducting radiological operations that have the potential to cause occupational radiation exposures. This procedure provides the process for completing formal (i.e., documented) ALARA reviews required by the Tt RPP.

The following activities are described in Section 4.0 of this procedure:

4.1 ALARA Reviews

2.0 REFERENCES

10 CFR 20

Tt RPP

DOE G 441.1-1, Management and Administration of Radiation Protection Programs Guide, 1999

DOE G 441.2-1, Occupational ALARA Program Guide, 1998

DOE-STD-1098-99, Radiological Control, 1999

ICRP 37, Cost-Benefit Analysis in the Optimization of Radiation Protection, 1983

ICRP 55, Optimization and Decision-Making in Radiological Protection, 1989

NCRP 116, Limitation of Exposure to Ionizing Radiation, 1993

NCRP 120, Dose Control at Nuclear Power Plants, 1994

NCRP 127, Operational Radiation Safety Program, 1998

NUREG/CR-6212, Value of Public Health and Safety Actions and Radiation Dose Avoided

PNL-6577, Health Physics Manual of Good Practices for Reducing Radiation Exposures to Levels that are As Low As Reasonably Achievable (ALARA), 1988

TM 5-801-10, General Design Criteria To Facilitate The Decommissioning Of Nuclear Facilities, 1992

3.0 GENERAL

3.1 EQUIPMENT

Not Applicable

3.2 SAFETY CONSIDERATIONS

Not Applicable

3.3 RESPONSIBILITIES

RPO supervision:

- When requested, conducts formal (documented), ALARA reviews in accordance with this procedure to support project radiological operations.
- Assists project management with the implementation of ALARA review requirements.

Radiological Control Technician:

- Completes the ALARA Section of the Radiological Work Permit to denote the type(s) of ALARA reviews required in accordance with this procedure.
- Performs informal (i.e., undocumented) ALARA reviews, as necessary, while developing technical work documents to support radiological operations and while performing work package close-out on jobs where formal ALARA reviews were not required..
- Assists project management with the implementation of ALARA review requirements.
- Completes and dispositions formal ALARA reviews in accordance with this procedure.

3.4 PREREQUISITES

Not Applicable

3.5 RECORDS

Records that are generated during the performance of this procedure include the following:

- ALARA Pre-job Reviews
- ALARA In-progress Reviews
- ALARA Post-job Reviews

The original copy is the record copy and is forwarded to project Quality Assurance or processing. Copies of the original documents may be made for information

3.6 PRECAUTIONS AND LIMITATIONS

Not Applicable

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

ALARA reviews are performed for work involving exposure to radiation or radioactive materials (i.e., radiological work). The review process employs a two-level review system (i.e., graded approach using both formal and informal review processes) to evaluate the implementation of ALARA engineering and operational controls with primary emphasis placed on the use of engineering controls.

3.9 ATTACHMENTS

Attachment 1 ALARA Review Trigger Levels

Attachment 2 ALARA Pre-Job Review Form

Attachment 3 ALARA In-Process Review Form

ALARA REVIEWS

Attachment 4 ALARA Post-Job Review Form

4.0 PROCEDURE

4.1 ALARA Reviews

Sections 4.1.1 to 4.1.3 describe the ALARA review process which is used for planning and overseeing radiological work to ensure that occupational radiation exposure received is ALARA. An ALARA review is comprised of pre-job, in-progress, and post-job reviews.

4.1.1 ALARA Pre-job Reviews

a. Line operations personnel perform informal, undocumented pre-job reviews if the trigger levels in Attachment 1 are not exceeded.

NOTE: The process of preparing job-specific technical work documents (i.e., involves consideration of workplace controls, use of personnel protective clothing, dose optimization as part of the ISMS process) is the most basic form of a pre-job review, and is necessary and sufficient for most radiological activities.

b. If the trigger levels in Attachment 1 are exceeded, a formal (documented and approved) pre-job review shall be performed. The ALARA Pre-job Review should be completed following the completion of a pre-job survey and a pre-job walkdown and prior to the completion of the technical work documents for the job in question.

c. Document a formal, ALARA Pre-job Review using Attachment 2. The ALARA Pre-job Review shall address the items below (at a minimum):

- Description of work scope.
- Radiological conditions including expected radiation, contamination and airborne levels.
- Expected dose (individual and collective TEDE) before any controls are applied.
- Engineering controls to be used for dose reduction such as:
  - Decontamination to reduce radioactivity
  - Controls to minimize spread of contamination (e.g., containment tent)
  - Use of portable or auxiliary ventilation to control airborne radioactivity
  - Use of temporary shielding
- Operational controls to be used for dose reduction, such as:
  - Special tools and work processes to reduce time in the radiological area
  - Special training and monitoring requirements
  - Use of training aids and practice runs
  - Deployment of specialty contractors
  - Prefabrication of parts
- Expected dose (individual and collective TEDE) after all controls are employed.

- Summary of radiological control requirements for work performance.

d. Radiological control requirements identified as part of the ALARA Pre-job Review shall be captured in the job-specific technical work documents, as well as the pre-job briefing.

e. Review and approval signatures for the ALARA Pre-job Review are obtained in accordance with the criteria provided in Attachment 1.

f. The completed pre-job review should be placed in the RWP package.

4.1.2 ALARA In-progress Reviews

a. Formal, ALARA In-progress Reviews are performed, if prescribed by the trigger levels in Attachment 1.

b. Document a formal, ALARA In-progress Review using Attachment 3. The ALARA In-progress Review shall address the items below (at a minimum):

- Work being performed as compared to initial, pre-planned job scope.
- Actual radiological conditions as compared to expected conditions.
- Effectiveness of engineering controls used.
- Effectiveness of operational controls used.
- Collective and individual TEDE dose received compared to the pre-job estimate.
- Expected individual and collective TEDE dose to finish the job compared to the pre-job estimate.
- Recommendations and corrective actions needed, if any.

c. Review and approval signatures for the ALARA In-progress Review are obtained in accordance with the criteria provided in Attachment 1.

d. Once the in-progress review is approved, it should be placed in the RWP package along with the pre-job review if one was performed. Any corrective action recommendations identified as a result of the review and deemed appropriate by project management will be implemented and personnel will be briefed on any changes.

4.1.3 ALARA Post-job Reviews

a. When a formal, ALARA Post-job Review is required (see Attachment 1) it shall address the items listed below (at a minimum). The review, which should include a critique (e.g., post-job debrief meeting) involving the persons who performed the work, is documented using Attachment 4.

- Final, overall work scope.
- Comparison of actual and pre-job estimates of individual and collective TEDE dose.
- Efficacy and cost of engineering controls used.
- Efficacy and cost of operational controls used.

- Any adverse conditions that occurred during the work such as:
  - Personnel over exposures
  - Unnecessary controls
  - Unexpected radiological conditions
  - Conflicts between radiological controls, operational requirements, and industrial hygiene/safety requirements
- Lessons learned.
- Recommendations on ways to control dose and contamination for similar activities.

b. Review and approval signatures for the ALARA Post-job Review are obtained in accordance with the criteria provided in Attachment 1.

c. Once the post-job review is approved, it should be placed in the RWP package along with the pre-job and in-progress reviews if they were performed.

ALARA Review Trigger Levels

Review Type [1]	Trigger Level [2]	Performed By	Approved By
ALARA Pre-Job Review	• Expected doss is greater than: - 100 mrem TEDE – individual dose, or - 500 mrem TEDE – collective dose - Airborne activity greater than 50 DAC - Removable contamination on accessible surfaces greater than pre-established values (e.g., greater than 100 times the values in Table 2-2) - Entry into areas where dose rates exceed 1 rem/hour - Potential releases of radioactive material to the environment	RPO Staff [3]	See Note 4
ALARA In-Process Review	• Whenever an ALARA Pre-Job Review is performed [5]	RPO Staff [3]	See Note 4
ALARA Post-Job Review	• Whenever required by the Project ALARA Committee • Actual Individual or collective dose exceeds ± 25% of the pre-job estimate including upgrades • "Stop radiological work" authority is implemented • Significant lessons learned are identified • Actual dose is greater than: - 1,000 mrem TEDE – individual dose, or - 5,000 mrem collective dose	RPO Staff [3]	See Note 4

[1] Each ALARA Review type listed must be documented and approved by the appropriate entity

[2] Trigger levels based on anticipated radiological conditions after implementation of engineering and operational controls

[3] Review performed by RCT or RPO supervision, determined by the RCM

[4] The appropriate approval level for the ALARA Review is based on the following criteria:

RPO supervision approves ALARA Reviews that do not exceed:

100 mrem TEDE – individual dose

500 mrem TEDE – collective dose

RCM approves ALARA Reviews that do not exceed:

500 mrem TEDE – individual dose

2500 mrem TEDE – collective dose

Project ALARA Committee approves ALARA Reviews that do exceed:

500 mrem TEDE – individual dose

2500 mrem TEDE – collective dose

[5] An in-process review for a short duration job (i.e., less than 5 days duration) should be combined with a post-job review.

ALARA PRE-JOB REVIEW FORM

RWP #:		
Review Criteria	**Status**	**Comments**
1. Are technical work documents available which accurately define the work? (List in Comments)	☐ Yes ☐ No ☐ N/A	
2. Has the procedure been verified through walk-downs or prior performance? (List in Comments)	☐ Yes ☐ No ☐ N/A	
3. Do procedures contain radiological hold points? (List in Comments)	☐ Yes ☐ No ☐ N/A	
4. Are there specific points in the work evolution at which radiological conditions are subject to change? If yes, are these addressed as hold points in work documents?	☐ Yes ☐ No ☐ N/A	
5. Has the work force performed this job previously?	☐ Yes ☐ No ☐ N/A	
6. Is specific training needed prior to job performance?	☐ Yes ☐ No ☐ N/A	
7. Are photographs, videos, and /or drawings available of actual equipment and work areas?	☐ Yes ☐ No ☐ N/A	
8. Can mock-up or other training be utilized?	☐ Yes ☐ No ☐ N/A	
9. Has the size of the work crew been minimized? evaluated?	☐ Yes ☐ No ☐ N/A	
10. Have all identified support groups been notified of scheduled work and briefing requirements?	☐ Yes ☐ No ☐ N/A	
11. Can work be delayed until short lived isotopes decay off?	☐ Yes ☐ No ☐ N/A	
12. Have primary sources of exposure been identified?	☐ Yes ☐ No ☐ N/A	
13. Is the work likely to result in the release of airborne radioactive materials?	☐ Yes ☐ No ☐ N/A	
14. Can engineering controls, (i.e., ventilation, HEPA filtration, containment devices, tool selection, etc.) reduce potential for airborne?	☐ Yes ☐ No ☐ N/A	
15. If airborne can not be eliminated through engineering and process controls, has use of respirators been evaluated in accord with RP-OP-004?	☐ Yes ☐ No ☐ N/A	
16. Can temporary shielding reduce worker dose?	☐ Yes ☐ No ☐ N/A	
17. Can task be moved to lower dose areas for work?	☐ Yes ☐ No ☐ N/A	
18. Have locations of lower dose waiting areas been located and the use explained to workers?	☐ Yes ☐ No ☐ N/A	
19. Can flushing of lines, components, etc. result in lower dose rates?	☐ Yes ☐ No ☐ N/A	
20. Can components be drained/filled to reduce dose rates?	☐ Yes ☐ No ☐ N/A	
21. Can decontamination result in lower dose rates?	☐ Yes ☐ No ☐ N/A	

ALARA PRE-JOB REVIEW FORM (continued)

Review Criteria	Status	Comments
22. Can radioactive components be placed in shielded containers to reduce dose rates?	☐ Yes ☐ No ☐ N/A	
23. Are stay time limits appropriate for reduction of individual exposure?	☐ Yes ☐ No ☐ N/A	
24. Have routes to and from work areas been identified?	☐ Yes ☐ No ☐ N/A	
25. Will staging areas be used for tools and equipment? Where?	☐ Yes ☐ No ☐ N/A	
26. Are required services (electrical, air, lighting, ventilation) available?	☐ Yes ☐ No ☐ N/A	
27. Are special communication devices required due to ambient noise levels or to reduce collective exposures?	☐ Yes ☐ No ☐ N/A	
28. Can remote tools or robotics be used?	☐ Yes ☐ No ☐ N/A	
29. Is any special equipment or procedural restriction required to ensure worker safety during work performance? (Include lockout/tagout requirements)	☐ Yes ☐ No ☐ N/A	
30. Is heat stress a concern? Have stay times been evaluated for heat stress considerations?	☐ Yes ☐ No ☐ N/A	
31. Does work involve use of hazardous materials?	☐ Yes ☐ No ☐ N/A	
32. Will work result in waste generation?	☐ Yes ☐ No ☐ N/A	
33. How will waste products be handled and disposed of?	☐ Yes ☐ No ☐ N/A	
34. Will liquids generated be collected or routed to drains? How? Have approvals been obtained?	☐ Yes ☐ No ☐ N/A	
35. Is whole body TLD sufficient to monitor potential exposures?	☐ Yes ☐ No ☐ N/A	
36. Should whole body TLD be moved to another body part or is multiple badging required?	☐ Yes ☐ No ☐ N/A	
37. Is extremity badging required?	☐ Yes ☐ No ☐ N/A	
38. Is neutron dosimetry required?	☐ Yes ☐ No ☐ N/A	
39. Does this work involve any criticality concerns? Have controls been identified?	☐ Yes ☐ No ☐ N/A	
40. Are RAMs or CAMs to be utilized for this work?	☐ Yes ☐ No ☐ N/A	
41. Is job-specific bioassay required during or following completion of work?	☐ Yes ☐ No ☐ N/A	
42. Are any non-routine items of protective clothing required? (Face shields, heavy rubber gloves, etc.)	☐ Yes ☐ No ☐ N/A	
43. Will photographs or videos be made to record the job or conditions?	☐ Yes ☐ No ☐ N/A	
44. Have current worker doses been reviewed?	☐ Yes ☐ No ☐ N/A	

ALARA PRE-JOB REVIEW FORM (continued)

Review Criteria	Status	Comments
45. Does job require review by Safety Engineer or Industrial Hygienist?	☐ Yes ☐ No ☐ N/A	
46. Are ACLs in place for workers, as required?	☐ Yes ☐ No ☐ N/A	
47. Is there a reasonable possibility that skin dose could exceed 5 rem?	☐ Yes ☐ No ☐ N/A	
48. Is there the potential for hot particles?	☐ Yes ☐ No ☐ N/A	
49. Have abnormal and emergency procedures and plans been reviewed?	☐ Yes ☐ No ☐ N/A	
50. Have points where signatures and second party or independent verifications are required been identified?	☐ Yes ☐ No ☐ N/A	
51. Have success or completion criteria, with contingency plans to anticipate difficulties been established?	☐ Yes ☐ No ☐ N/A	

COMMENTS MAY BE ANNOTATED ON ATTACHED FORM
WITH REFERENCE TO CRITERIA IN ALARA REVIEW.

REQUIREMENTS TO BE ADDED TO RWP

ALARA Estimates	**DDE**	**CEDE**	**TEDE**
Original Person Rem estimate	_____	_____	_____
Revised Person Rem estimate	_____	_____	_____

Review Performed By:_____ Date:_____

Review Approved By: _____ Date:_____

ALARA IN-PROCESS REVIEW FORM

RWP #:_____ **Rev:**_____ **Start Date:**_____

Review Date:_____ **Performed By:**_____

ALARA Estimates	**Actual (To Date)**
Person Rem:_____	**Person Rem:**_____
Person Hours:_____	**Person Hours:**_____
DDE:_____ **CEDE:**_____	**DDE:**_____ **CEDE:**_____

Review Criteria	Status	Comments
1. Is work being performed in accordance with technical work documents?	☐ Yes ☐ No ☐ N/A	
2. Are all workers at job site actively participating in work? Are incidental exposures minimized?	☐ Yes ☐ No ☐ N/A	
3. Are workers knowledgeable of radiological conditions in work area?	☐ Yes ☐ No ☐ N/A	
4. Are workers aware of their exposure data?	☐ Yes ☐ No ☐ N/A	
5. Are tools and equipment available at job site adequate for tasks to be performed?	☐ Yes ☐ No ☐ N/A	
6. Are lockout/tagout procedures being followed?	☐ Yes ☐ No ☐ N/A	
7. Were any unanticipated radiological conditions encountered?	☐ Yes ☐ No ☐ N/A	
8. Can additional dose reduction measures be applied to further reduce worker dose?	☐ Yes ☐ No ☐ N/A	
9. Is work area maintained orderly and clean?	☐ Yes ☐ No ☐ N/A	
10. Have workers experienced any difficulties with heat?	☐ Yes ☐ No ☐ N/A	
11. Are any observable health or safety hazards present?	☐ Yes ☐ No ☐ N/A	
12. Have workers identified any potential difficulties affecting completion of job?	☐ Yes ☐ No ☐ N/A	

COMMENTS MAY BE ANNOTATED ON ATTACHED FORM
WITH REFERENCE TO CRITERIA IN ALARA REVIEW.

Corrective Actions Taken/Recommended:_____

_____

_____

Review Performed By:_____ Date:_____

Review Approved By: _____ Date:_____

ALARA POST-JOB REVIEW FORM

RWP #:_____ Start Date:_____ Completion Date:_____

EXPOSURE DATA FOR JOB

Estimates	**Actual**
Person Rem:_____	**Person Rem:**_____
Person Hours:_____	**Person Hours:**_____
DDE:_____ **CEDE:**_____	**DDE:**_____ **CEDE:**_____

ALARA Goal:_____person-rem

Review Criteria	Status	Comments
1. Were technical work documents accurate, sequenced correctly, and usable?	☐ Yes ☐ No ☐ N/A	
2. Were equipment needs identified in procedure and did they reflect materials needed for the job?	☐ Yes ☐ No ☐ N/A	
3. Were prerequisite activities completed prior to start of job?	☐ Yes ☐ No ☐ N/A	
4. Were support groups present when required for job evolution?	☐ Yes ☐ No ☐ N/A	
5. Were estimated manpower requirements exceeded? If yes, explain why.	☐ Yes ☐ No ☐ N/A	
6. Was job specific training completed for this job? If yes, was it adequate for the job?	☐ Yes ☐ No ☐ N/A	
7. Were any unplanned or unanticipated conditions encountered? Explain.	☐ Yes ☐ No ☐ N/A	
8. Were low dose areas and staging areas used? If so, were they effective?	☐ Yes ☐ No ☐ N/A	
9. Were required services available (electrical outlets, ventilation, lights, etc.)?	☐ Yes ☐ No ☐ N/A	
10. If temporary shielding was used, was it adequate?	☐ Yes ☐ No ☐ N/A	
11. Were engineering controls used to reduce potential for airborne radioactive materials? If yes, were they effective?	☐ Yes ☐ No ☐ N/A	
12. Were contamination control practices followed and effective?	☐ Yes ☐ No ☐ N/A	
13. Were respirators used? Identify impact on job performance.	☐ Yes ☐ No ☐ N/A	
14. Are procedure changes needed to accommodate lessons learned during this job performance?	☐ Yes ☐ No ☐ N/A	
15. Are additional radiological hold points needed in technical work documents? If yes, explain.	☐ Yes ☐ No ☐ N/A	

Review Criteria	Status	Comments
16. Are equipment or process changes needed to help reduce exposures for the next job performance? If yes, explain.	☐ Yes ☐ No ☐ N/A	
17. Could actions be taken to prevent future performance of this job? Explain.	☐ Yes ☐ No ☐ N/A	
18. Were person-rem estimates exceeded? Why?	☐ Yes ☐ No ☐ N/A	
19. Were man-hr estimates exceeded? Why?	☐ Yes ☐ No ☐ N/A	
20. Could activities have been done differently to reduce exposures? Explain.	☐ Yes ☐ No ☐ N/A	

COMMENTS MAY BE ANNOTATED ON ATTACHED FORM
WITH REFERENCE TO CRITERIA IN ALARA REVIEW.

Attach a listing of attendees

Data Analysis

Recommended Corrective Actions:

RPO Actions:_____

_____

_____

_____

_____

Project Actions:_____

_____

_____

_____

_____

Review Performed By:_____ Date:_____

Review Approved By: _____ Date:_____

RADIOLOGICAL SURVEYS

1.0 PURPOSE

The purpose of this procedure is to provide techniques and instructions for the Radiological Control Technician (RCT) in the performance and documentation of radiological surveys.

SCOPE

The following activities are described in Section 4.0 of this procedure:

4.1 Instrument Selection

4.2 Radiological Survey Techniques

4.3 Conduct of Radiological Surveys

4.4 Radiological Survey Documentation

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

TtNUS Worker Protection Plan (WPP)

TtNUS Site-Specific Health and Safety Plan (HASP)

49 CFR 172, *Hazardous Materials Table, Special Provisions, Hazardous Materials*

Communications, Emergency Response Information and Training Requirements

49 CFR 173, *Shippers - General Requirements for Shipments and Packagings*

3.0 GENERAL

3.1 EQUIPMENT

- Portable radiological survey equipment.
- Survey media (e.g., cloth smears, Masslinn-type swipes).
- Radioactive Material Tag/Label.
- Radiological Survey Forms.

3.2 SAFETY CONSIDERATIONS

- All radiological surveys shall be performed in accordance with ALARA policies, governing work documents, and contamination control practices. If area hazards are unknown or may have changed, obtain current hazard information from the responsible Environment, Health and Safety representative.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Implementation of this procedure.

- Ensuring that RCTs are qualified to perform this procedure.
- Ensuring that all survey documentation is reviewed.
- Verifying that all documentation generated in support of this procedure meets the requirements of this procedure prior to approval.
- Ensuring the documentation is properly filed and protected

3.3.2 RCTs are responsible for:

- Complying with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The RCT should review available survey data if unfamiliar with the area or current radiological conditions.

3.4.2 Survey numbers are sequentially numbered. The survey number should be on all survey documentation

3.5 RECORDS

RPO survey records are generated during implementation of this procedure. Records include the following forms:

- Radiological Survey Form.
- Radiological Survey Continuation Form.

Records are maintained in accordance with the TtNUS records management policy and applicable program and project requirements. The record copies are filed on site for the duration of the project.

Handwritten survey documentation shall be completed in permanent black or blue-black ink only. Changes to survey documentation shall only be made to the record copy and shall be made in black or blue ink and shall be made with a single line, initialed and dated.

3.6 PRECAUTIONS AND LIMITATIONS

3.6.1 When entering areas of unknown radiation levels, the highest scale available on the survey instrument should be selected prior to entry and the instrument window should be open.

3.6.2 To avoid contaminating an instrument case, instruments may be placed in plastic bags or similar devices. If alpha and/or beta measurements are being made, the plastic must not cover the instrument window.

3.6.3 Alpha radiation has a very limited range; pure alpha-emitting radionuclides dispersed in a thin, semi-moist surface layer or covered with an absorbing layer of dust or dirt may not be detectable. Similarly, rusty, abrasive, generally non-smooth porous surfaces will absorb alpha particles and inhibit their detection. Particular attention, therefore, should be directed to the condition of the surface(s) when monitoring for alpha contamination.

Items, material, and equipment may require a preliminary Large Area Wipe (LAW) survey to assess contamination conditions.

CAUTION: Wipe material may be contaminated.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

This procedure implements the requirements of 10 CFR 20.

3.9 ATTACHMENTS

Attachment 1 Radiological Survey Form

Attachment 2 Radiological Survey Continuation Form

Attachment 3 Guidance on Performing Surveys for Unrestricted Use

Attachment 4 Radioactive Contamination Limits

Attachment 5 Radiation and Contamination Limits for Radioactive Material Package Transport/Transfer

Attachment 6 Radiological Survey Frequency

4.0 PROCEDURE

4.1 INSTRUMENT SELECTION

4.1.1 SELECT the radiation detection and/or contamination measurement instrument(s), which are appropriate for the radiation energies and types of radiation to be monitored.

CAUTION: Instrument limitations and radiological source characteristics must be considered when selecting the appropriate instrument.

4.1.2 PERFORM a pre-operational check of the instrument(s) in accordance with applicable procedures, if one has not already been done for that day.

4.2 RADIOLOGICAL SURVEY TECHNIQUES

4.2.1 RADIATION SURVEYS

Radiation surveys are typically conducted by taking both open (OW) and closed window (CW) readings any time beta or low energy x/ gamma rays are present or when the types of radiation are unknown.

NOTE: Although the areas have been well characterized, surveys should be performed to verify that conditions have not changed and that unanticipated radiation sources from adjacent site operations have not impacted radiological conditions.

DOCUMENT measurements in accordance with Section 4.2 and 4.4.

4.2.1.1 OBTAIN background radiation levels (dose rates) for the area(s) of interest when taking uR/hr readings.

4.2.1.2 For General Area (Gamma):

a. General area surveys are normally conducted with the instrument held at waist level with the instrument window closed (CW).

b. **DOCUMENT** survey results as **mrem/hr @ GA**.

4.2.1.3 Items (Gamma)

a. OBTAIN CW dose rate measurements at 30 cm (~1 ft) from the item;

b. **DOCUMENT** survey results as **mrem/hr @ 30 cm**.

4.2.1.4 Items (Beta-Gamma)

a. Using an ionization chamber:

1. OBTAIN an open window (OW) dose rate measurement and a closed window (CW) dose rate measurement for each item or area of interest. Measurements should be taken at approximately 1 inch (2.5 cm) which is a “contact” (CT) reading.

2. REPEAT as necessary to characterize the item/area.

3. DETERMINE the beta dose rate (*D* β) by subtracting the CW reading from the OW reading and multiply by the appropriate Correction Factor (CF). The CF for each survey instrument is typically 3.5 – 3.8, but 4 will be used as a conservative estimate and to ease in data calculations.

D β = (OW - CW) 4

b. **DOCUMENT** results as **mrad /hr Dβ @CT**.

4.2.1.5 Skin Dose (SD) Measurements (Beta-Gamma)

a. Using an ionization chamber:

1. OBTAIN an open window (OW) dose rate measurement and a closed window (CW) dose rate measurement for each item or area of interest. Measurements should be taken at approximately 1 foot (30 cm).

2. REPEAT as necessary to characterize the item/area.

3. DETERMINE the beta dose rate (*D* β) by subtracting the CW reading from the OW reading and multiply by the appropriate Correction Factor (CF). The CF for each survey instrument is typically 3.5 – 3.8, but 4 will be used as a conservative estimate and to ease in data calculations. Add CW reading and report as below.

Skin Dose = [(OW - CW) 4] + CW

b. **DOCUMENT** results **as mrem/hr @ 30 cm SD**.

4.2.1.6 Extremity Dose (ED) Measurements (Beta-Gamma)

a. Using an ionization chamber:

1. OBTAIN an open window (OW) dose rate measurement and a closed window (CW) dose rate measurement for each item or area of interest. Measurements should be taken at approximately 1-2 inches (5 cm).

2. REPEAT as necessary to characterize the item/area.

3. DETERMINE the beta dose rate (*D* β) by subtracting the CW reading from the OW reading and multiply by the appropriate Correction Factor (CF). The CF for each survey instrument is typically 3.5 – 3.8, but 4 will be used as a conservative estimate and to ease in data calculations. Add CW reading and report as below.

Extremity Dose = [(OW - CW) 4] + CW

b. **DOCUMENT** results as **mrem/hr @ 5cm ED**.

4.2.2 SURFACE CONTAMINATION SURVEYS

Surface contamination surveys consist of both direct monitoring for evaluating total surface contamination and wipes for monitoring of removable contamination levels. Direct monitoring may not be practical in high background areas or for certain low energy beta emitters (H-3, Ni-63, etc.). Direct monitoring for contamination will be performed with the survey meter on the slow response setting, as applicable.

DOCUMENT survey results in accordance with Section 4.2.2 and 4.4.

4.2.2.1 Surface Contamination – Direct Scans

a. Prior to performing surveys, OBTAIN background level in counts per minute (cpm) for each instrument to be used.

b. To maximize the capabilities of the instrument and the user:

1. PERFORM surveys in areas with a background that is as low as feasible. Background should not exceed count rates of 300 cpm (β-γ) and 0 cpm (α)

2. USE the audible response rather than relying on meter fluctuations.

3. SURVEY as close to the surface as possible,* minimizing contact of the instrument with the surface.

4. SURVEY approximately 1cm* from the surface (as measured from the detector face) for beta or gamma, and 0.5 cm for alpha.

c. SCAN the surface of the item or material for each potential type of radiation. For larger items/areas, begin by scanning an area of approximately 1 m^2.

d. If surveying for beta/gamma radiation, SCAN at a rate between 2.5 cm and 5 cm (1 to 2 inches) per second. If surveying for alpha radiation, SCAN at a rate between 1 cm and 2.5 cm (0.5 to 1 inch) per second.

* See Section 3.6 for Precautions.

e. When surveying for comparison against Attachment 4 limits, a static count is required at the location of the highest instrument reading.

1. HOLD the instrument as close to the surface as possible without damaging or contaminating the probe, but no more than 1 cm* from the surface.
2. COUNT for no less than one minute.

f. REPEAT previous steps as necessary to characterize the item and/or area.

g. DETERMINE the net count rate by subtracting the background count rate from the surface count rate.

h. If the net count rate does not exceed background and no static counts are required:

DOCUMENT reading as **ND dpm αβγ**.

i. If the net count rate is positive:

DETERMINE the contamination level in dpm by dividing the net count rate by the instrument efficiency for that radionuclide. Instrument efficiencies are located on the instrument calibration sticker or certificate.

j. If the measurement must be compared to a limit (e.g., for posting or release survey), DETERMINE the maximum measurement within the contaminated area.

1. For an area of contamination ≥ the size of the probe

- CORRECT the measurement to 100 cm^2 by multiplying by the appropriate correction factor for the probe.

CORRECTION FACTORS

6.7 for 44-9 or equivalent

0.8 for 43-89 or equivalent

1.3 for 43-5 or equivalent

NOTE: Correction factors are determined by dividing 100 by the active area of the probe.

- **DOCUMENT** as **dpm/100cm^2 with αβγ (as applicable)**,

2. For an area of contamination < the size of the probe

- **DOCUMENT** as **dpm/100cm^2 with αβγ (as applicable)**,

k. If more than one probe type is used to survey a particular type of radiation (i.e., two probes used for beta/gamma measurements), IDENTIFY which probe was used for a particular measurement on the Radiological Survey Form.

4.2.2.2 Removable Surface Contamination – 100 cm^2 Surveys

NOTE: This type of survey is required if the measurement must be compared to a limit (e.g., for posting or release surveys).

a. SELECT the appropriate type(s) of media for performing 100 cm^2 removable contamination surveys (e.g. cloth smears).

b. WIPE an area with the selected media, applying moderate pressure. The area of the wipe should be 100 cm^2. For items with an accessible area of less than 100 cm^2, wipe the entire accessible surface.

c. LABEL the media with the unique number that corresponds to the item/location identified on the Radiological Survey Form (see Attachment 1). If doing on the spot field counting for work area indications, this step may be omitted.

d. REPEAT the previous steps as necessary to characterize the area of contamination.

NOTE: Wipe locations should include those areas where direct static measurements were above background.

e. SCAN the wipe(s) to determine gross activity. Do not count highly contaminated wipes in the swipe counter to avoid internally contaminating laboratory equipment.

f. ANALYZE wipes using an appropriate counter. If results are being compared to a limit, wipes must be counted with instrumentation capable of seeing that limit.

g. SUBTRACT instrument background and CONVERT corrected cpm to dpm by dividing result by instrument efficiency.

h. **DOCUMENT** survey results in units of **dpm/100 cm^2 with αβγ (as applicable)**

If no result was found to be above limits to which survey was compared, RECORD as less than (<) limits, with αβγ (as applicable).

EXAMPLES: <20 α <200 βγ dpm/100 cm^2, or

<1K dpm/100 cm^2 βγ

4.2.2.3 Removable Surface Contamination – Large Area Wipes (LAW)

NOTE: Large area wipes may NOT be used to release items/material for unrestricted use or to determine posting/labeling. Depending on scan results and reason for survey, it may be necessary to perform additional surveys in accordance with section 4.2.2.2 of this procedure.

a. SELECT the appropriate type(s) of media (e.g., Masslinn®) for performing large area wipe surveys.

b. WIPE an area with the selected media, applying moderate pressure.

NOTE: Use caution when conducting LAW to assure that contamination is not spread and change Masslinn frequently in dusty areas to avoid overloading.

c. SCAN the wipe using an appropriate contamination detection instrument.

d. SUBTRACT instrument background and CONVERT corrected cpm to dpm by dividing result by instrument efficiency.

e. RECORD measurement and REPEAT the previous steps as necessary to characterize the area.

f. **DOCUMENT** survey results in units of **dpm/LAW with αβγ (as applicable)**.
If no activity above background is detected, RECORD as **ND dpm/LAW with αβγ (as applicable)**.

NOTE: The LAW may be discarded as radioactive waste upon determination of contamination levels.

4.3 CONDUCT OF RADIOLOGICAL SURVEYS

4.3.1 ROUTINE RADIOLOGICAL SURVEYS

This section provides the requirements for identifying, scheduling, and tracking routine radiation and contamination surveys. Radiological survey frequencies can be found in Attachment 6.

4.3.1.1 The RPO shall establish a routine survey schedule and convey this schedule to the appropriate RCTs. Schedules shall be updated as necessary. Routine surveys are designated by frequency and type.

a. Frequency of survey:

- Daily (within a work day)
- Weekly (within a work week)
- Monthly (within a calendar month)
- Quarterly (within a calendar quarter)
- Semi-Annually (within a calendar 6 month period)
- Annually (within a calendar year)

b. Type of survey:

- Radiation
- Contamination
- Air Sample

4.3.1.2 DOCUMENT completion of routine surveys using a Routine Survey Tracking Log or equivalent tracking system.

4.3.2 UNRESTRICTED RELEASE OF RADIOACTIVE MATERIAL

4.3.2.1 UNRESTRICTED RELEASE OF MATERIALS

Unrestricted (free) release is the release of property to uncontrolled areas (i.e., the public) in accordance with 10 CFR 20, such that possession and utilization is granted without regard or concern for residual radiation content.

a. Material used in Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas cannot be removed from these areas until evaluated and surveyed by RPO.
Refer to Attachment 3 for additional guidance on performing unrestricted release surveys.

b. This section does **not** apply to release surveys for the following:

- Contaminated soils.
- Building and similar real property.
- Contaminated personnel or contaminated clothing.
- Volumetrically contaminated material.
- Items and materials made radioactive (i.e., activated) by neutron radiation when such activation can be detected using methods described in this procedure.
- Items and materials where potentially contaminated surfaces are inaccessible for measurements (e.g., pipes, drains, ductwork, and electronic internals) when available history or survey measurements demonstrate that the contamination levels of inaccessible surfaces are likely to exceed the values specified in Attachment 4.
- Hazardous waste materials (e.g., paints, solvents, chemicals, cleaners, and fuels) with volumetric contamination or contamination in depth (e.g., concrete that has been contaminated) are considered bulk-contaminated items and may not be released.

c. Unless it is not practical to perform direct monitoring (e.g., when the radionuclide of concern is H-3), both direct and indirect monitoring shall be performed in accordance with Section 4.2.2.

d. Release criteria for material, excluding consumer products containing radioactive materials and Naturally Occurring Radioactive Material NORM:

- Total (fixed plus removable) surface contamination must be less than the limit in the “Total” column of Attachment 4, **AND** Removable surface contamination must be less than the limit in the “Removable” column of Attachment 4.

e. If survey results are not within the unrestricted release criteria indicated in Section 4.3.2.1, label the material/item (as appropriate) in accordance with RP-OP-005 and implement additional radiological controls as needed.

4.3.2.2 UNRESTRICTED RELEASE OF VEHICLES AND HEAVY EQUIPMENT

Equipment used in Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas cannot be removed from these areas until evaluated and surveyed by RPO. The surfaces to be surveyed should clean and dry prior to survey.

The following are recommendations for obtaining a representative survey for unrestricted release of vehicles/heavy equipment. In all cases, PERFORM surveys in accordance with Section 4.2.2, and USE guidance in Attachment 3, as needed.

a. General survey guidelines include:

- Survey the tires, wheel wells, seat, floorboard, pedals, steering wheel, and random locations on the body and undercarriage of vehicles. Include the bucket, blade, forks, hook, ball, mowers, bush hog, vents, air intakes, tracks, rollers, pins, fittings, radiator, etc. in surveys of equipment.
- Check for contaminated dirt and dust that may accumulate on the external surfaces of hydraulic lift assemblies, especially if leakage has occurred. The air filter can also become contaminated.

NOTE 1: When surveying vehicles and heavy equipment for unrestricted use, it is often not feasible to survey every surface of the item because most of the external and all of the internal vehicle surfaces are not readily accessible for survey. Survey those areas most likely to be contaminated and draw conclusions about the remainder of the vehicle from this survey. If it is determined that any of the remaining (unsurveyed) surfaces are likely to be contaminated above the release limits specified in Attachment 4, decontamination and additional surveys must be performed prior to unrestricted release. If this includes the removal of oils, hydraulic fluids, and filters, these will be disposed of at the direction of RPO supervisor.

NOTE 2: To move equipment, equipment components contaminated by radionuclides from radiological areas must be either radiologically decontaminated to achieve release criteria or managed/controlled in accordance with the RPP. For movement out of a radiological area, it is not necessary to drain fluids from this equipment. However, fluids which are not deemed as uncontaminated must be managed to prevent spreading contamination to environs.

b. USE the release criteria given in Section 4.3.2.1 of this procedure.

4.3.3 SURVEY FOR TRANSPORTATION OF RADIOACTIVE MATERIAL

4.3.3.1 SURVEY FOR OFFSITE SHIPMENT OF RADIOACTIVE MATERIAL

This section describes the surveys required to comply with Department of Transportation (DOT) 49 CFR 173 Shippers – General Requirements for Shipments and Packaging, and 10 CFR 20, radiation and contamination limits that apply to outgoing and incoming shipments.

a. PERFORM applicable radiation and contamination surveys in accordance with Section 4.2.

b. For off-site shipments of packages shipped as non-exclusive use, DETERMINE the maximum dose rate measurements:

- One meter from the external surfaces of the package, and
- On contact with all accessible surfaces, including the bottom, of the package.

c. For off-site shipments of packages and vehicles shipped as exclusive use, DETERMINE the maximum dose rate measurement at the following locations:

- One meter from the external surfaces of the package (see NOTE below).
- On contact with the external surfaces of the package.
- On contact with the external surfaces (including the top and bottom) of the transport vehicle.

- Two meters from external surfaces (excluding the top and bottom) of the transport vehicle.
- In any normally occupied area of the vehicle (e.g., the cab). This includes the "sleeper" portion of a cab, if so equipped.

NOTE: The measurement at one meter will be used to determine the Transportation Index (TI). The TI is a dimensionless number, rounded up to the next tenth, which is placed on the label of a package to designate the degree of control to be exercised by the carrier. For nonfissile material, the TI represents the maximum radiation level in millirem per hour at one meter from the external surface of the package. For fissile material, the TI represents the maximum radiation level in millirem per hour at one meter from the external surface of the package or, for criticality control purposes, the number obtained by dividing 50 by the allowable number of packages that may be transported together, whichever number is larger.

d. OBTAIN a sufficient number of wipes to provide a representative assessment of the removable contamination from inside of package, outside of package, and/or vehicle surfaces.
   - A 300 cm^2 area for outgoing shipments, or
   - A 100 cm^2 area for incoming shipments

e. COMPARE the survey results with the limits found in Attachment 4 and/or Attachment 5 for the appropriate type of transport.

f. If any radiological conditions exceed the values listed in Attachment 4 and/or Attachment 5, NOTIFY RPO supervision and the shipping organization, prior to tagging the material/vehicle for shipment or delivery.

g. For each package of radioactive material that is incoming,
   - RPO personnel must be present and monitor the internal surfaces of the package, in accordance with Section 4.2 of this procedure.
   - COMPLETE and ATTACH appropriate labels/postings in accordance with RP-OP-005.

4.3.3.2 SURVEY FOR ONSITE TRANSFER OF RADIOACTIVE MATERIAL

This section describes the surveys required for onsite transfer of radioactive material. A radioactive material transfer occurs when radioactive material is moved outside one controlled area and is conveyed to another controlled area.

a. PERFORM applicable radiation and contamination surveys in accordance with Section 4.2.

b. DETERMINE the maximum dose rate measurements at contact and one meter from the external surface of the package when surveys are required for onsite transfer of materials. If no detectable contact measurement is found, one meter reading does not have to be performed.

c. OBTAIN a sufficient number of 100 cm^2 area wipes to provide a representative assessment of the removable contamination from package and/or vehicle surfaces

d. COMPARE the survey results with the limits found in Attachment 4 and/or Attachment 5 for the appropriate type of transport. The radiation limits for Nonexclusive Use apply to onsite transfer of material.

e. If any radiological conditions exceed the values listed in Attachment 4 and/or Attachment 5, NOTIFY RPO supervision and the shipping organization, prior to tagging the material/vehicle for shipment or delivery.

f. For each package of radioactive material that is being prepared for onsite transfer, COMPLETE and ATTACH appropriate labels in accordance with RP-OP-005.

4.3.4 SURVEY OF RADIOACTIVE AND MIXED WASTES

a. PERFORM radiation level and contamination surveys prior to and during packaging of the waste item(s) to aid in future characterization.

b. REPORT inappropriate packaging to the Line organization. If the waste must be repackaged, INFORM the customer that the survey will have to wait until the items are properly packaged. Inappropriate packaging may include:

- Waste not in double plastic bags.
- Heavy items not also packaged in a secondary container to aid in moving the waste.
- Items with sharp edges not protected/covered.
- Items in open bags or bags with holes or tears.
- Outer package without proper markings (i.e., .Radioactive Material. or .Radioactive Waste.).

c. Unless the generator has determined that tritium or other pure low-energy beta emitter (e.g., Ni-63, S-35, P-32, and C-14) is the only radionuclide present, PERFORM a radiation survey on the package.

NOTE: If contact radiation levels exceed 200 mrem/hr, notify the generator that the waste will need to be repackaged or shielded prior to shipment. Insure that the package is properly posted and that personnel access is controlled commensurate with the hazard.

d. PERFORM a survey for removable surface contamination on the outer package/container.

e. On the survey form, clearly IDENTIFY items with unique descriptions and/or numbers.

f. MARK/LABEL the item(s) with the same descriptive code used in the previous step.

g. COMPLETE and ATTACH a Radioactive Material Tag/Label RP-OP-005.

4.4 RADIOLOGICAL SURVEY DOCUMENTATION

RADIOLOGICAL SURVEYS

Throughout this section, the Radiological Survey Form (Attachment 1) and the Radiological Survey Continuation Form (Attachment 2) will be referred to as the Form. Photographs may be used in place of illustrations, but should be imported onto the Radiological Survey Form whenever possible. For purposes of this procedure, Form will refer to both illustrations and photographs.

4.4.1 Radiological Survey Form (and the Radiological Survey Continuation Form, as needed)

a. OBTAIN a Survey number from the project Radiological Survey Log and ENTER on the form.

b. ENTER page numbers in appropriate spaces on the form.

c. ENTER the survey location on the form. Be as specific as possible. If additional detail is needed to describe a location, ADD the detail to the Remarks section of form.

d. ENTER the Radiological Work Permit (RWP) number in the space provided if the survey was done to support an RWP, otherwise ENTER “NA” or ”N/A” (Not Applicable).

e. ENTER the date and time that the survey was begun.

f. ENTER the purpose of the survey.

g. ENTER the model, probe type(s), and serial number(s) for the instrument(s) used in the performance of the survey in the spaces provided.

h. ENTER each air sampler serial number next to the corresponding location number.

i. ENTER illustration(s) of the item or area surveyed, ENTER all applicable survey data in accordance with this procedure and form legends, and COMPLETE form documentation.

Illustrations are not required for every survey but should be used to add clarity to a survey or help record exact locations where surveys are completed, as necessary. Photographs may be used in place of illustrations, but should be imported onto the form whenever possible.

NOTE: If sections are not applicable, INDICATE this by marking those sections as not applicable (NA), lining through the section(s) and marking them as NA, or adding a statement in the remarks.

4.4.2 Radiation Surveys

a. ENTER the measured dose rates (including background, if using a Model 19) on the Form. Units are assumed to be mrem/hr unless otherwise noted.

b. INDICATE the type of radiation, if other than gamma, on the Form.

c. INDICATE the distance(s) at which the measurement(s) was/were taken on the Form, in accordance with Section 4.2.

d. ENTER any applicable remarks in the “Remarks” section on the Form. This section should be used to provide follow-up information and to document survey conditions, limitations, or assumptions.

4.4.3 Surface Contamination Surveys

a. If applicable, IDENTIFY locations surveyed for transferable contamination with a unique number on an illustration. If an illustration is not used, ADD a description for each

item/location and identify numbers. Provide survey results by the corresponding number in the appropriate area on the form.

b. If applicable, IDENTIFY direct surface survey results and units for each item/location on the illustration. If an illustration is not used, ADD a description for each item/location and identify results.

c. ENTER any applicable remarks in the "Remarks" section on the Form. This section should be used to provide customers with necessary follow-up information and to document survey conditions, limitations, or assumptions.

4.4.4 Radiological Survey Map Legend, as applicable

a. IDENTIFY the location of 100 cm^2 wipes with numbers inside circles and the location of LAWs with numbers inside triangles.

b. IDENTIFY the location of static counts with letters inside rectangles.

c. IDENTIFY the location of step-off pads using a rectangle with the letters "SOP" written inside the rectangle.

d. IDENTIFY the location of dose rates where the readings were taken. See "Legend" on the form for units and distances to be written next to results.

e. IDENTIFY the location where any air sample was taken with "AS". If more than one air sample must be recorded on the same map, IDENTIFY locations by "AS-1", "AS-2",. etc.

4.4.5 Completion of Survey Documentation

a. COMPLETE survey documentation in a timely manner.

b. Handwritten documentation shall be done in black or blue-black ink only.

c. PRINT name, SIGN, and DATE the Radiological Survey Form in the spaces provided.

d. ENSURE that all pages are numbered in sequential order and that the survey number is on each page. The format for numbering pages is Page X of Y, where X is the page number and Y is the total number of pages.

e. ATTACH all survey documentation and TRANSMIT to RPO supervision for review/approval.

f. RPO supervision shall:

- Verify that the documentation meets the requirements of this section prior to approval.
- Review and sign/initial survey documentation in a timely manner.
- Ensure the documentation is filed appropriately.

g. When RPO supervisor/lead personnel perform any RC/HP Tech duties, the RCM shall perform reviews, field oversight, and daily direction of radiological operations.

h. Copies of reviewed/approved surveys shall be stamped "Copy" or "Information Only".

i. Changes to survey documentation shall only be made to the record copy. Changes shall be made in black or blue-black ink and initialed and dated.

Radiological Survey Form

Radiological Survey Form

Survey #:	Page of

Location:	RWP#:	Date:	Time:

Purpose:

Instrument and Probe Type	Instrument Serial #	Air Sampler Serial #		Surveyor Print / Sign
		1		
		2		
		3		
		4		
		5		

(#)	α Tranferable Contamination (dpm/100cm²)	βγ Tranferable Contamination (dpm/100cm²)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

△	Tranferable Contamination (dpm/LAW)	
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

ABC	Static Count (dpm/100cm²)	
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		

Illustrations/Remarks:

Legend ND= No detectable activity above background

(#) = 100cm² wipe | SOP = Step Off Pad | Dose Rates in mrem/hr@30cm (unless otherwise noted)

△ = LAW | AS-# = Air Sample | GA=General Area SD=Skin Dose (30cm) Dβ=mrad/hr

ABC = Static Count | ⬠ = Soil Sample (Results Attached) | CT=Contact(2.5cm) ED=Extremity Dose (5cm)

Reviewed by:_____ Date:_____

Radiological Survey Continuation Form

Guidance on Performing Surveys for Unrestricted Use

Degree of Surveillance

The degree of surveillance should be considered as a graded approach, and refers to the percentage of an item/area to be surveyed. Using professional judgment, the RCT should evaluate the history/use of the item(s) to be surveyed as well as the environment to which the item(s) have been exposed.

Use of the following table will increase consistency of free release surveys. It should be noted that if a large number of items require surveillance, or if very large items are to be released, RPO supervision needs to be consulted for additional guidance or alternative approaches to surveillance strategy.

Conditions

The conditions under which an area/item are evaluated should be based upon both historical and recent survey data, when applicable.

Recommended Degree of Surveillance for Free Release (Unrestricted Use) of Material

Degree of Surveillance	Conditions
Not Applicable	1. Known history 2. Located in a Controlled Area but not located in a Contamination Area, High Contamination Area, or Airborne Radioactivity Area 3. Low potential for contamination by other causes (e.g., use/storage of radioactive material, activation)
~ 10%	1. History based on process-knowledge 2. Located in Contamination Area 3. Probability of contamination low
10 - 50%	1. History based on process knowledge 2. Possibly located in Contamination Area 3. Probability of contamination moderate
50 - 100%	1. Located in Contamination Area, High Contamination Area, Airborne Radioactivity Area 2. Probability of contamination moderate to high

Contamination Survey Guidance

The RCT should first plan the survey based upon the appropriate degree of surveillance. Unless it is not practical to perform direct survey (such as when H-3 is the only radionuclide of concern), the survey begins by scanning an area approximately equivalent to 1 m2, or the entire item if less than 1 m2, using appropriate survey instruments(s). The RCT determines the location of the highest reading within this area for each type of radiation.

At the location of the highest reading (treating alpha and beta-gamma readings independently, as appropriate), a static measurement is collected. This reading will be referred to as the maximum measurement and is documented for each radiation type. If the area uniformly has readings at background radiation levels, static measurement is not required.

If the maximum measurement in this 1 m2 area is less than the applicable limit for total contamination, no further direct measurements are required for this particular area. (See Attachment 4.)

If the maximum measurement in this 1 m2 area is greater than the applicable limit for total contamination but less than three times this limit, the RCT should collect multiple static measurements within the area to determine an average value. Unless otherwise deemed appropriate, 3 or 4 static measurements should be taken to determine the average. If the average measurement (the supplemental static measurements along with the initial maximum) is less than the limit for total contamination, no further direct measurements are required.

If, in this 1 m2 area, the average of all direct measurements is greater than the limit for total contamination or any static measurement is greater than three times the applicable limit for total contamination, no additional direct measurements are required until decontamination has been attempted, or a determination to discard the item as radioactive waste is made.

Having completed direct survey in particular area, a wipe sample is collected at the location of the maximum measurement (or as otherwise considered to be appropriate from survey planning).

If multiple static measurements were needed to determine an average value, wipes are collected at each such point.

This process continues until the appropriate degree of surveillance has been achieved.

RADIOACTIVE CONTAMINATION LIMITS

Radionuclide (See Note 1)	**Removable (dpm/100cm^2) (See Note 2)**	**Total (Fixed + Removable) (dpm/100cm^2) (See Note 3)**
U-natural, U-235, U-238, and associated decay products	1,000 α	5,000 α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129, Am-241, Np-237	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224,U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. Includes mixed fission products containing Sr-90.	1,000 β-γ	5,000 β-γ
Tritium and tritiated compounds, Ni-63,C-14	1,000	N/A

Notes:

1. The values in this table, with the exception noted in footnote 5, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha-and beta-gamma-emitting nuclides exists, the limits established for alpha-and beta-gamma-emitting nuclides apply independently.

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

3. The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value.

4. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

5. This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

6. Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this table is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a “Total” value does not apply.

RADIATION AND CONTAMINATION LIMITS FOR RADIOACTIVE MATERIAL PACKAGE TRANSPORT/TRANSFER

Radiation Limits for Outgoing and Incoming Shipments And Onsite Transfer of Material *

Location	**Exclusive Use (mrem/hr)**	**Non Exclusive Use & Onsite Transfer (mrem/hr)**
Contact with package	200*	200
One meter from package	NA	10
External surfaces of the vehicle	200	NA
Two meters from the external surfaces of the transport vehicle	10	NA
In any normally occupied position in the cab or vehicle	2	NA

* If the shipment is made in a closed transport vehicle, the package is secured within the vehicle so that its position remains fixed during transportation, and there are no loading or unloading operations between the beginning and end of the transportation, the limit is 1000 mrem/hr.

- Additional surveys may be required per 49 CFR.

Contamination Limits for Outgoing and Incoming Shipments*

Contaminant	**μCi/cm^2**	**dpm/ cm^2**
β-γ emitter, alpha emitters with a Half-life < 10 days, U nat, Th nat, 235U, 238U, 232Th, 228 Th, 230Th in ores or physical concentrate	10^{-5}	22
All other alpha emitters	10^{-6}	2.2

(Contamination levels for onsite transfer must meet the limits of Attachment 4 of this procedure).

* An incoming shipment in an exclusive use vehicle may not exceed 10 times these limits (49 CFR 173.443(b))

RADIOLOGICAL SURVEY FREQUENCY*

Area	Radiation	Contamination
CONTROLLED AREAS		
Adjacent to Radioactive Material Areas	-----	Quarterly
Adjacent to contamination boundaries or postings of areas established for contamination control	----	Quarterly
RADIOLOGICAL BUFFER AREAS		
In office spaces located in Radiological Buffer Areas where the potential exists for personnel exposure to external radiation	Monthly	----
In routinely occupied areas adjacent to Radiological Buffer Areas established for exposure to external radiation	Monthly	----
In office spaces located in Radiological Buffer Areas established for contamination control	----	Monthly
Lunch rooms/eating areas adjacent to Radiological Buffer Areas established for contamination control	----	Weekly
In routinely occupied Radiological Buffer Areas and locker rooms adjacent to Radiological Buffer Areas established for contamination control	----	Monthly
Inside Radiological Buffer Areas established for contamination control	----	Monthly
RADIATION AREAS		
At temporary boundaries to confirm adequacy of posting	Monthly	----
In routinely occupied areas	Monthly	----
HIGH RADIATION AREAS & HIGH RADIATION AREA BOUNDARIES		
After extended periods of closure, when levels are expected to change	Upon Entry	----
During continuous operations	Weekly	----
CONTAMINATION, HIGH CONTAMINATION, AND AIRBORNE RADIOACTIVITY AREAS		
In routinely occupied Contamination Areas	----	Monthly or Upon Entry
Lunch rooms/eating areas adjacent to Contamination Areas	----	Daily
Contamination control points, or radiological change areas	----	Weekly or Upon Entry
Step-off pads		Daily
RADIOACTIVE MATERIAL AREAS		
In Posted Radioactive Material Areas	Quarterly or Upon Entry	Monthly
AIRBORNE RADIOACTIVITY AREAS		
In posted Airborne Radioactivity Areas	Job Specific	Job Specific
OTHER		
Fixed Contamination Areas (fixed and removable contamination surveys, check labels and paint)	----	Annually
Operating HEPA Filter Ventilation Units	Monthly	Upon Entry
Operating Temporary HEPA vacuum cleaners or containment devices	Daily	Daily
Temporary Shielding	----	Monthly
Inspections of the physical access controls to High and Very High Radiation Areas, in operational or occupied facilities, to verify controls are adequate to prevent unauthorized entry	Weekly (inspection of controls only)	

* DOE-STD-1098-99 and DOE Radiological Control Manual, Revision 1

TETRA TECH, INC

Procedure No: RP-OP-003 Rev 0

AIR SAMPLING

1.0 PURPOSE

This procedure is for sampling radioactive airborne materials in the workplace for occupational safety. It includes requirements for compliance with 10 CFR 20, Standards for Protection Against Radiation and 10 CFR 835, Occupational Radiation Protection, as implemented by the Tetra Tech, Inc. (Tt) Radiation Protection Plan (RPP).

SCOPE

The air sampling described in this procedure includes the use of fixed and portable equipment, grab samplers and personal air (lapel) samplers. Instructions are for area monitoring and personnel monitoring.

This procedure does not apply to air sampling for effluent monitoring or to the use of installed process monitoring systems.

The following activities are described in Section 4.0 of this procedure:

4.1 General

4.2 Use Of Personal (Lapel) Air Samplers

4.3 Use Of Portable Low Volume Air Samplers

4.4 Use Of Portable High Volume (Grab) Air Samplers

4.5 Sample Collection Instructions

4.6 Initial Screening for Short-lived Isotopes

4.6 Sample Counting

4.7 Documentation Of Airborne Radiological Surveys

2.0 REFERENCES

10 CFR 20, Standards for Protection Against Radiation

10 CFR 835, Occupational Radiation Protection

DOE, Technical Position Paper RCTP 95-01, Monitoring of Airborne Radioactivity, February 13, 1996.

DOE, G 441.1-8, Air Monitoring Guide, March 17, 1999

NRC Regulatory Guide 8.25, “Air Sampling in the Workplace,” 1992

NUREG 1400, “Air Sampling In The Workplace,” September 1993

3.0 GENERAL

3.1 EQUIPMENT

- Calibrated air sampling equipment
- Airborne Radiological Survey forms, or equivalent
- Sample collection envelopes
- Sample media

- Contamination survey instruments
- Any additional equipment specified by a governing TWD

3.2 SAFETY CONSIDERATIONS

- Follow the requirements of any TWD for the work location.
- Do not operate portable air sampling equipment in potentially explosive or combustible atmospheres until the facility owner says the area is safe.
- Exercise electrical safety precautions when placing equipment and when making electrical connections.
- Place air samplers so their exhaust will not re-suspend radioactive material. Also, route the exhaust from tritium monitors to unoccupied areas as needed to implement the ALARA principle.
- Ensure that hoses and electrical cords do not create a tripping hazard.
- Check high volume samplers for overheating.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Implementation of this procedure.
- Ensuring that RCTs are qualified to perform this procedure.
- Ensuring that all survey documentation is reviewed.
- Verifying that all documentation generated in support of this procedure meets the requirements of this procedure prior to approval.
- Ensuring the documentation is properly filed and protected

3.3.2 RCTs are responsible for:

- Complying with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological air sampling and while handling sample media.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

- Follow the current and approved operating procedures for air monitoring equipment or samplers.

3.5 RECORDS

The following records are generated in support of this document. These records shall be maintained in accordance with project requirements. Copies of the records may be made for information purposes. Mark inapplicable sections on forms as "N/A."

- Radiological Survey Forms.
- Air Sample Survey Forms

3.6 PRECAUTIONS AND LIMITATIONS

- Naturally occurring radon daughters can give a false indication of airborne radioactivity. The counting lab will determine the presence of radon on lapel samples. For samples from area monitors, RCTs may determine the presence of radon by comparing the activity on a sample at the beginning and end of a half-hour. If the activity decreases by a factor of two, radon daughters may be assumed if other short-lived radioactive material is not suspected.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Section 4.0 of this procedure implements requirements of 10 CFR 835.401 (a) (1)-(5) and 403 (a) (1)-(3).

The following are definitions of terms unique to this procedure. Consult the RPP glossary for standard, radiological safety terms.

Air Sampling – A form of air monitoring, in which an air sample is collected and analyzed at a later time, sometimes referred to as retrospective air monitoring.

Breathing Zone Air Monitoring – Actions conducted to detect and quantify the radiological conditions of air from the general volume of air breathed by the worker, usually at a height of 1 to 2 meters. Personal Air Sampling is the normal method of assessment. If personal Air Sampling is impractical, a low volume sampler at a height of 1 to 2 meters may be used.

Continuous Air Sampling – Air sampling conducted over relatively long periods of time to identify average levels of airborne radioactive materials in a work area. This type of sampling is usually performed by use of a low volume sampler. Long sampling time and the large volume of air collected over that time, gives this type of sampling arrangement the greatest radionuclide concentration sensitivity.

General Area Air Sampling – Actions conducted to detect and quantify the radiological conditions of air from a work area. This type of sampling differs from breathing zone sampling in that the sample result may not be representative of the air an individual is breathing unless the airborne contamination is homogeneous throughout the work area. This type of monitoring is typically performed by low-volume samplers or high-volume samplers.

Grab Sampling – A single sample collected from the workplace air over a short time interval, typically less than one hour. Grab sampling should be used for temporary or non-routine situations, determining current conditions in the air to establish posting and personal protection requirements, and/or as a backup for other types of air sampling in the event of equipment failure. This type of sampling is also useful for identifying the concentration of airborne radionuclides with very restrictive DAC allowances, such as transuranics, in a short period of time. The larger volume of air collected in the short time period provides

a lower minimum detectable concentration (MDC) for the radionuclide of interest. Grab sampling is also referred to as intermittent sampling.

Personal Air Sampling – The sampling of air for radioactive material near a worker's nose and mouth. This is usually by a portable pump and collection tube worn on the body with the filter holder worn on or near the shirt collar, such as a lapel sampler. This is the most representative method for estimating breathing zone concentrations.

3.9 ATTACHMENTS

Attachment 1 Determination of Minimum Sample Volume

Attachment 2 Airborne Radiological Survey Form

Attachment 3 Personal Air Sampling Trigger Level Guidance

Attachment 4 Conversions and Calculations

Attachment 5 Personal Air Sampling Data Sheet

4.0 PROCEDURE

4.1 GENERAL

Determination of the need for air monitoring:

Consider both actual and potential radiological conditions. Use recent sampling results to estimate actual conditions. Estimating potential conditions requires using judgment and experience that a radiological condition could exist. For example, walking through a high contamination area or cutting, grinding or welding on radioactive material can generate airborne radioactivity concentration of concern. When evaluating potential conditions, consider both normal situations and unusual situations. NUREG-1400, (Section 1) provides an acceptable method for evaluating the need for air sampling. A copy is available at http://tis.eh.doe.gov/whs/rhmwp/regs.html.

4.1.1 Workplace air shall be monitored in any of the following situations:

- An individual is likely to receive an exposure of 40 or more derived air concentration (DAC) hours in a year.
- As needed to characterize airborne radioactive material where respiratory protective devices are required for protection against airborne radioactive material.

4.1.2 Workplace air should be monitored if any of the following criteria are met:

- A baseline of airborne radioactivity levels is desired.
- To establish possible airborne radioactive material area boundaries and determine posting requirements.
- To determine if respiratory protection should be worn.
- To assess possible airborne radioactive material hazards during maintenance on contaminated systems or during loss of process controls.
- To determine the type and frequency of bioassay measurements needed.

- To estimate exposures when bioassay measurements are unavailable or unreliable.
- To ensure that airborne radioactivity levels have not changed, resulting in the need to change engineered or administrative controls.

4.1.3 Breathing zone samples are the primary means of monitoring workers where 100 millirem (40 DAC-hrs) during a year is likely.

NOTE: Personal Air Samplers should not be used for general area sampling. Monitor work area airborne radioactivity using low or high volume samplers

NOTE: The smaller the DAC for a radionuclide (for example, Pu-239), the more difficult are measurements. Longer counting times, sampling times, and larger volumes of air are needed.

See Attachment 1 for sample volume requirements for a 30-minute count.

4.1.4 See RPO supervision regarding selection of air sampling equipment, collection media and equipment placement. DOE, G 441.1-8, Air Monitoring Guide, may be consulted regarding placing air monitoring devices.

4.1.5 PROTECT sampling equipment from external contamination (i.e., place samplers on a clean plastic sheet).

4.2 USE OF PERSONAL (LAPEL) AIR SAMPLERS

4.2.1 Personal air samplers support the Internal Dosimetry Program. The need for personal air samplers will be determined by RPO and prescribed in the RWP.

4.2.2 If anti-contamination clothing is worn, PLACE the pump under the clothing to protect it from contamination with the filter head outside in the breathing zone. If not feasible, place the pump in a plastic bag with an exhaust hole, then survey and free-release it when done.

NOTE: When wearing a sampler is infeasible, the sampler may be suspended. The air sampler filter head must sample the breathing zone.

4.2.3 Personal air sampler filter heads shall not be covered by respiratory protective equipment.

4.3 USE OF PORTABLE LOW VOLUME AIR SAMPLERS

Low volume samplers are used to monitor work areas. They have flow rates of about 30 to 40 liters per minute.

4.3.1 The need for air sampling will be determined by RPO. Examples of situations whaere air sampling should be performed include:

- Work in Contamination or High Contamination Areas
- Intrusive work in Soil Contamination Areas
- Area monitoring at the boundaries of radiological areas established for contamination control.
- As directed by RPO supervision

4.3.2 If using the low volume sampler for breathing zone sampling, LOCATE the filter/cartridge in an area representative of the breathing air.

NOTE: ATTACH smooth, flexible tubing to the low volume sampler as needed to position the sampler head. ENSURE the sampler has been calibrated with that length of tubing. EVALUATE the system setup for line loss prior to use.

4.3.3 A gooseneck attachment may be used with the sampler.

4.3.4 ENSURE the job duration and flow rate of the pump will be adequate to meet the required minimum sampling volume. (See Attachment 1)

NOTE: Running the sampler for longer than the job duration to obtain the needed volume of air is prohibited since the result will not show the airborne concentrations during the job.

4.4 USE OF PORTABLE, HIGH VOLUME (GRAB) AIR SAMPLERS

High volume air samplers are used during jobs too short for other samplers. These samplers pull about 6 cubic feet per minute or more. They are useful for monitoring radionuclides with small DACs.

CAUTION: The high volume sampler is often used for 30 minutes or less. Extended use may cause the pump to overheat.

4.4.1 The need for high volume air samples will be determined by RPO.

4.4.2 ENSURE the flow rate of the pump and sampling time will meet the required sampling volume. (See Attachment 1)

NOTE: Running the sampler for longer than the job duration to obtain the needed volume of air is not permitted.

4.4.3 MINIMIZE the sampling time to prevent dust loading where particulate concentrations are high (i.e., welding, burning, grinding).

4.5 SAMPLE COLLECTION INSTRUCTIONS

4.5.1 PREPARE and OPERATE the sampler according to its procedure.

4.5.2 BEGIN sample collection and RECORD Start Time on collection envelope.

4.5.3 After sample has run for needed duration, REMOVE the sample media and SURVEY for contamination. Sample media with activity above background shall be reported to the counting facility before submittal.

NOTE: USE tweezers or a similar tool to remove the sample media from the air sampler. If removing sample with fingers, don gloves first if required for the area. Change gloves as needed to avoid cross contamination. Handle samples carefully during removal and transport to reduce loss of radioactive material.

4.5.4 PLACE sample in envelope, and RECORD Stop Time on envelope.

4.5.5 RECORD all required information on collection envelope,

DOCUMENT sample activity on Radiological Survey Form, and

DELIVER sample to counting facility.

4.6 Initial Screening for Short-lived Isotopes

Due to naturally occurring radon and thorium gases in the atmosphere and their particulate daughters being carried directly or indirectly on dust, air samples may show significant activity from these isotopes alone. Radon daughters, whose longest half-life is approximately 45 minutes, may be considered as completely decayed four hours after the completion of sampling. Thoron daughters, whose longest half-life is 10.6 hours should take approximately 72 hours to be considered completely decayed.

4.6.1 Probe air sample at a minimum of 60-minutes from when air sample was collected and compare results to determine if a radon component is present. The calculated half-life for the radon component will normally fall between 30 - 60 minutes.

Radionuclide half-life can be estimated using the following equation.

$$T\,½ = \frac{(.693)(time)}{-\ln\left(\frac{A}{Ao}\right)}$$

Where:

T½ = Half-life

Time = time between the two counts in question

Ao = Activity of the first count (ccpm)

A = Activity of the second count (ccpm)

4.6.2 If screening results do not follow the radon decay scheme, notify RPO supervision that there may be transuranic airborne activity.

4.7 Sample Counting

Particulate samples shall be analyzed for gross alpha and beta-gamma activity.

See RCM for the controlling DAC limits for project operations.

4.7.1 Create an Airborne Radiological Survey Form for each lo-vol and hi-vol sample using the appropriate computer database and enter General Information, Air Sample Collection Information, and Personnel Information (as applicable).

Create a Personal Air Sampling Data Sheet for each lapel sample using the appropriate computer database and enter all applicable information.

4.7.2 Count air sample for the minimum 10 minutes or the increased time required for minimum detectable counts as indicated by database.

4.7.3 Enter total counts, count time, and background counts into computer form in the "1st count" section for lo-vol and hi-vol samples. Field Sample Analysis Data section is completed on the Personal Air Sampling Data Sheet for lapel samples.

4.7.4 Subsequent counting of the lo-vol and hi-vol air samples should occur 24 hours later ("2nd count") to determine if there is a thorium component. A final count ("3rd count") of the sample should be performed at 72 hours to document final sample activity. Long-lived radionuclide activity can be calculated after determining that any radon and thorium components have decayed.

NOTE: If during decay counting, no further noticeable decay is indicated, the long lived activity and Derived Air Concentration (DAC) values can be calculated. The database calculates these values using the following formulas:

$$LongLivedActivity(uCi/ml) = \left[\frac{activity \times AF}{eff. \times vol \times 2.22E+6}\right]$$

Where:

AF = Absorption Factor (1.25 for alpha and beta-gamma)

activity = corrected air sample activity (ccpm)

eff = counter efficiency

vol = air sample volume in milliliters

$$DAC = \frac{\text{Long Lived Activity}}{\text{DACLim}}$$

Where:

Long Lived Activity = Calculated activity of decayed sample

DAC_{Lim} = Air sample concentration limits

$DAC_{Total} = DAC_{alpha} + DAC_{beta}$

. 4.8 DOCUMENTATION OF AIRBORNE RADIOLOGICAL SURVEYS

4.8.1 When required counts have been completed, PRINT form.

4.8.2 OBTAIN appropriate analyst signatures, and

FORWARD to RPO management for review.

4.8.3 FORWARD lapel samples and associated Personal Air Sampling Data Sheets to WSRC Central Counting Facility (CCF) for entry into Internal Dosimetry tracking system.

DETERMINATION OF MINIMUM SAMPLE VOLUME

The following is the minimum volume needed to detect 10% of a DAC based on a Lower Limit of Detection (LLD) for the scaler of 0.4 dpm alpha with a 95% confidence of detection and a 30 minute count. Ten-minute samples at a minimum should be pulled unless otherwise approved by the RPO Supervision.

DAC from 835 μCi/ml	Sample Volume (ft^3)	Sample Volume (l)
2E-13	531	15052
4E-13	266	7526
5E-13	213	6021
6E-13	177	5017
7E-13	152	4300
1E-12	107	3024
2E-12	54	1512
5E-12	22	612
6E-12	18	504
2E-11	5	150
2E-10	.5	15
3E-10	.4	10
5E-10	.2	6
6E-10	.2	5
2E-08 and all above this	.1	1.5

* For information regarding DACs that are not listed see the 10 CFR 835, Appendix A.

Airborne Radiological Survey Form

Air Sample #:

General Information

Location: Date: RWP #: Instrument Type:

Purpose:

Surveyor:

Air Sample Collection Information

Sampler Type: Sampler #: Flow Rate: Flow Unit: Total Flow (ml):

Time On: Time Off: Respirators Used ☐ Protection Factor:

Personnel Information

Name	ID#	Name	ID#	Name	ID#

Counting Information

1st Count Date: Time: Instrument: α efficiency: β efficiency:

	Cnt Time (min)	Bkgd (cpm)	Total Cnts	Conc. (uCi/ml)	DAC
α					
β					

Total DAC:

Analyst Signature: _____

2nd Count Date: Time: Instrument: α efficiency: β efficiency:

	Cnt Time (min)	Bkgd (cpm)	Total Cnts	Conc. (uCi/ml)	DAC
α					
β					

Total DAC:

Analyst Signature: _____

3rd Count Date: Time: Instrument: α efficiency: β efficiency:

	Cnt Time (min)	Bkgd (cpm)	Total Cnts	Conc. (uCi/ml)	DAC
α					
β					

Total DAC:

Analyst Signature: _____

Comments:

Printed Name: _____

Reviewer Signature: _____ Date: ___/___/___

Technical Basis for Air Sampling Activities

(Reserved for Project Specific Information as required)

Figure 1
HV-1

Figure 2
LV-1

Figure 3
LV-14M

Figure 4
MSA Escort

CONVERSIONS AND CALCULATIONS

Military Time Conversion			
Midnight	2400	Noon	1200
1:00 am	0100	1:00 pm	1300
2:00 am	0200	2:00 pm	1400
3:00 am	0300	3:00 pm	1500
4:00 am	0400	4:00 pm	1600
5:00 am	0500	5:00 pm	1700
6:00 am	0600	6:00 pm	1800
7:00 am	0700	7:00 pm	1900
8:00 am	0800	8:00 pm	2000
9:00 am	0900	9:00 pm	2100
10:00 am	1000	10:00 pm	2200
11:00 am	1100	11:00 pm	2300

Equations

Run Time (Minutes) = Sample End Time – Sample Start Time

Average Flow Rate (lpm or cfm) = (Beginning Air Flow + Ending Air Flow) / 2

Total Volume of Air = Run Time (Minutes) x Average Flow Rate (lpm or cfm)

Milliliters of Air = Total Volume of Air (liters) x 1000

Conversion of cubic feet to milliliters = 2.832E+04 mL / ft3

Conversion of dpm to µCi = 4.505E-7 µCi / dpm

Personal Air Sampling Data Sheet

Date	Employee User ID	Employee Name	Isotope of Interest ☐ Pu ☐ U ☐ Sr	Bioassay Required PAS? ☐ Yes ☐ No
Facility	Air Sample Barcode No. (7 Digits)	RWP/SRWP No.	RSLS No.	

Other Employees Assigned to This PAS

User ID	Employee Name	User ID	Employee Name	User ID	Employee Name
User ID	Employee Name	User ID	Employee Name	User ID	Employee Name

PAS Issue Data

PAS Pump No.	Issued By (Initial)	Respiratory Protection (select one)	DC-Lite Serial No.	Time On	Start Flow Rate (mLpm)	Time Off	Stop Flow Rate (mLpm)	Averate Flow Rate (mLpm)
		○ Full Face ○ Plastic Hood ○ None ○ Plastic Suit ○ PAPR						

Field Sample Analysis Data

Counted By (Initials)	Counter ID No. / Cal. Due Date	Count Date / Count Time	Net Activity (dpm)	DAC-hr Value

Pu-239 DAC-hr = $\frac{\text{Sample dpm}}{(13{,}320) \times (0.72)} \times \frac{20{,}000}{\text{Average Flow Rate}} \times 2{,}000$

U DAC-hr = $\frac{\text{Sample dpm}}{(88{,}800) \times (0.72)} \times \frac{20{,}000}{\text{Average Flow Rate}} \times 2{,}000$

Sr-90 DAC-hr = $\frac{\text{Sample dpm}}{(8{,}880{,}000) \times (0.72)} \times \frac{20{,}000}{\text{Average Flow Rate}} \times 2{,}000$

Comments

Completed by (RCO Inspector Signature)	Date
Reviewed by (FLM Signature)	Date
Data Verified in DAC-hr Database (CCF Signature)	Date

RADIOLOGICAL RESPIRATORY PROTECTION

1.0 PURPOSE

To provide guidance and requirements to Radiological Control Technicians (RCTs) on the proper selection of respiratory protection devices used for protection against the inhalation of airborne radioactive contaminants.

Guidance and requirements contained in this procedure comply with and supplement applicable requirements and guidance of the Tetra Tech, Inc. (Tt) Radiological Protection Plan (RPP).

The following activities are described in Section 4.0 of this procedure:

4.1 General Information

4.2 Selection of Respiratory Protection Devices

4.3 Use of Respiratory Protection Devices

4.4 Removal of Respiratory Protection Devices

4.5 Release of Respiratory Protection Devices

4.6 Respirator Decontamination

2.0 REFERENCES

10 CFR 20, Standards for Protection Against Radiation

10 CFR 835, Occupational Radiation Protection

Tt Radiation Protection Plan (RPP)

Tt Site-Specific Health and Safety Plan (SSHASP)

DOE Order 440.1A, Worker Protection Management for DOE Federal and Contractor Employees

ANSI Z88.2-1992, American National Standard for Respiratory Protection

DOE Radiological Control Technical Position RCTP 2000-5, Use of Respiratory Protection Device Assigned Protection Factors for Radiological Protection Purposes

29 CFR 1910.134, Respiratory Protection

NUREG-0041, Manual of Respiratory Protection Against Airborne Radioactive Materials, October,1976

3.0 GENERAL

3.1 EQUIPMENT

Respiratory protection devices:

MSA Ultravue® negative pressure respirators with P100 HEPA filter cartridges, or equivalent.

MSA Ultra Elite® Twin-Cartridge respirators with P100 HEPA filter cartridges, or equivalent.

3.2 SAFETY CONSIDERATIONS

Specifics of the Radiological Respiratory Protection Program are contained in Chapter 5, Part 3 of the Tt RPP. RCTs shall read that section before implementing this procedure.

3.3 RESPONSIBILITIES

RPO supervision:

- Implementing this procedure.
- Ensuring that RCTs are qualified to perform this procedure.
- Providing support for determination of feasible engineering controls when assessing the need for respiratory protection.
- Assisting in the selection of the appropriate type/class of respirator that will provide adequate protection for each radiological contaminant.
- Reviewing the concentration of radiological contaminants in the work area both prior to respirator selection and periodically during respirator use as needed.
- Informing RPM if contamination is found on the inside of a respirator facepiece and/or on an individual's face after removal of respiratory equipment.

Radiological Control Technician:

- Immediately stopping the activity when unable to follow this procedure as written, and notifying RPO supervision; initiating a Procedure Change Notice," if applicable.
- Assessing the radiological respiratory hazard(s) in a work area and specifying respiratory protection for this work, if needed.
- Performing periodic monitoring of radiological hazards in the work area in accordance with RP-OP-003 and RP-OP-004 to ensure that the assigned respiratory protection is effective against the hazard(s) of concern.
- Surveying respirators that have been decontaminated, per RP-OP-002.
- Informing their RPO supervision if contamination is found on the inside of a respirator facepiece and/or on an individual's face after removal of respiratory equipment.

3.4 PREREQUISITES

Engineered controls for airborne radioactive material are preferred to respirator protection and must be considered before respirators are used. Personnel who wear respiratory protection shall comply with the requirements of Section 9 of the SSHASP.

3.5 RECORDS

Records may be generated during implementation of this procedure. The original copy is the record copy and is forwarded to project Quality Assurance for processing. Copies of the original documents may be made for information. All Radiological Respiratory Protection will be designated on the Radiological Work Permit.

3.6 PRECAUTIONS AND LIMITATIONS

3.6.1 Specifics of the Radiological Respiratory Protection Program are contained in Chapter 5, Part 3 of the Tt RPP. RCTs shall read that section before implementing this procedure.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

3.8.1 Section 4.0 of this procedure implements 10 CFR 835.1003(a) and (b).

3.8.2 Definitions

Some Standard Environment, Health and Safety (EH&S) definitions can be found in the RPP. The following definitions supplement that glossary.

Aerosol	Particles, solids, or liquids, suspended in air.
Airline Respirator	An atmosphere-supplying respirator in which the air respirable gas is not designed to be carried by the user (formerly called supplied-air respirators)
Air-Purifying Respirator (APR)	A respirator in which ambient air is passed through an air-purifying element that removes the contaminant(s). Air is passed through the air-purifying element by means of the breathing action of the user.
Assigned Protection Factor (APF)	The expected workplace level of respiratory protection that would be provided by a properly functioning/fitted respirator and trained user.
Atmosphere-Supplying Respirator	A class of respirators that supply a respirable atmosphere, independent of the workplace atmosphere.
Continuous-Flow Respirator	An atmosphere-supplying respirator that provides a continuous flow of respirable gas to the respiratory inlet covering.
Demand Respirator	An atmosphere-supplying respirator that admits respirable gas to the facepiece only when a negative pressure is created inside the facepiece by inhalation.
Immediately Dangerous to Life or Health (IDLH)	Any atmosphere that poses an immediate hazard to life or poses immediate irreversible debilitating effects on health.
Positive-Pressure Respirator	A respirator in which the pressure inside the respiratory inlet covering is normally positive with respect to ambient air.
Self-Contained Breathing Apparatus (SCBA)	An atmosphere-supplying respirator in which the respirable air source is designed to be carried by the user.

3.9 ATTACHMENTS

Attachment 1 Respirator Use Recommendation Charts

4.0 PROCEDURE

4.1 GENERAL INFORMATION

Engineering controls and safe work practices should be implemented to contain radioactivity at the source, thereby reducing the need for respiratory protection. Use of respiratory protection should be considered under the following conditions:

- When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists.
- During breach of contaminated systems or components.
- When work is to be done in areas or on equipment identified as High Contamination Areas.
- During work on contaminated or activated surfaces with the potential to generate airborne radioactivity in excess of 0.1 times the Derived Air Concentration (DAC).
- Work in Environmental Restoration sites where engineered controls are not feasible.
- When requested by radiation workers.

Only NIOSH approved respirators shall be used. Changes or modifications void the respirator's NIOSH approval.

4.2 SELECTION OF RESPIRATORY PROTECTION DEVICES

The selection of respiratory protection devices for protection against airborne radioactive material has roles for both RCTs and IH personnel. In general, RCTs determine the need for respiratory protection while IH personnel document the selection of the equipment. Both are involved in the selection of a particular respiratory protection device.

4.2.1 To the extent possible, DETERMINE the following:

- Radionuclides of concern and the physical properties of each. This information should be recorded in the RWP/TWD covering the operation.
- Worker activity, such as continuous or intermittent, and rate, such as light, medium, or heavy.
- Work location and area(s) of potential hazard(s).
- Duration and frequency of the job.

4.2.2 MEASURE (in accordance with RP-OP-002) or ESTIMATE the area dose rate(s) of the work site.

4.2.3 OBTAIN representative air sample(s) in accordance with RP-OP-003 to determine the airborne radionuclide concentration(s) at the work site, unless:

- The acquisition of air sample(s) is not practical.
- The acquisition of air sample(s) is not consistent with the ALARA principle.
- This is a first time activity.
- The work itself may generate airborne activity.

For these cases, CONTACT RPO supervision for guidance. Steps 4.2.4 and 4.2.5 shall be performed by RPO supervision.

4.2.4 DETERMINE the Derived Air Concentration (DAC) for each radionuclide of concern (see 10 CFR 835, Appendix A). If unsure of the appropriate DAC value, USE conservative values.

4.2.5 DETERMINE the fraction of the DAC in the work area by dividing the measured or estimated radionuclide concentration by the corresponding DAC value.

$$\frac{Radionuclide\ Activity\ Concentration\ (\mu Ci/ml)}{DAC\ value\ (\mu Ci/ml)} = DAC\ Fraction$$

a. If two or more radionuclides of concern are present and the concentration of each radionuclide can be determined, CALCULATE the DAC fraction as follows:

$$\frac{\mu Ci/ml_A}{DAC_A} + \frac{\mu Ci/ml_B}{DAC_B} + \ldots + \frac{\mu Ci/ml_n}{DAC_n} = DAC\ Fraction$$

b. If two or more radionuclides of concern are present, and the concentration of one or more of the radionuclides is not known, CALCULATE the DAC fraction based on the most restrictive DAC for the radionuclides of concern.

4.2.6 If the DAC fraction is < 0.1, DOCUMENT that respiratory protection is not required. This may be done on the Airborne Radiological Survey Form or an attachment to the RWP.

4.2.7 If the DAC fraction is equal to or exceeds 0.1, DETERMINE if the use of respiratory protection is recommended by using the appropriate chart in Attachment 1 and finding the point where the area dose rates (measured or estimated) and the DAC fraction intersect.

a. Respiratory protection is recommended when intersecting points are located OUTSIDE of the shaded area of the graph.

b. Respiratory protection may not be warranted for short-term jobs. If needed, CONTACT RPM for assistance.

c. Respiratory protection may not be consistent with the ALARA principle due to the potential for increased external exposure when intersecting points are located WITHIN the shaded area of the graph.

NOTE: RPP Article 119 states" Tt will not allow personnel to enter posted Airborne Radioactivity Areas (ARA) without proper respiratory protection." This section and the accompanying attachment are included in the event that a situation occurs where RPM concurs that an exception to this policy is in keeping with the ALARA principle.

4.2.8 If respiratory protection is recommended, SELECT a respirator that has an Assigned Protection Factor (APF) greater than the value of the DAC fraction. APFs for commonly used respirators are listed below.

Respirator Type	APF
Air Purifying (APR) - Full Face	50
Airline Hood (Supplied-Air)	1,000
SCBA	10,000

4.2.9 CONTACT project Safety representative for assistance if: there is a potential for an oxygen-deficient environment; a confined space hazard exists; there is thermal stress (heat or cold), or there are chemical or biological materials involved in the activity.

4.2.10 DOCUMENT the type of respirator selected and any work time restrictions on the RWP.

4.2.13 ATTACH or INCLUDE any supporting calculations with the RWP, for example, DAC calculations.

4.3 USE OF RESPIRATORY PROTECTION DEVICES

WARNING: RCTs should remind personnel to check the fit of respirators each time a respirator is donned or adjusted.

4.3.1 EVALUATE the level of airborne radioactivity in the workplace per RP-OP-003.

4.3.2 EVALUATE air sample(s) as soon as practicable to ensure that the appropriate respiratory protection is being used.

4.3.3 STAND DOWN the job and RE-EVALUATE respiratory requirements if air sample results demonstrate the potential for the DAC fraction to exceed the APF. Notify RPO supervision and Project Management if you stand down a job.

4.4 REMOVAL OF RESPIRATORY PROTECTION DEVICES

4.4.1 If required by the RWP or RPO supervision's instructions that respiratory devices be surveyed before reuse that day, PERFORM a surface contamination survey on both the inside and outside of the mask.

4.4.2 If the respiratory equipment is not going to be re-used the day of use, SURVEY the respiratory protection equipment (checking inside and outside the mask) as soon as practical upon its removal. Avoid contaminating the inside of the facepiece.

4.4.3 If contamination is found on the inside of a respirator facepiece, NOTIFY RPO supervision as soon as practical. DOCUMENT contamination levels and place respirator in a sealed bag so that it can be inspected for possible failure.

4.4.4 Initial failure inspections will be performed by RPO. Failure inspections and return to service certifications may also be performed by the vendor at their offsite facility.

4.5 RELEASE OF REPIRATORY PROTECTIVE DEVICES

4.5.1 If respirator contamination levels are below the release limits in RP-OP-002, REMOVE the respirator from the Radiological Area as soon as is practical. TAG with a Material Release Tag as necessary.

4.5.2 If respirator contamination levels exceed the release limits in RP-OP-002, CONTROL the equipment as radioactive material and process for shipment to vendor facility for decontamination. If decontamination in the field is necessary, perform in accordance with RP-OP-008.

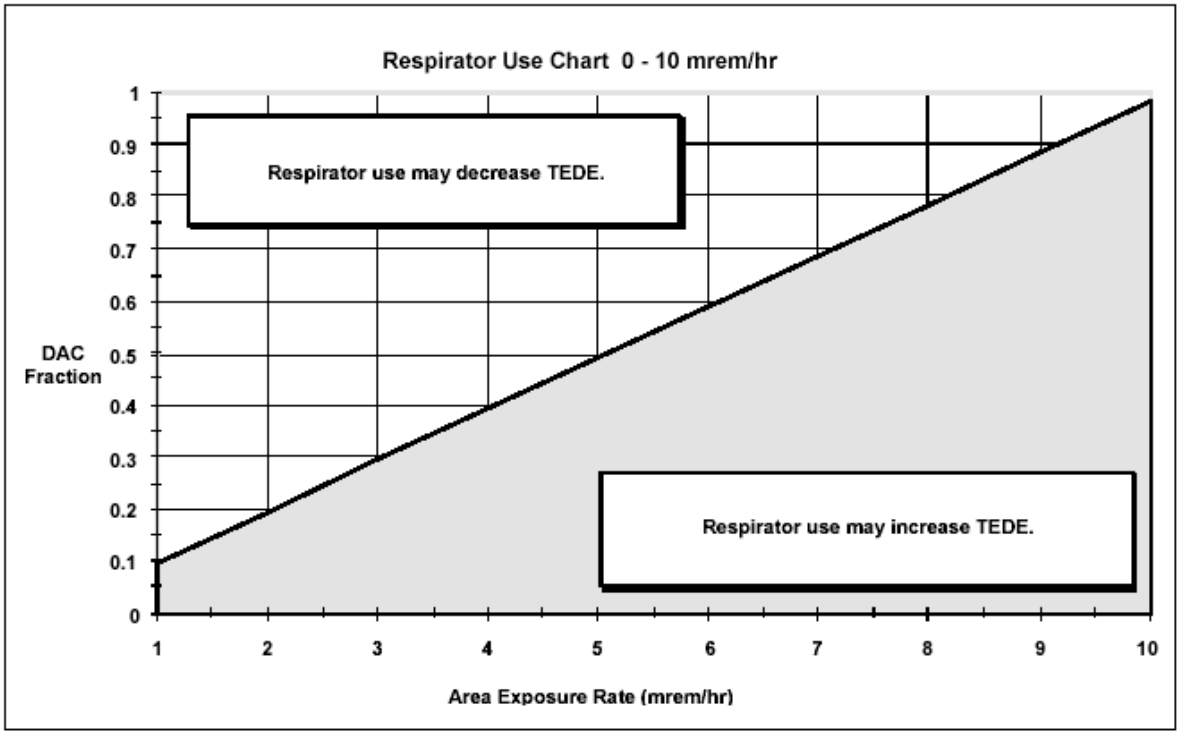
NOTE: Respirator filters will not be reused, therefore once the respirator is removed at the end of shift filters will be disposed of as radwaste.

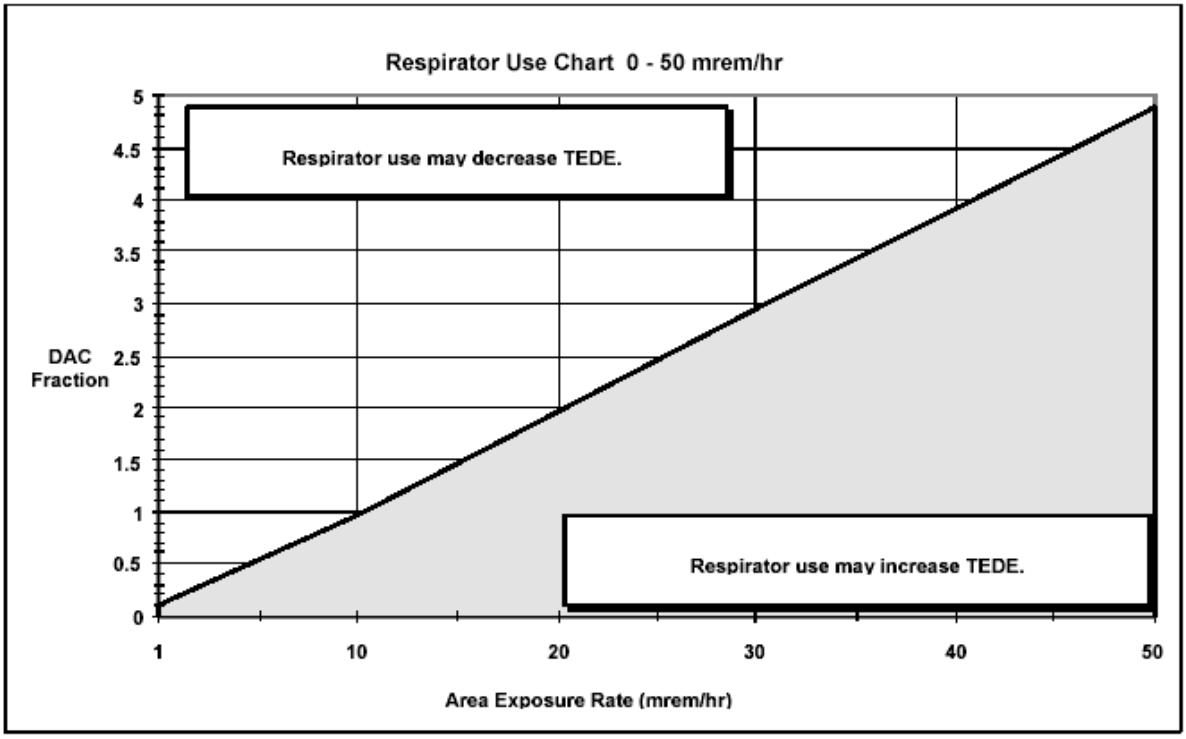
4.6 RESPIRATOR DECONTAMINATION

4.6.1 ASSIST personnel with the decontamination of their respiratory protection equipment, as necessary.

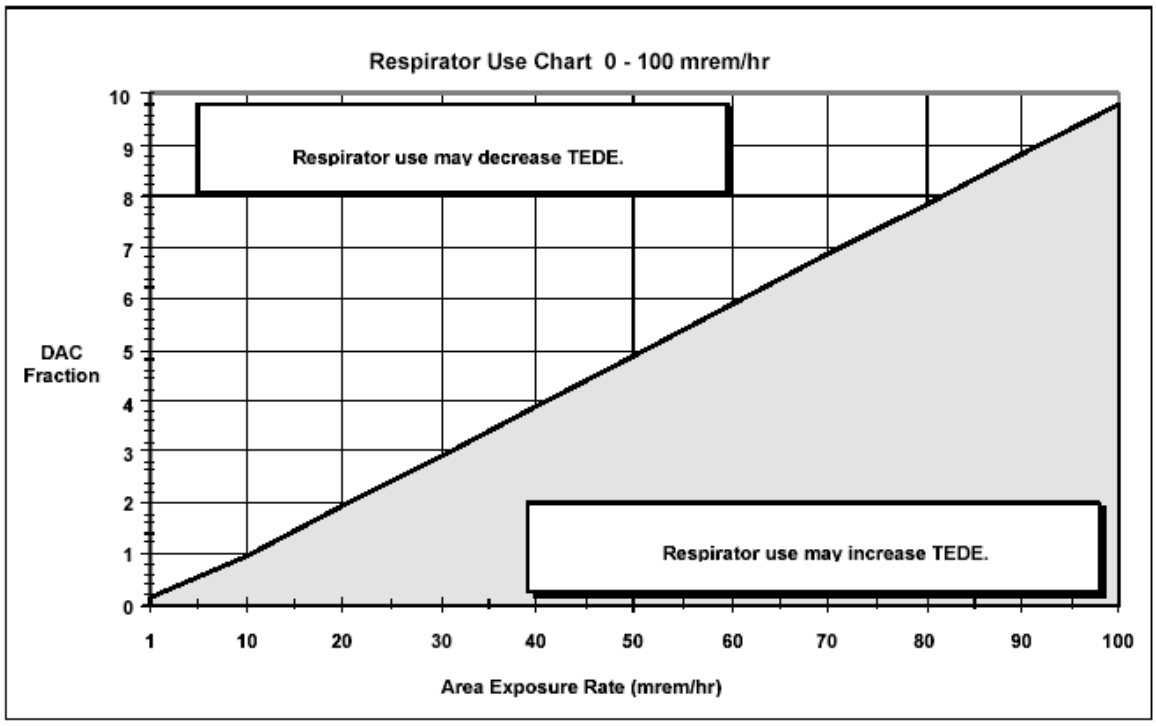
NOTE: Respirators may be decontaminated with proprietary cleaners. MSA requires the use of Confidence Plus® Germicidal Cleaner.

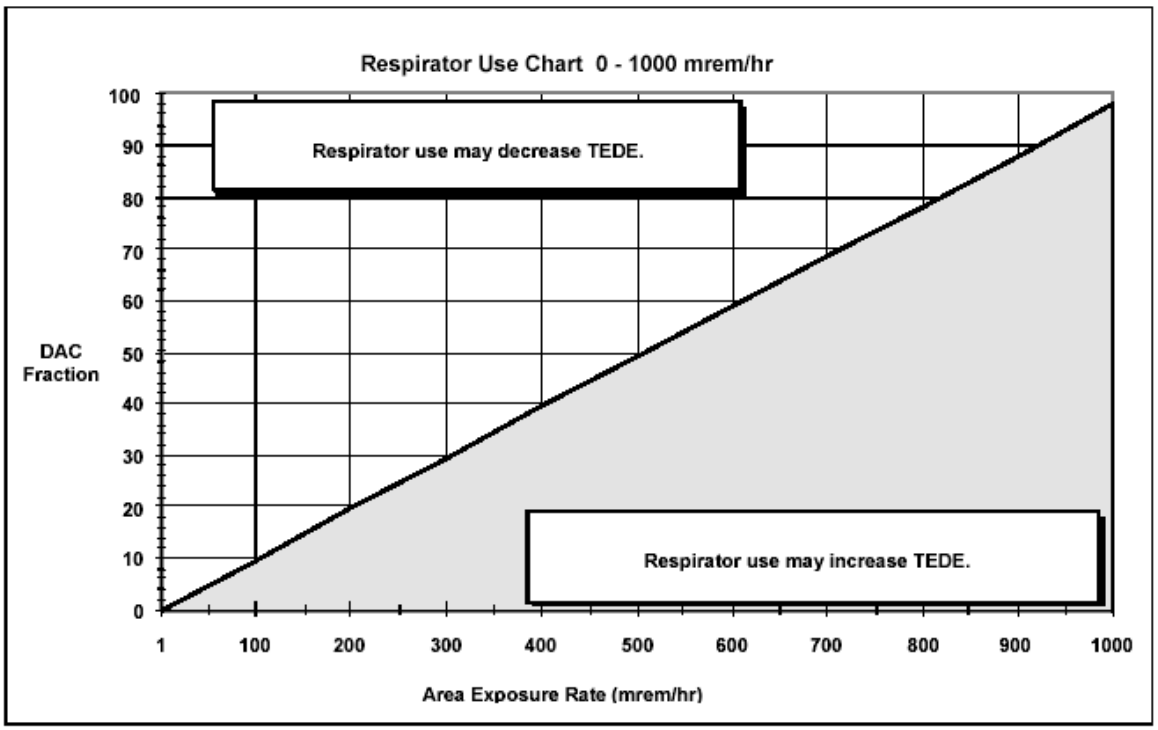
Respirator Use Recommendation Charts





Respirator Use Recommendation Charts





RADIOLOGICAL POSTING, LABELING, AND ENTRY CONTROL

1.0 PURPOSE

This procedure presents the requirements and guidance for establishing radiological controls that are consistent with 10 CFR 20 (NRC) and 10 CFR 835 (DOE). This procedure describes the use of visual and audible indicators, physical barricades, and administrative controls that are available to facility management and RCTs when establishing and verifying the adequacy of area radiological controls.

SCOPE

This procedure addresses all signs, labels, barriers, and administrative controls that are used to alert personnel to the presence of ionizing radiation or radioactive material to assist individuals in maintaining exposures ALARA. This procedure applies to all RPO support activities.

The following activities are described in Section 4.0 of this procedure:

4.1 Radiological Characterization

4.2 Requirements for Posting and Labeling

2.0 REFERENCES

10 CFR 20, Standards for Protection Against Radiation

10 CFR 835, Occupational Radiation Protection

DOE, DOE-STD-1098-99, Radiological Control, July 1999

DOE, G 441.1-10, Posting and Labeling for Radiological Control Guide

Tt Radiation Protection Plan (RPP)

3.0 GENERAL

3.1 EQUIPMENT

- Radiological warning signs, stickers, labels, and tags
- Information inserts for warning signs
- Radiological warning rope and tape
- Radiological warning chains
- Stanchions
- Duct tape, or equivalent
- Heavy-duty safety scissors, wire cutters, etc., for cutting rope, tape, etc. Portable radiological survey equipment.

3.2 SAFETY CONSIDERATIONS

Personnel establishing physical barriers with ropes, tape, or other materials that require cutting to length shall exercise appropriate safety precautions when using cutting tools. Safety scissors

should be used, if available, as much as possible. The use of knives, razors, and similar implements should be kept to a minimum.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Implementation of this procedure.
- Ensuring that RCTs are qualified to perform this procedure.

3.3.2 RCTs are responsible for:

- Complying with this procedure.
- Ensuring compliance with posting, labeling, and entry control requirements during the conduct of work activities.
- Identifying and properly disposing of unauthorized signs and labels; and documenting violations in accordance with project guidance.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

Not applicable

3.5 RECORDS

No records are directly generated during the course of implementing this procedure.

3.6 PRECAUTIONS AND LIMITATIONS

Not applicable

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

No Revision Bars were used due to complete re-write of procedure.

3.8 ATTACHMENTS

Attachment 1 Required and Supplemental Area Posting

Attachment 2 Required Labeling

Attachment 3 Posting and Labeling Exceptions

Attachment 4 Accepted Signs and Inserts for Radiological Postings

Attachment 5 Entry Control Requirements for High and Very High Radiation Area

RADIOLOGICAL POSTING, LABELING, AND ENTRY CONTROL

4.0 PROCEDURE

4.1 RADIOLOGICAL CHARACTERIZATION

4.1.1 Radiological surveys shall be performed, if necessary, as the basis for posting, labeling, and entry controls. Surveys will be conducted and documented in accordance with RP-OP-002, RP-OP-003, and RP-OP-013.

4.1.2 Using current radiological survey data, COMPARE measured or estimated radiological conditions to posting criteria found in the RPP. DETERMINE the type of postings appropriate for the area and the hazards involved or verify the adequacy of existing controls. VERIFY radiological conditions at boundaries to affected area with surveys if necessary.

4.1.3 RPO supervision may authorize the use of radiological data from existing surveys in lieu of new survey for areas with stable, well-characterized conditions, or if ALARA considerations preclude a new survey.

4.1.4 For areas not routinely accessed, surveys shall be performed prior to, or during personnel entry. These surveys shall provide radiological information required to assess hazards associated with work to be performed.

4.2 REQUIREMENTS FOR POSTING AND LABELING

4.2.1 Posting requirements in this procedure are intended to supplement the requirements already listed in the RPP. Required and supplemental postings (including entry control requirements) are shown in Attachment 1. Required and supplemental labeling are shown in Attachment 2. Exceptions to posting and labeling requirements are shown in Attachment 3. Accepted signs and inserts (including format, hazard ranking) are shown in Attachment 4. Entry control requirements for High and Very High Radiation Areas is in Attachment 5.

4.2.2 Boundaries for posted radiological areas should consist of permanent structures (such as walls or fences) or specific radiological demarcations (such as yellow and magenta rope, chain, or tape). Entry/exit points may be marked with cones, whiskers, or other similar identifiers as approved by Radiological Protection Manager.

Note: Ropes and chains should not be attached to energized devices, operating handles, valves or other operating components.

4.2.3 Appropriate signs should be placed intermittently along the accessible boundaries of an area. Typically signs will be posted every 40 – 75 feet, depending on the physical layout of the area. Signs should not be placed more than a maximum of 100 feet apart. In areas in which the longest dimension is ≤40 ft., it is only necessary to display a sign at the designated entry point, provided the entire boundary is clearly visible from any avenue of approach.

4.2.4 Normally inaccessible areas (e.g., manholes which would require the use of tools or lifting equipment to open) should be marked indicating potential radiological hazards. Once opened, such areas should be controlled in the same manner as normally accessible areas.

4.2.5 Posting may be used to reflect potential or intermittent conditions.

4.2.6 Contamination/radiation levels or ranges should be indicated on a status insert or survey map posted at the entrance to a radiological area and updated as conditions change significantly. Inserts such as “Contact RPO (or HP) Prior to Entry” or “Do Not Enter” may be used in lieu of status insert or survey map in areas with no ongoing work activity by workgroups other than RPO.

4.2.7 NOTIFY RPO supervision immediately if areas for which controls have been established are new, or if area posting and/or entry control requirements have changed.

4.2.8 Areas containing multiple radiological conditions (e.g., contamination and high radiation) within the same immediate area shall have each hazard identified. Areas with multiple, but separate radioactive material or radiological areas, shall have access points posted with the highest hazard condition likely to be encountered upon immediate entry into the specific controlled area, radioactive material area or radiological area.

Required and Supplemental Area Posting

Posting (including insert) Postings also require standard radiation warning trefoil.	**Requirements and Access Controls**
Caution, ***Controlled Area*** ***(DOE ONLY)***	• Mandatory if RBA, radiological or radioactive material areas exist. • It is not necessary to erect physical barriers to identify the boundaries of Controlled Areas. Signs should be placed at normal access routes to identify the area. • Worker Responsibilities Sign required
Caution, ***Radiological Buffer Area*** *(RBA)* ***(DOE ONLY)***	• Completely surrounded by barrier. • Surrounding entry/exit point of CA, minimum • **"Entering/Exiting RBA" Sign** and **Count Rate Meter with Hand and Foot Frisk directions** at entry/exit • *TLD Required for Entry insert required* if dose rate is ≥0.07 mrem/hr in a High Occupancy Area. or ≥0.2 mrem/hr in a Med/Low Occupancy Area
Caution, ***Radiological Controlled Area*** *(RCA)* ***(NRC ONLY)***	• Completely surrounded by barrier. • **"Entering/Exiting RCA" Sign** and **Count Rate Meter with Hand and Foot Frisk directions** at entry/exit • *TLD Required for Entry insert required* if dose rate is ≥0.07 mrem/hr in a High Occupancy Area. or ≥0.2 mrem/hr in a Med/Low Occupancy Area
Caution, ***Radioactive Material(s)***	• Completely surrounded by barrier. • No RCA/RBA required, unless exposure control needed (>100mrem/yr)
Caution, ***Radiation Area*** *(RA)* *TLD Required for Entry*	• Completely surrounded by barrier. • *Status (insert or map)* • *See Section 4.2.6 for direction on inactive areas*
Danger, ***High Radiation Area*** *(HRA)* *TLD, Supplemental Dosimetry, & RWP Required for Entry*	• PHYSICAL ACCESS CONTROLS REQUIRED (specified by RPM) • *Status (insert or map)* • *See Attachment 5*
Grave Danger, ***Very High Radiation Area*** *(VHRA)* *Special Controls Required for Entry*	• PHYSICAL ACCESS CONTROLS REQUIRED (specified by RPM) • *Status (insert or map)* • *See Attachment 5*

Caution, ***Contamination Area*** *(CA)*	• Completely surrounded by barrier. • **SOP, PPE Receptacles PPE Donning/Doffing Sign** and **Count Rate Meter with Whole Body Frisk directions** at entry/exit • *Status (insert or map)* • *See 4.2.6 for inactive areas*
Danger, ***High Contamination Area*** *(HCA)* *RWP Required for Entry*	• Completely surrounded by barrier. • **SOP, PPE Receptacles, & PPE Donning/Doffing Sign** and **Count Rate Meter with Whole Body Frisk directions (**if not located in a CA**)** at entry/exit • *Status (insert or map)* • *See 4.2.6 for inactive areas*
Caution, *Or Danger (when required-NRC only)* ***Airborne Radioactivity Area*** *(ARA)* *RWP Required For Entry*	• Completely surrounded by barrier. • Airborne concentrations routinely exceed 0.1 DAC. • Must also be posted as a *CA.* • *Status (insert or map)*
Caution, ***Underground Radioactive Material Area*** ***(DOE ONLY)*** *(URMA)* *Contact RPO Prior to Digging*	• No physical barriers to identify boundaries, only signs along identified hazard. • No Controlled area or RBA, unless exposure control needed (>100mrem/yr)
Caution, ***Soil Contamination*** ***(DOE ONLY)*** *(SCA)* *Contact RPO Prior to Digging*	• No physical barriers to identify boundaries, only signs along identified hazard. • See RP-OP-013 for more direction • No Controlled Area or RBA required, unless exposure control needed (>100mrem/yr)
Caution, ***Fixed Contamination*** ***(DOE ONLY)***	• Areas of fixed contamination, outside of CA and determined by RPM to be likely transferred, shall be marked to indicate boundaries of fixed contamination and painted with two layers of different colored paint (different than surrounding areas). • An inventory of Fixed Contamination Areas shall be maintained by the RPO. • No Controlled Area or RBA required, unless exposure control needed (>100mrem/yr)

NOTE 1: Posting definitions and criteria can be found in Chap. 2, Part 3 and Glossary of the RPP.

NOTE 2: DOE ONLY If the total effective dose equivalent (TEDE) to an individual is likely to exceed 100 mrem in a year from a Soil Contamination Area, an Underground Radioactive Material Area or a Fixed Contamination Area, then those areas must be contained within a posted Controlled Area. If monitoring shows that contamination transferred out of a Soil Contamination Area exceeds the removable contamination limits specified by the RPP Table 2-2, then the area must also be posted as a Contamination Area or a High Contamination Area.

REQUIRED LABELING

LABEL or TAG Labels or tags also require standard radiation warning trefoil.	**Conditions**
Caution, *Radioactive Material*	Radioactive items or containers of radioactive material exceeding one-tenth the quantities specified by the RPP, Appendix 4A or unknown quantities. Vehicles transporting radioactive material where 49 CFR requirements do not apply (does not cross or travel on a public access road)
Caution, *Radioactive Material* *Or* *Caution* *Internal Contamination*	Equipment, components, or other items with actual or potential internal contamination. When using radioactive material label or tag, internal or potential internal contamination should be added and additional information should be given.
Caution, *Radioactive Material*	Components, equipment, or other items with fixed contamination and are restricted for use only within radiologically controlled areas. Locations and levels of contamination should be identified on label

NOTE 1: Yellow and magenta bags printed with Caution Radioactive Material and trefoil do not require a label or tag if appropriate information is also written on the bag.

NOTE 2: If an item is too small to accommodate a label, then the label should be applied to the exterior container or storage location.

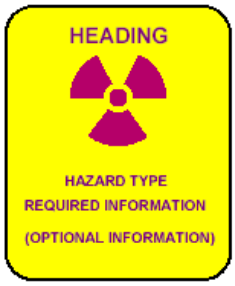
NOTE 3: It is not necessary to apply additional labels if the device and/or container is pre-labeled by the manufacturer and is adequate to convey the potential radiological hazard.

POSTING AND LABELING EXCEPTIONS

Posting/Label	Exception
Radiological Buffer Area ***(DOE ONLY)***	High contamination or airborne radioactivity areas that are completely within contamination areas Inactive contamination, high contamination, or airborne radioactivity areas (i.e., areas to which entry has been prohibited by posting or barricades) Exposure control, if other posted boundaries or controls provide equivalent employee protection Exposure control, if general employees who are not trained as radiological workers are restricted from unescorted entry to controlled areas.
URMA ***(DOE ONLY)***	Physical or administrative controls are implemented to ensure appropriate radiological controls are established prior to excavating, penetrating, or otherwise disturbing underground radioactive materials and when access is not likely to result in individual doses greater than 100 millirem in a year.
Radioactive Material Area Posting	(DOE & NRC) Area is posted as a radiological area; **or** (DOE) Each item or container of radioactive material is labeled in accordance with the requirements of the RPP and this procedure and is located inside of a Controlled Area/RCA; **or** (DOE) The radioactive material consists solely of structures or installed components which have been activated (i.e., neutrons or particles from accelerators); **or** The area contains quantities of radioactive material less than one-tenth the values listed in the RPP Appendix 4A (DOE)or 10CFR20, App C (NRC).
Radioactive Material Labeling	Items or containers are used, handled and stored in posted and controlled radioactive material areas or radiological areas and sufficient information is provided to permit individuals to take precautions to avoid or control exposures; **or** The quantity of material is less than one tenth the limits specified in the RPP Appendix 4A (DOE) or 10CFR20, App C and/or App B Table 3 (NRC); **or** The material is packaged, labeled and marked in accordance with DOT regulations or equivalent DOE directives governing radioactive material transportation; **or** The material is inaccessible or accessible only to individuals authorized to handle or use the material or to work in the vicinity; **or** The material is installed in manufacturing or process equipment such as piping, tanks or reactor equipment. NOTE: Radioactive material labels applied to sealed sources may be excepted from the color specifications found in the RPP.

NOTE: Caution should be exercised in applying exceptions to ensure that posting, labeling and other associated information will be sufficient to clearly indicate to affected individuals the radiological hazards present in an area and required protective actions. Exceptions do not apply to other requirements (e.g., PPE).

ACCEPTED SIGNS AND INSERTS FOR RADIOLOGICAL POSTINGS



Headings

CAUTION

DANGER

GRAVE DANGER

Hazard Type

VERY HIGH RADIATION AREA

HIGH RADIATION AREA

HIGH CONTAMINATION AREA

AIRBORNE RADIOACTIVITY AREA

RADIATION AREA

CONTAMINATION AREA

RADIOACTIVE MATERIAL(S)

SOIL CONTAMINATION AREA *(DOE Only)*

FIXED CONTAMINATION AREA *(DOE Only)*

UNDERGROUND RADIOACTIVE MATERIAL AREA *(DOE Only)*

RADIOLOGICAL BUFFER AREA *(DOE Only)*

RADIOLOGICALLY CONTROLLED AREA *(NRC Only)*

CONTROLLED AREA *(DOE Only)*

When allowed by procedure, multiple radiological conditions can be posted on one with the most stringent heading, the radiological areas listed in decreasing order of importance, and any supplemental information listed last. The hazards above are listed in order of importance and placement on sign

Required and Optional Inserts

AUTHORIZED PERSONNEL ONLY

CONTACT RCT PRIOR TO ENTRY

CONTACT RPO PRIOR TO DIGGING

DO NOT ENTER

RWP REQUIRED FOR ENTRY

TLD REQUIRED

This is not intended to be all inclusive. Special conditions may require inserts not listed here.

ENTRY CONTROL REQUIREMENTS FOR HIGH AND VERY HIGH RADIATION AREA

1. Administrative controls and one or more of the following physical controls shall be used to prevent inadvertent or unauthorized access to high and very high radiation areas:
   - Control devices on entrances;
   - Conspicuous visual and/or audible alarms; or
   - Locked entrance ways;

2. Areas with entrance or access points consisting of doors that are locked should be considered accessible to individuals. However, areas with entrance or access points consisting of doors or portals, such as man hole covers, that are bolted or otherwise more permanently sealed may be considered inaccessible, unless such doors or portals are opened on a routine basis. In general, areas with entrance or access points that require the use of tools or lifting equipment to gain access may be considered inaccessible to individuals. However, for ALARA purposes, these entrance or access points should be marked indicating the radiological hazard that exists, or is likely to exist, behind the entrance or access point and a warning not to open the barrier without authorization from the radiation protection organization. Once the entrance point has been unsealed, (whether or not such acts have been authorized), the area should be considered to be accessible.
3. The number, issue, and use of keys will be strictly controlled by the RPM where locked entryways are used to control access to high and very high radiation areas when areas exist.
4. A list of high and very high radiation areas will be maintained by the RPM when areas exist. Do not post these areas in combination with any other radiological area.
5. Weekly inspections of the physical access controls to high and very high radiation areas will be performed, in operational or occupied facilities, to verify controls are adequate to prevent unauthorized entry and ensure the effectiveness and operability of barricades, devices, alarms, and locks. These inspections will be documented in the routine log book when areas exist.
6. Additional requirements are found in RPP, Appendix 3B.

RADIOLOGICAL WORK PERMITS

1.0 PURPOSE

The purpose of this procedure is to provide instructions for Radiological Control Technicians (RCTs) and other RPO personnel in the preparation, distribution, administration, revision, and termination of Radiological Work Permits (RWPs).

An RWP is a work control document issued for performance of a specific job in a specific area where the work may affect or change the radiological conditions. RWPs are issued for the duration of the job, with a maximum initial valid period of one year permitted.

The following activities are described in Section 4.0 of this procedure:

4.1 RWP Numbering & RWP Log

4.2 RWP Development

4.3 RWP Revision or Replacement While Active

4.4 RWP Termination

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

Tetra Tech (Tt) Radiological Protection Plan RPP

3.0 GENERAL

3.1 EQUIPMENT

Not Applicable

3.2 SAFETY CONSIDERATIONS

Since heat stress may be an issue during radiological operations, the possibility exists that personnel working in Contamination Areas (CA) may need hydration. Rather than require individuals to doff protective clothing and exit the area, the following provisions may be enacted with RPO approval.

a. Personnel in the CA should have their gloves and facial area monitored to ensure no detectable contamination is present.

b. Put on an additional pair of clean, disposable gloves and remonitor to verify that they are not contaminated.

c. Outside personnel should supply personnel with fluids (i.e., water, Gatorade®, etc.) in disposable, single use containers. Containers should be disposed of as radwaste.

d. After hydration, remonitor facial area to verify no contamination.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Ensuring that RCTs are qualified to perform this procedure.

- Review and concurrence of RWPs and revisions to RWPs.
- Approval of RWP Termination Packages.

3.3.2 RCTs are responsible for:

- Complying with this procedure.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

Not Applicable

3.5 RECORDS

Records that are generated during the performance of this procedure include the following:

- Radiological Work Permits
- RWP Logbook, if applicable.
- Radiological Work Permit Sign-In Sheets
- ALARA Pre-Job Review Form
- ALARA Briefing Record
- ALARA In-Progress Review form
- ALARA Post-Job Review Form
- ALARA Attendance Records
- RWP Termination Checklists

3.6 PRECAUTIONS AND LIMITATIONS

Not Applicable

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. No revision bars used due to entire document being changed.

3.8 ATTACHMENTS

Attachment 1 Example of Radiological Work Permit

Attachment 2 Example of Radiological Work Permit Sign-In Sheet

Attachment 3 RWP Termination Checklist

Attachment 4 ALARA Briefing Record

Attachment 5 ALARA Attendance Record

4.0 PROCEDURE

4.1 RWP NUMBERING and RWP LOG

4.1.1 The RWP number must be as follows:

The first 2 digits will indicate the calendar year. Example: 04 would indicate calendar year 2004.

These 2 digits will be followed by alphabetic characters that identify the facility or project.

The last three digits will be the next sequential number (i.e. 04-DT-001)

4.1.2 The RWP Log shall contain, as a minimum, the following information:

- RWP Number
- Job Description
- Revision Numbers and Effective Dates
- Number of Controlled Copies and locations
- Termination Date
- Termination By
- Reason for Termination

4.2 RWP DEVELOPMENT

RPO shall assess radiological controls and complete applicable sections of the RWP, based on:

- Discussions with project management and support personnel.
- Related RP procedures.
- The Tt RPP

4.2.1 PERFORM pre-job survey(s) of the work area in accordance with RP-OP-002 and RP-OP-003 as appropriate.

a. If the work area has well characterized radiological conditions, or if no radiological conditions exist prior to commencement of work, the pre-job survey may be performed after RWP approval and concurrent with the commencement of work.

b. Previous survey data may be used in place of a pre-job survey when either:

- Performing a survey would be contrary to ALARA practices.
- The last survey performed in the area is less than six calendar months old AND activities performed in the area have not changed (or had the potential to change) the radiological conditions since this last survey.

c. The pre-job survey should include the following, as applicable:

- A map of the work area detailing boundaries, postings, entrance and exit points, low dose staging areas, and step-off pad locations.

- An assessment of all radiological hazards (known and potential) associated with the work area.

4.2.2 If the potential for other hazards (e.g., physical hazards, confined spaces, etc.) are identified, CONTACT the safety representative for guidance to determine whether or not radiological controls will be impacted.

4.2.3 ENTER the next sequential number, in accordance with Section 4.1.1, in the RWP Unique Identifying Number

4.2.4 ENTER the job location on the RWP form under Area and Facility. ENTER requestor's name and phone number in the appropriate section of the RWP form, along with the date requested.

4.2.5 DESCRIBE the work covered by this RWP. The job description should include enough detail to adequately explain the job and associated radiological hazards. The type of radiological areas that will be entered under this RWP can be stated here, as necessary.

4.2.6 DETERMINE sign-In frequency, issue date, expiration date, briefing requirements, air sampling requirements, RWT requirements and ENTER on the RWP form.

RWP Sign In/Out: INDICATE the RWP sign in/out requirements. ProRad accepts the following options:

- Monthly (one time entry sign-in prior to first entry of the calendar month, exit sign-out not required)
- Each Entry/Exit (Sign-in prior to and as close to the actual time of entry and sign-out after exit). The closer to the actual time of entry and exit the more accurate the dose received can be correlated to the task.

Radiological workers may be signed in on more than one Monthly sign-in RWP at a time (simultaneously).

Monthly sign-in frequency RWPs CAN NOT have EPDs, multi-packs, or extremity dosimeters.

Workers shall only be signed in on one Each Entry RWP at any time.

Workers signed-in on an Each Entry RWP will not be permitted entry on another RWP until they have signed-out on a previous Each Entry RWP.

4.2.7 Radiological Conditions

a. RECORD pre-job survey number(s) in the small "Radiological Conditions" section.

b. If pre-job survey(s) will be determined concurrent with the commencement of work or other sources, ENTER information here.

4.2.8 Airborne Radioactivity:

a. RECORD the DAC value next to the appropriate radionuclide of concern.

b. If airborne radioactivity is not a concern, MARK as 'NA'.

c. If pre-job surveys are not feasible or if levels cannot be adequately assessed, RPO supervision may estimate airborne radioactivity concentrations. INDICATE an estimated activity concentration with an asterisk (*).

4.2.9 Surface Contamination

a. ENTER the highest removable surface contamination levels for the work area, as applicable.

b. ENTER the radionuclide(s), if known.

c. If pre-job surveys are not feasible or if levels cannot be adequately assessed, RPO supervision may estimate the amount of contamination. INDICATE an estimated amount with an asterisk (*). ESTABLISH hold points as described in Section 4.2.24 as necessary to determine the levels.

4.2.10 Radiation Levels

a. ENTER applicable radiation levels in the space(s) provided. CLEARLY INCLUDE the appropriate units if other than mrem/hr.

b. If pre-job surveys are not feasible or if levels cannot be adequately assessed, RPO supervision may estimate the radiation levels. INDICATE an estimated amount with an asterisk (*).

c. If radiation levels do not apply, RECORD ‘N/A.’

4.2.11 Special Precautions

- Present any special instructions in short, easy-to-follow steps.
- Discuss any special dose or contamination reduction considerations or special frisking requirements for the job not covered by existing controls (i.e. posted instructions).
- Identify an special monitoring requirements.
- Be specific and detailed enough so that the worker can perform the task(s) without direct supervision.

4.2.12 Protective Clothing (PC)

a. SPECIFY PC requirements to be used for task on page 1 of RWP. If multiple tasks are listed on page 2 of the permit, continue PC requirements on page 3.

b. LIST all task numbers used (e.g. 1-7) in task number section that required that level of PC. Page 2 and 3 are nor required for job requiring only one dress requirement and no dose concerns.

c. USE the “Other” box and space as needed to specify exceptions or additions to PC requirements.

4.2.13 Respiratory Protection

a. INDICATE the type of respiratory protection required based on RP-OP-004 on page 1. If multiple tasks are listed on page 2 of the permit, continue respiratory protection requirements on page 3.

b. If respiratory protection is not required, MARK the 'Not Required' box.

4.2.14 Dosimetry & Bioassay

a. INDICATE the type(s) of required dosimetry on page 1 (or 3, if necessary) of RWP to be used for each task.

Acceptable dosimetry options include:

- UD-802 TLD (monthly, each shift, each entry RWPs)
- Mk2 EPD (each shift, each entry RWPs only)
- Multi-pack (each shift, each entry RWPs only)
- Extremity (each shift, each entry RWPs only)

b. If 'Multipack' or 'Extremity' dosimetry is needed, INDICATE the placement of the dosimetry, and DESCRIBE the proper use and placement of multiple or self-reading or electronic dosimetry in the Special Precautions section of the RWP.

c. If bioassay is required, MARK all required types of bioassay. Acceptable bioassay codes include:

- Not Required (no in-vitro bioassay is required for a task)
- Pu (Plutonium)
- U (Uranium)
- Am (Americium)
- Sr (Strontium)
- Pu-MS (2 liter Plutonium for Mass Spectroscopy)
- WBC (Whole Body Count)
- Chest Count

d. If a bioassay other than one on the above list is required, contact RPM.

4.2.15 Suspension Guides

a. INDICATE the radiological conditions that would cause work to be suspended for the particular task.

b. In order for work to resume after these guidelines have been exceeded, conditions should be evaluated and reasons for the unexpected conditions should be considered by RPO supervision and responsible project management. If it is agreed that it is safe to proceed with new conditions and RWP controls are still adequate, RPO supervision should document suspension guide changes in the RPO Logbook

in order for work to proceed on a temporary basis. A new revision should be initiated within one week of the logbook entry.

4.2.16 Specific Precautions and Radiological Conditions (page 2, as applicable)

As appropriate, LIST and EXPLAIN any Specific Radiological Conditions section.

Radiological hold points can be entered in this section and should include the criteria that must be met or action that must be taken to satisfy the hold point prior to continuing with subsequent steps in the planned activity.

The following activities and potential conditions should be considered for inclusion as radiological hold points.

- Radiation Protection action needed to assess changing radiological conditions and ensure implementation of required controls.
- Potential for radiation doses in excess on the applicable administrative control level (ACL).
- Potential for elevated airborne radioactivity levels.
- Potential for elevated or changing removable surface contamination levels on accessible surfaces.
- Potential for unplanned or uncontrolled release of radioactive material to the environment.

4.2.17 Estimated Exposure Summary – Job Breakdown by Task (page 2, as applicable)

a. LIST Job Breakdown by Task and Man-hr Estimate, as appropriate.

b. LIST Penetrating, Extremity, and Skin dose rate from survey data for each task, as applicable.

c. DETERMINE Man-rem Estimate and Penetrating Ratio then TOTAL column to establish Man-rem Limit. If this total exceeds the established Administrative Control level of 800 mrem (Section V of RWP form), do not continue with RWP and contact RPM.

4.2.18 If an ALARA Review is required:

a. ROUTE the RWP through the appropriate level involved in the ALARA review (i.e., Project Manager, RPM, ALARA Committee) for “ALARA Approval” signature on form.. ALARA Review and Briefing forms should be attached to the RWP Package, as applicable.

b. ADD or ADDRESS any recommendations that come out of the ALARA Review.

4.2.19 ENSURE that the 1) RWP number has been recorded on each page of the RWP, and 2) that all pages of the RWP packet are numbered.

4.2.20 ROUTE the RWP to RPO and Project Management, as applicable for review and signature.

4.2.21 PROVIDE controlled to appropriate locations and LOG RWP information into the RWP Log.

4.2.22 RETAIN the original RWP until its termination.

4.3 RWP REVISION OR REPLACEMENT WHILE ACTIVE

Revisions require the same level of approval as that for the original RWP. In addition, workers must sign an RWP Sign-In Sheet to acknowledge the revision. Controlled copies will be made from the approved, revised document and logged into the RWP Logbook.

NOTE: If a minor change that does not affect radiological controls or the scope of radiological work, only RPO supervision needs to sign off on the change by single line strike out with date and initials on original and all controlled copies; signatures are not required of Project Management or workers. RPO supervision makes this determination.

4.3.1 If the RWP has already been revised 4 times, TERMINATE the RWP in accordance with Section 4.4 below and re-issue the RWP.

4.3.2 SUMMARIZE revision(s) in the RWP Logbook.

4.3.3 ROUTE the revised RWP to RPO Management and Project Superintendent for review and signature.

4.3.4 All workers shall re-sign the revised RWP.

4.4 RWP TERMINATION

4.4.1 REMOVE controlled copies of the RWP, ensure all copies are accounted for, and destroy copies.

4.4.2 RETRIEVE or OBTAIN the following items for inclusion in an RWP Termination Packet:

- The original RWP.
- Any documentation associated with the RWP (e.g., ProRadSign-In Printouts, ALARA Review attendance records).
- An RWP Termination Checklist (see Attachment 4).

4.4.3 ENTER name of person completing the RWP termination and the RWP termination date in the space provided on the RWP form.

4.4.4 ENTER the RWP number on the RWP Termination Checklist.

4.4.5 COMPLETE the Post-Job Conditions/Analysis section of the RWP Termination Checklist as follows:

a. INDICATE the reason for termination.

b. INDICATE whether Post-Job Surveys were performed to support this RWP. If yes, LIST the corresponding survey numbers.

c. INDICATE whether other surveys were performed to support this RWP. If yes, LIST corresponding survey numbers.

4.4.6 COMPLETE the Termination Packet section of the RWP Termination Checklist as follows:

a. INDICATE if all pages of the record copy RWP are in the Termination Packet by marking the appropriate box.

b. INDICATE if all record copies of RWP Sign-In Printouts are in the Termination Packet by MARKING the appropriate box.

c. INDICATE if the original/record copies of any ALARA Reviews (pre-job, in-progress, post-job) and associated Attendance Records are in the Termination Packet by MARKING the appropriate box. If ALARA Reviews were not required, MARK the corresponding 'N/A' box(es).

d. INDICATE if data from supplemental self-reading dosimeters (SRD) or electronic personal dosimeters (EPD) are provided by MARKING the appropriate box. If supplemental SRD/EPDs were not required, MARK the 'N/A' box.

e. LIST any additional documentation that is included in the packet.

4.4.7 In the Verification/Approval section of the RWP Termination Checklist:

a. ENTER the name of the individual completing the Termination Package.

b. SIGN and DATE where indicated.

4.4.8 If attachments or additional pages are used with the RWP Termination Checklist:

a. ENTER the RWP number and page number on each sheet.

b. STAPLE all pages together.

4.4.9 ATTACH all items marked as being included in the Termination Packet.

4.4.10 ENTER the termination date and the reason for termination in the RWP Log.

4.4.11 ROUTE the Termination Package to RPO supervision for review and approval.

4.4.12 RPO supervision shall:

a. REVIEW the RWP package for completeness.

b. PRINT his/her name and organization on the RWP Termination Checklist.

c. SIGN and DATE the RWP Termination Checklist.

d. COMPLETE necessary information in the RWP Logbook.

4.4.13 ROUTE the complete RWP Termination Package for project administrative filing

Radiological Work Permit

RWP Unique Identifying Number	Revision Number

Cover Sheet

Sign In Frequency:	Issue Date:	Expiration Date:

Section I

Work Req/Pkg No: N/A	Location Region: N/A	Area:
Procedure No: N/A	Location ID: N/A	Facility:
Project No: 3158	Location Sequence: N/A	Building: N/A
Estimated Job Duration (Days)	System: N/A	Requested By:
Component Type: N/A	Equipment Type: N/A	Tel/Pager No:
Component No: N/A	Equipment No: N/A	Date Requested:
Equipment/Component Name:		

Job Description:

Comments:

Section II

☐ Conditions May Change Significantly During Job

Contamination Areas Survey Frequency:

☐ During the Initial Daily Entry ☐ At Completion of Job
☐ Periodically During Work ☐ As Specified in the RWP

☐ ALARA Review Req'd?
☐ Pre-Job Briefing Req'd?
☐ Air Sampling Req'd?

RWT Qualifications

☐ Rad Worker I
☐ Rad Worker II

Radiological Conditions:

Dose Rates (mrem/hr)	Contamination Levels (per 100 cm²)		Airborne Levels	
			☐ DAC Pu	☐ DAC U
	α		☐ N/A µCi/cc Pu	☐ N/A µCi/cc U
	βγ		☐ DAC FP	N/A µCi/cc HTO
	N/A	T_3	☐ N/A µCi/cc FP	

Special Precautions:

Task Number(s): (Job-Specific RWPs Only)

Task Specific Bioassay Req'ts: ☐ Pu ☐ Pu-MS ☐ Sr ☐ U ☐ N/A ☐ Am ☐ N/A ☐ Chest Count ☐ WBC ☐ Not Req'd

☐ N/A Specialized RWT: N/A

Protective Clothing Requirements

Indicate Number in Box

☐ Cotton Coveralls ☐ Cloth Hood ☐ Lab Coat
☐ Tyvek Coveralls ☐ Pair Glove Liners ☐ Hard Hat
☐ Pair Gloves ☐ Other:
☐ Pair Booties
☐ Pair Rubber Shoe Covers
☐ Pair Plastic Shoe Covers

Dosimetry Requirements

☐ UD-802 TLD ☐ Mk2 EPD
☐ N/A UD-807 TLD ☐ N/A Mk2n2 EPD
☐ N/A RS-912 TLD ☐ Multi-pack
☐ N/A ND ☐ Extremity

Respiratory Protection

☐ N/A mil Plastic Suit
☐ N/A mil Plastic Suit
☐ N/A mil Plastic Suit
☐ Full-Face Respirator w/
☐ N/A esh Air Hood
☐ Other:
☐ Not Required

Suspension Guides

Removable Contamination (per 100 cm²)	α	Working Dose Rate (mrem/hr)	
	βγ		
Airborne Concentration			

Section III

ALARA Approval:	Date:		
Lead Work Group Approval:	Date:	Industrial Hygiene Approval: N/A	Date:
RCO Approval:	Date:	RWP Termination:	Date:

Radiological Work Permit

RWP Continuation (Sheet A)

RWP Unique Identifying Number	Revision Number

Section II Continuation

Special Precautions (Continuation):

Specific Radiological Conditions:

Radiological Control Operations Coverage Requirements:

☐ Continuous ☐ Initial

☐ Intermittent ☐ At Completion

Section IV

Estimated Exposure Summary

	Part 1		**Part 2**					
No.	Job Breakdown by Task	RWP Man-hrs	Extremity mrem/hr	Skin mrem/hr	Penetrating mrem/hr	Man-rem Estimate		Extremity/Skin To Penetrating Ratio
						Extremity/Skin	Penetrating	
1								: 1
2								: 1
3								: 1
4								: 1
5								: 1
6								: 1
7								: 1
8								: 1
9								: 1
10								: 1
11								: 1
12								: 1
13								: 1
14								: 1
						Estimated Total		
						Man-rem Limit		

Actual Penetrating Man-rem for Job: _____

Section V

Administrative Control Level (Individual Exposure Limits)

Annual Penetrating Limit (mrem)

800

Radiological Work Permit

RWP Continuation (Sheet B)

RWP Unique Identifying Number	Revision Number

Task Number(s): (Job-Specific RWPs Only)

Task Specific Bioassay Req'ts: ☐ Pu ☐ Pu-MS ☐ Sr ☐ U ☒ N/A Np ☐ Am ☒ N/A T ☐ Chest Count ☐ WBC ☐ Not Req'd

☒ N/A Specialized RWT: N/A

Protective Clothing Requirements

Indicate Number in Box

☐ Cotton Coveralls ☐ Cloth Hood ☐ Lab Coat
☐ Tyvek Coveralls ☐ Pair Glove Liners ☐ Hard Hat
☐ Pair Gloves ☐ Other:
☐ Pair Booties
☐ Pair Rubber Shoe Covers
☐ Pair Plastic Shoe Covers

Dosimetry Requirements

☐ UD-802 TLD ☐ Mk2 EPD
☒ N/A UD-807 TLD ☒ N/A Mk2n2 EPD
☒ N/A SRS-912 TLD ☐ Multi-pack
☒ N/A CND ☐ Extremity

Respiratory Protection

☒ N/A 6 mil Plastic Suit
☒ N/A 9 mil Plastic Suit
☒ N/A 12 mil Plastic Suit
☐ Full-Face Respirator w/
☒ N/A Fresh Air Hood
☐ Other:
☐ Not Required

Suspension Guides

Removable Contamination (per 100 cm²)	α	**Working Dose Rate (mrem/hr)**	
	βγ		
Airborne Concentration			

Task Number(s): (Job-Specific RWPs Only)

Task Specific Bioassay Req'ts: ☐ Pu ☐ Pu-MS ☐ Sr ☐ U ☒ N/A Np ☐ Am ☒ N/A T ☐ Chest Count ☐ WBC ☐ Not Req'd

☒ N/A Specialized RWT: N/A

Protective Clothing Requirements

Indicate Number in Box

☐ Cotton Coveralls ☐ Cloth Hood ☐ Lab Coat
☐ Tyvek Coveralls ☐ Pair Glove Liners ☐ Hard Hat
☐ Pair Gloves ☐ Other:
☐ Pair Booties
☐ Pair Rubber Shoe Covers
☐ Pair Plastic Shoe Covers

Dosimetry Requirements

☐ UD-802 TLD ☐ Mk2 EPD
☒ N/A UD-807 TLD ☒ N/A Mk2n2 EPD
☒ N/A SRS-912 TLD ☐ Multi-pack
☒ N/A CND ☐ Extremity

Respiratory Protection

☒ N/A 6 mil Plastic Suit
☒ N/A 9 mil Plastic Suit
☒ N/A 12 mil Plastic Suit
☐ Full-Face Respirator w/
☒ N/A Fresh Air Hood
☐ Other:
☐ Not Required

Suspension Guides

Removable Contamination (per 100 cm²)	α	**Working Dose Rate (mrem/hr)**	
	βγ		
Airborne Concentration			

Task Number(s): (Job-Specific RWPs Only)

Task Specific Bioassay Req'ts: ☐ Pu ☐ Pu-MS ☐ Sr ☐ U ☒ N/A Np ☐ Am ☒ N/A T ☐ Chest Count ☐ WBC ☐ Not Req'd

☒ N/A Specialized RWT: N/A

Protective Clothing Requirements

Indicate Number in Box

☐ Cotton Coveralls ☐ Cloth Hood ☐ Lab Coat
☐ Tyvek Coveralls ☐ Pair Glove Liners ☐ Hard Hat
☐ Pair Gloves ☐ Other:
☐ Pair Booties
☐ Pair Rubber Shoe Covers
☐ Pair Plastic Shoe Covers

Dosimetry Requirements

☐ UD-802 TLD ☐ Mk2 EPD
☒ N/A UD-807 TLD ☒ N/A Mk2n2 EPD
☒ N/A SRS-912 TLD ☐ Multi-pack
☒ N/A CND ☐ Extremity

Respiratory Protection

☒ N/A 6 mil Plastic Suit
☒ N/A 9 mil Plastic Suit
☒ N/A 12 mil Plastic Suit
☐ Full-Face Respirator w/
☒ N/A Fresh Air Hood
☐ Other:
☐ Not Required

Suspension Guides

Removable Contamination (per 100 cm²)	α	**Working Dose Rate (mrem/hr)**	
	βγ		
Airborne Concentration			

RWP SIGN-IN SHEET

RWP#:_____

Date	Name (Printed)	Signature *	Emp. ID	TASK #	Time In	Time Out	Dose In	Dose Out	Total Dose

* **By my signature, I verify that I have read, understand, and will comply with this RWP.**

Reviewed by:_____ Date:_____

RWP Termination Checklist

RWP #:_____

Post-Job Conditions/Analysis

Reason for Termination: ☐ Job Completed ☐ Change in Scope ☐ Change in Job Site
☐ RWP Expired ☐ ALARA Levels Exceeded
☐ Other:_____

Post-Job Survey(s) Performed? ☐ No ☐ Yes Survey Number(s):_____

Other Survey(s) Performed? ☐ No ☐ Yes Survey Number(s):_____

Termination Packet

RWP (includes Special Instructions)	☐ Yes	☐ No	
RWP Sign-In and/or Printouts	☐ Yes	☐ No	
ALARA Pre-Job Review	☐ Yes	☐ No	☐ N/A
Attendance Record	☐ Yes	☐ No	☐ N/A
ALARA In-Process Review(s)	☐ Yes	☐ No	☐ N/A
Attendance Record	☐ Yes	☐ No	☐ N/A
ALARA Post-Job Review	☐ Yes	☐ No	☐ N/A
Attendance Record	☐ Yes	☐ No	☐ N/A
SRD/EPD Data	☐ Yes	☐ No	☐ N/A

Additional Documentation:_____

Verification/Approval

RCT:	_____ (Printed Name)	_____ (Signature)	_____ (Date)
RPO:	_____ (Printed Name)	_____ (Signature)	_____ (Date)

ALARA Briefing Record

RWP #:_____ Revision #:_____ Date:_____

Scope of Work To Be Performed (refer to RWP and any applicable ALARA Reviews):_____

Radiological Conditions (review RWP and current survey information):_____

Procedural and Technical Work Document Requirements (review any requirements applicable to work scope:

Special Radiological Conditions:_____

Radiological Hold Points:_____

Industrial Safety/Hygiene Considerations (review SSHASP requirements, etc.):_____

Communications and Coordination with Other Groups:_____

Housekeeping and Waste Management/Minimization:_____

Emergency Response Provisions:_____

Briefing Performed By:

(Printed Name)	(Signature)
(Printed Name)	(Signature)
(Printed Name)	(Signature)

ALARA Attendance Record

RWP #:_____ Revision #:_____ Date:_____

Printed Name	Signature	Company

RADIOACTIVE MATERIAL SHIPPING AND TRANSPORT

1.0 PURPOSE

The purpose of this procedure is to provide techniques and instructions for the Radiological Control Organization (RC)) in the performance and documentation of shipping radioactive materials.

SCOPE

The following activities are described in Section 4.0 of this procedure:

4.1 Training Requirements

4.2 Shipping Requirements

4.3 Transport Requirements

4.4 Radiological Surveys and Documentation

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

TtNUS Site-Specific Health and Safety Plan (HASP)

TtNUS Field Sampling Plan (FSP)

TtNUS Quality Assurance Project Plan (QAPP)

49 CFR 172, *Hazardous Materials Table, Special Provisions, Hazardous Materials*

Communications, Emergency Response Information and Training Requirements

49 CFR 173, *Shippers - General Requirements for Shipments and Packagings*

3.0 GENERAL

3.1 EQUIPMENT

- Portable radiological survey equipment.
- Survey media (e.g., cloth smears, Masslinn-type swipes).
- Radioactive Material Tag/Label.
- Radiological Survey Forms.
- Shipping Packaging

3.2 SAFETY CONSIDERATIONS

- All radiological surveys shall be performed in accordance with ALARA policies, governing work documents, and contamination control practices. If area hazards are unknown or may have changed, obtain current hazard information from the responsible Environment, Health and Safety representative.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Implementation of this procedure.
- Ensuring that RCTs are qualified to perform this procedure.
- Ensuring that all survey documentation is reviewed.
- Verifying that all documentation generated in support of this procedure meets the requirements of this procedure prior to approval.
- Ensuring the documentation is properly filed and protected

3.3.2 RCTs are responsible for:

- Complying with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The RCT should review available survey data if unfamiliar with the materials being shipped.

3.4.2 Survey numbers are sequentially numbered. The survey number should be on all survey documentation

3.5 RECORDS

RPO survey records are generated during implementation of this procedure. Records include the following forms:

- Radiological Survey Form.
- Chain of Custody Documents (documents may be generated and maintained by project sample custodian).

Records are maintained in accordance with the TtNUS records management policy and applicable program and project requirements. The record copies are filed on site for the duration of the project.

Handwritten survey documentation shall be completed in permanent black or blue-black ink only. Changes to survey documentation shall only be made to the record copy and shall be made in black or blue-back ink and shall be made with a single line, initialed and dated.

3.6 PRECAUTIONS AND LIMITATIONS

3.6.1 When surveying materials of unknown radiation levels, the highest scale available on the survey instrument should be selected prior to survey and the instrument window should be open.

3.6.2 To avoid contaminating an instrument case, instruments may be placed in plastic bags or similar devices. If alpha and/or beta measurements are being made, the plastic must not cover the instrument window.

3.6.3 Alpha radiation has a very limited range; pure alpha-emitting radionuclides dispersed in a thin, semi-moist surface layer or covered with an absorbing layer of dust or dirt may not be detectable. Similarly, rusty, abrasive, generally non-smooth porous surfaces will absorb alpha particles and inhibit their detection. Particular attention, therefore, should be directed to the condition of the surface(s) when monitoring for alpha contamination.

Items, material, and equipment may require a preliminary Large Area Wipe (LAW) survey to assess contamination conditions.

CAUTION: Wipe material may be contaminated.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Consult with TtNUS Health and Safety when materials with a mixed hazard are being shipped.

3.9 ATTACHMENTS

Attachment 1 Radiological Survey Form

Attachment 2 Guidance on Performing Surveys for Unrestricted Use

Attachment 3 Radioactive Contamination Limits

Attachment 4 Radiation and Contamination Limits for Radioactive Material Package Transport/Transfer

Attachment 5 Labels for Inner and Outer Package

4.0 PROCEDURE

4.1 SHIPPING REQUIREMENTS

4.2 TRANSPORT REQUIREMENTS

4.3 RADIOLOGICAL SURVEYS AND DOCUMENTATION

4.1 Shipping Requirements

NOTE: DOT regulations require that personnel be properly trained in order to ship hazardous materials. If you have not been properly training, or not under the direct supervision of a qualified person, do not continue with this procedure.

4.1 .1 Packaging, Labeling, and Marking Radioactive Materials

A Class 7 (radioactive) material has very restrictive packaging requirements in accordance with DOT regulations. 49 CFR lists conditions under which this material is excepted from many requirements (“Excepted Package”). Most shipments made by TtNUS will fall into this category

The three most common types of excepted packages are "Limited Quantity", "Radioactive Instruments and Articles", and "Empty Radioactive" packages. A "Limited Quantity" shipment would most likely be applicable for the items routinely used by TtNUS. The requirements for "Limited Quantity" excepted packages have been condensed for this procedure and are listed below. Since TtNUS uses FedEx for the shipping of all hazardous material, the requirements have been simplified to use with this carrier. Radioactive Materials not considered "Excepted Packages" or shipped by other than FedEx are non-routine and are not covered in this procedure.

Comment [AS1]: Does stuff in Transportation make this false?

Excepted packages for LIMITED QUANTITY (49 CFR 172.421)

1. Package does not contain any other hazardous material or hazardous waste.

2. Radioactive material package must meet the following radiological criteria

- activity per package is less than limits found in 49 CFR 173.425
- does not contain more than 2 grams fissile material
- the radiation level at any point on the external surface of the package does not exceed 0.5 mrem/ hour
- the removable surface contamination on the external surface of the package is <220 dpm/100 cm2 βγα (low tox) and <22 dpm/100cm2 all other α

3. The inner package must be double containerized and marked with a "Radioactive Material" label including trefoil with survey results, date, and surveyor's name (Attachment 5).

Inner package for **liquid materials** must

- Be leak-proof. watertight primary and secondary containers (i.e. canister, jar)
- Not contain more than 1L in primary container
- Have positive closures on primary container
- Contain absorbent material placed between primary and secondary package in amounts to absorb all liquids in the package.

Inner package for **solid materials** must

- Be sift-proof, watertight primary and secondary containers (i.e. plastic bag, sealed Styrofoam container)
- Not contain more than 500g in primary container
- Have positive closures on primary container

4. The outer package must

- meet the general design requirements (see below) for hazardous material container
- not contain more than 4L total liquids and 4 kg total solid hazardous materials
- be sealed, including any means contents could escape (i.e. cooler with drain spout must be taped)
- have adequate internal filler or cushioning to protect contents
- be marked with “Radioactive Material – Excepted Package” and “UN2910” label (Attachment 5)

General Design Requirements for Hazardous Material Shipping Containers

1. The package can be easily handled and properly secured in or on a conveyance during transport.
2. Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.
3. The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.
4. The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.
5. Each feature that is added to the package will not reduce the safety of the package.
6. The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use
7. All valves through which the package contents could escape will be protected against unauthorized operation.
8. For transport by air, the integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from −40 °C (−40 °F) to +55 °C (131 °F); and packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in ^{2}).

Additional criteria for labeling a package are as follows:

- Each label must be affixed to a package background of contrasting color, or must be segregated in a manner to cause the label to stand out. All labels must be legible.

- The package must be of adequate size to affix all of the necessary labels. Labels may not overlap onto other sides of the package.

- If the package is an irregular shape, then labels may be attached as tags.

- When packages must be kept with one side always up, oriented arrows should be placed in the required direction at least on three opposite sides of the package 120º opposed from one another. For example, liquids containers must be shipped with their cap up and the orientation arrows should point up.

NOTE: Other labels may be appropriate and should be added to certain packages. Examples include Fragile/Handle with Care labels, "Heavy" labels (typically needed for packages that weigh 70 pounds or more), "Cargo Aircraft Only" labels, and others.

4.1.2 Shipping Documentation

If package does not contain any other hazardous material or hazardous waste, a "Shipper's Declaration for Dangerous Goods" is **NOT** required. When filling out the airbill for "Special Handling", "Yes – Shipper's Declaration not required" should be checked when asked, "Does this shipment contain dangerous goods?".

4.2 TRANSPORT REQUIREMENTS

TRANSPORTING RADIOACTIVE MATERIAL IN PERSONAL/RENTAL VEHICLES

Transporting radioactive material in personal, company, or rental vehicles may also be regulated by DOT depending on the material and the quantity involved and is discouraged. Personnel transporting this material must be a trained radiological worker and material must be surveyed/labeled by Health Physics. The material also has to be transported and stored with special postings to protect inadvertent exposure to members of the public. Contact the RPO Supervision for approval and guidance if there is a need to transport.

4.2.1 OFFSITE SHIPMENT OF RADIOACTIVE MATERIAL

This section describes the surveys required to comply with Department of Transportation (DOT) 49 CFR 173 Shippers – General Requirements for Shipments and Packaging, and 10 CFR 20, radiation and contamination limits that apply to outgoing and incoming shipments.

a. PERFORM applicable radiation and contamination surveys in accordance with Section 4.3.

Comment [AS2]: You are here
Change everything to TRANSPORT instead of ship to differentiate???

b. For off-site shipments of packages shipped as non-exclusive use, DETERMINE the maximum dose rate measurements:

- One meter from the external surfaces of the package, and
- On contact with all accessible surfaces, including the bottom, of the package.

c. For off-site shipments of packages and vehicles shipped as exclusive use, DETERMINE the maximum dose rate measurement at the following locations:

- One meter from the external surfaces of the package (see NOTE below).
- On contact with the external surfaces of the package.
- On contact with the external surfaces (including the top and bottom) of the transport vehicle.
- Two meters from external surfaces (excluding the top and bottom) of the transport vehicle.
- In any normally occupied area of the vehicle (e.g., the cab). This includes the "sleeper" portion of a cab, if so equipped.

NOTE: The measurement at one meter will be used to determine the Transportation Index (TI). The TI is a dimensionless number, rounded up to the next tenth, which is placed on the label of a package to designate the degree of control to be exercised by the carrier. For nonfissile material, the TI represents the maximum radiation level in millirem per hour at one meter from the external surface of the package. For fissile material, the TI represents the maximum radiation level in millirem per hour at one meter from the external surface of the package or, for criticality control purposes, the number obtained by dividing 50 by the allowable number of packages that may be transported together, whichever number is larger.

d. OBTAIN a sufficient number of wipes to provide a representative assessment of the removable contamination from inside of package, outside of package, and/or vehicle surfaces.

- A 300 cm^2 area for outgoing shipments, or
- A 100 cm^2 area for incoming shipments

e. COMPARE the survey results with the limits found in Attachment 4 and/or Attachment 5 for the appropriate type of transport.

f. If any radiological conditions exceed the values listed in Attachment 4 and/or Attachment 5, NOTIFY RPO supervision and the shipping organization, prior to tagging the material/vehicle for shipment or delivery.

g. For each package of radioactive material that is incoming,

- RPO personnel must be present and monitor the internal surfaces of the package, in accordance with Section 4.2 of this procedure.
- COMPLETE and ATTACH appropriate labels/postings in accordance with RP-OP-005.

4.2.2 SURVEY FOR ONSITE TRANSFER OF RADIOACTIVE MATERIAL

Comment [AS3]: Should this be 4.3??

This section describes the surveys required for onsite transfer of radioactive material. A radioactive material transfer occurs when radioactive material is moved outside one controlled area and is conveyed to another controlled area.

a. PERFORM applicable radiation and contamination surveys in accordance with Section 4.2.

b. DETERMINE the maximum dose rate measurements at contact and one meter from the external surface of the package when surveys are required for onsite transfer of materials. If no detectable contact measurement is found, one meter reading does not have to be performed.

c. OBTAIN a sufficient number of 100 cm^2 area wipes to provide a representative assessment of the removable contamination from package and/or vehicle surfaces

d. COMPARE the survey results with the limits found in Attachment 4 and/or Attachment 5 for the appropriate type of transport. The radiation limits for Nonexclusive Use apply to onsite transfer of material.

e. If any radiological conditions exceed the values listed in Attachment 4 and/or Attachment 5, NOTIFY RPO supervision and the shipping organization, prior to tagging the material/vehicle for shipment or delivery.

f. For each package of radioactive material that is being prepared for onsite transfer, COMPLETE and ATTACH appropriate labels in accordance with RP-OP-005.

4.2.3 SURVEY OF RADIOACTIVE AND MIXED WASTES

a. PERFORM radiation level and contamination surveys prior to and during packaging of the waste item(s) to aid in future characterization.

b. REPORT inappropriate packaging to the Line organization. If the waste must be repackaged, INFORM the customer that the survey will have to wait until the items are properly packaged. Inappropriate packaging may include:

- Waste not in double plastic bags.
- Heavy items not also packaged in a secondary container to aid in moving the waste.
- Items with sharp edges not protected/covered.
- Items in open bags or bags with holes or tears.
- Outer package without proper markings (i.e., .Radioactive Material. or .Radioactive Waste.).

c. Unless the generator has determined that tritium or other pure low-energy beta emitter (e.g., Ni-63, S-35, P-32, and C-14) is the only radionuclide present, PERFORM a radiation survey on the package.

NOTE: If contact radiation levels exceed 200 mrem/hr, notify the generator that the waste will need to be repackaged or shielded prior to shipment. Insure that the package is properly posted and that personnel access is controlled commensurate with the hazard.

d. PERFORM a survey for removable surface contamination on the outer package/container.

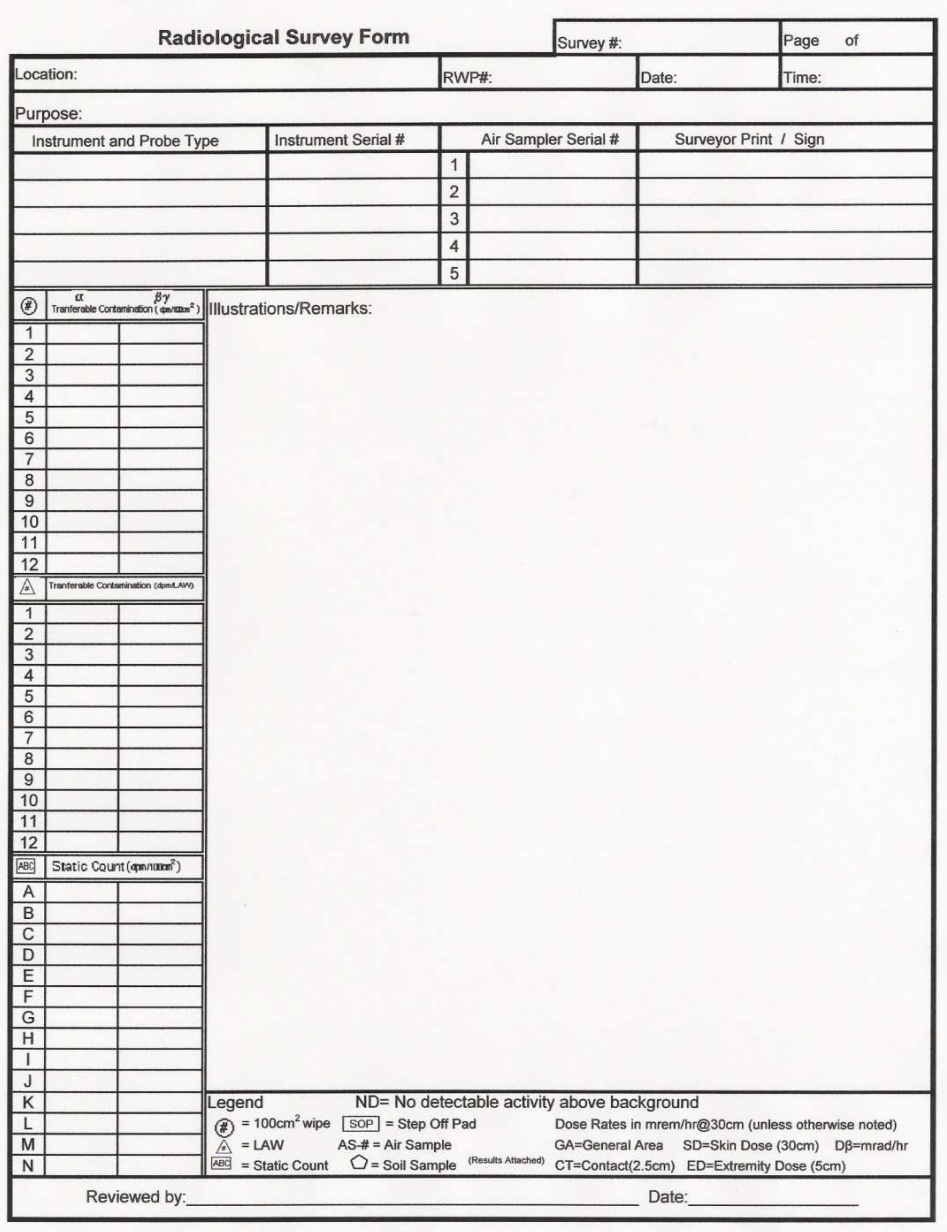
e. On the survey form, clearly IDENTIFY items with unique descriptions and/or numbers.

f. MARK/LABEL the item(s) with the same descriptive code used in the previous step.

g. COMPLETE and ATTACH a Radioactive Material Tag/Label RP-OP-005.

Comment [AS4]: Should more be added? Is offsite and onsite covered well?

Radiological Survey Form



Radiological Survey Form

Survey #:	Page of
Location:	RWP#:	Date:	Time:
Purpose:			

Instrument and Probe Type	Instrument Serial #		Air Sampler Serial #	Surveyor Print / Sign
		1		
		2		
		3		
		4		
		5		

(#)	α Tranferable Contamination (dpm/100cm²)	βγ Tranferable Contamination (dpm/100cm²)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

(△)	Tranferable Contamination (dpm/LAW)	
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

(ABC)	Static Count (cpm/100cm²)	
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		

Illustrations/Remarks:

Legend ND= No detectable activity above background

(#) = 100cm² wipe [SOP] = Step Off Pad Dose Rates in mrem/hr@30cm (unless otherwise noted)

(△) = LAW AS-# = Air Sample GA=General Area SD=Skin Dose (30cm) Dβ=mrad/hr

(ABC) = Static Count ⬠ = Soil Sample (Results Attached) CT=Contact(2.5cm) ED=Extremity Dose (5cm)

Reviewed by:_____ Date:_____

Guidance on Performing Surveys for Unrestricted Use

Degree of Surveillance

The degree of surveillance should be considered as a graded approach, and refers to the percentage of an item/area to be surveyed. Using professional judgment, the RCT should evaluate the history/use of the item(s) to be surveyed as well as the environment to which the item(s) have been exposed.

Use of the following table will increase consistency of free release surveys. It should be noted that if a large number of items require surveillance, or if very large items are to be released, RPO supervision needs to be consulted for additional guidance or alternative approaches to surveillance strategy.

Conditions

The conditions under which an area/item are evaluated should be based upon both historical and recent survey data, when applicable.

Recommended Degree of Surveillance for Free Release (Unrestricted Use) of Material

Degree of Surveillance	**Conditions**
Not Applicable	1. Known history 2. Located in a Controlled Area but not located in a Contamination Area, High Contamination Area, or Airborne Radioactivity Area 3. Low potential for contamination by other causes (e.g., use/storage of radioactive material, activation)
~ 10%	1. History based on process-knowledge 2. Located in Contamination Area 3. Probability of contamination low
10 - 50%	1. History based on process knowledge 2. Possibly located in Contamination Area 3. Probability of contamination moderate
50 - 100%	1. Located in Contamination Area, High Contamination Area, Airborne Radioactivity Area 2. Probability of contamination moderate to high

Contamination Survey Guidance

The RCT should first plan the survey based upon the appropriate degree of surveillance. Unless it is not practical to perform direct survey (such as when H-3 is the only radionuclide of concern), the survey begins by scanning an area approximately equivalent to 1 m2, or the entire item if less than 1 m2, using appropriate survey instruments(s). The RCT determines the location of the highest reading within this area for each type of radiation.

At the location of the highest reading (treating alpha and beta-gamma readings independently, as appropriate), a static measurement is collected. This reading will be referred to as the maximum measurement and is documented for each radiation type. If the area uniformly has readings at background radiation levels, static measurement is not required.

If the maximum measurement in this 1 m2 area is less than the applicable limit for total contamination, no further direct measurements are required for this particular area. (See Attachment 4.)

If the maximum measurement in this 1 m2 area is greater than the applicable limit for total contamination but less than three times this limit, the RCT should collect multiple static measurements within the area to determine an average value. Unless otherwise deemed appropriate, 3 or 4 static measurements should be taken to determine the average. If the average measurement (the supplemental static measurements along with the initial maximum) is less than the limit for total contamination, no further direct measurements are required.

If, in this 1 m2 area, the average of all direct measurements is greater than the limit for total contamination or any static measurement is greater than three times the applicable limit for total contamination, no additional direct measurements are required until decontamination has been attempted, or a determination to discard the item as radioactive waste is made.

Having completed direct survey in particular area, a wipe sample is collected at the location of the maximum measurement (or as otherwise considered to be appropriate from survey planning).

If multiple static measurements were needed to determine an average value, wipes are collected at each such point.

This process continues until the appropriate degree of surveillance has been achieved.

RADIOACTIVE CONTAMINATION LIMITS

Radionuclide (See Note 1)	**Removable (dpm/100cm^2) (See Note 2)**	**Total (Fixed + Removable) (dpm/100cm^2) (See Note 3)**
U-natural, U-235, U-238, and associated decay products	1,000 α	5,000 α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129, Am-241, Np-237	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224,U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. Includes mixed fission products containing Sr-90.	1,000 β-γ	5,000 β-γ
Tritium and tritiated compounds, Ni-63,C-14	1,000	N/A

Notes:

1. The values in this table, with the exception noted in footnote 5, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha-and beta-gamma-emitting nuclides exists, the limits established for alpha-and beta-gamma-emitting nuclides apply independently.
2. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
3. The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm^2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm^2 area exceeds three times the applicable value.
4. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
5. This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.
6. Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this table is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a “Total” value does not apply.

RADIATION AND CONTAMINATION LIMITS FOR RADIOACTIVE MATERIAL PACKAGE TRANSPORT/TRANSFER

Radiation Limits for Outgoing and Incoming Shipments And Onsite Transfer of Material *

Location	**Exclusive Use (mrem/hr)**	**Non Exclusive Use & Onsite Transfer (mrem/hr)**
Contact with package	200*	200
One meter from package	NA	10
External surfaces of the vehicle	200	NA
Two meters from the external surfaces of the transport vehicle	10	NA
In any normally occupied position in the cab or vehicle	2	NA

* If the shipment is made in a closed transport vehicle, the package is secured within the vehicle so that its position remains fixed during transportation, and there are no loading or unloading operations between the beginning and end of the transportation, the limit is 1000 mrem/hr.

- Additional surveys may be required per 49 CFR.

Contamination Limits for Outgoing and Incoming Shipments*

Contaminant	**μCi/cm^2**	**dpm/ cm^2**
β-γ emitter, alpha emitters with a Half-life < 10 days, U nat, Th nat, 235U, 238U, 232Th, 228 Th, 230Th in ores or physical concentrate	10^{-5}	22
All other alpha emitters	10^{-6}	2.2

(Contamination levels for onsite transfer must meet the limits of Attachment 4 of this procedure).

* An incoming shipment in an exclusive use vehicle may not exceed 10 times these limits (49 CFR 173.443(b))

LABELS FOR INNER AND OUTER PACKAGE

Example of Inner Package Radioactive Material Label

CAUTION

Radioactive Material

Description: _____

Maximum contamination: _____dpm/100cm$_2$

Maximum Dose Rate: _____mrem/hr

Surveyed By: _____ Survey Date: _____

Example of Outer Package Radioactive Material Label

Radioactive Material Excepted Package

This package contains radioactive material, excepted package and is in all respects in compliance with the applicable international and national governmental regulations.

UN 2910

The information for this package need not appear on the Notification to Captain (NOTOC)

TETRA TECH, INC

Procedure No: RP-OP-008 Rev 0

DECONTAMINATION OF ITEMS, MATERIALS, AND WORKPLACE SURFACES

1.0 PURPOSE

The purpose of this procedure is to provide the Radiological Control Technicians (RCT) with instructions for the removal of radioactive contamination from tools, equipment and general work areas. The instructions in this procedure are mandatory for RCTs when the RCT is to perform the work regardless of who owns the contaminated item. This document provides the RCT the information to convey to line operations personnel when line personnel request guidance. This procedure DOES NOT provide specific decontamination techniques; there are too many techniques to present in one procedure.

SCOPE

This procedure applies to the non-destructive decontamination of surfaces, items, materials, etc., contaminated with radioactive material. This procedure does not apply to surfaces, items, etc., contaminated with hazardous chemicals or mixed materials. This procedure also does not apply to the decontamination of personnel.

The following sections are discussed in this procedure:

4.1 GENERAL

4.2 DECONTAMINATION OF ITEMS, MATERIALS, AND WORKPLACE SURFACES

4.3 DECONTAMINATION OF RADIOLOGICAL SURVEY INSTRUMENTS

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

Tetra Tech Radiological Protection Plan

RP-OP-009, *Responding to Radiological Incidents*

3.0 GENERAL

3.1 EQUIPMENT

3.1.1 Below is a sample list of cleaning agents for radioactive decontamination. Other cleaning agents can be used at the discretion of the RPO supervision and the RCT.

NOTE: These cleaning agents will not generate mixed waste when combined with radioactive material. When using other cleaning agents, avoid creating mixed waste.

- Simple Green®
- Spray Away® Glass Cleaner
- Tide®
- Touch & Glow®
- Windex® Glass Cleaner
- Windex® Institutional Formula Glass Cleaner
- Water

- Alcohol-free baby wipes

3.1.2 There are varieties of absorbent material available to clean spills, for example, Masslinn® wipes, paper towel, and Maratuff® wipes.

3.1.3 Sticky tape (i.e., masking or duct tape) can also be used to remove particulate contamination.

3.1.4 Contamination survey equipment and supplies.

3.2 SAFETY CONSIDERATIONS

- During the performance of decontamination activities, caution should be taken to maintain personnel radiation doses, both internal and external, As Low As Reasonably Achievable (ALARA).
- If necessary, refer to the decontamination agent's MSDS sheet for information regarding that product.
- Unplug electrical equipment prior to decontaminating.
- Be aware of rotating parts, pinch points and awkward postures during decontamination activities.

3.3 RESPONSIBILITIES

RPO supervision:

- Responsible for the implementation of this procedure, for ensuring that radiological control technicians (RCTs) are qualified to perform this procedure and for documenting their qualifications.

Radiological Control Technicians are responsible for:

- Following this procedure when performing the decontamination of tools, equipment, and general work areas.
- Providing guidance compliant with the content of this procedure to line personnel who are performing decontamination of items, materials and workplace surfaces, when guidance is requested by line personnel.
- Notifying RPO supervision when an error in the procedure is identified or when an improvement in the radiation protection method can be made.

3.4 PREREQUISITES

- A Radiological Work Permit (RWP), as appropriate.
- Ensure that appropriate survey instrumentation is available to monitor the progress of the decontamination.
- Ensure that an adequate supply of appropriate decontamination materials is available.
- Ensure that appropriate radiological waste containers are available.

3.5 RECORDS

Contamination and radiation surveys shall be documented in accordance with RP-OP-002. Completed forms, survey maps, etc., generated during the performance of this procedure shall be

forwarded to project Quality Assurance for processing. Copies of the original documents may be made for information

3.6 PRECAUTIONS AND LIMITATIONS

- Sweeping in Contamination Areas is not permitted.
- Liquid radioactive waste should be minimized.
- When decontaminating equipment, beware of the requirements of any project plan, if applicable. Be aware of any applicable requirements for this type of work, such as work planning and preparation, waste characterization, volume reduction and waste minimization.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Not Applicable

4.0 PROCEDURE

4.1 GENERAL

NOTE: Waste generated during decontamination activities should be handled in accordance with contract.

4.1.1 USE the minimum quantity of cleaning agents necessary to complete the job.

4.1.2 TAKE reasonable efforts to contain loose surface and/or airborne contamination during decontamination efforts.

4.1.3 REFER to RP-OP-002 for the unrestricted release limits of items, materials, and surfaces.

NOTE: Waste items (rags, wipes, paper towels, etc.) contaminated with the cleaning agents specifically listed in Section 3.1 and generated from radioactive decontamination operations are NOT Resource Conservation and Recovery Act (RCRA) mixed waste.

4.2 DECONTAMINATION OF ITEMS, MATERIALS, AND WORKPLACE SURFACES

4.2.1 ENSURE that an approved RWP exists for the decontamination of items, materials and workplace surfaces.

4.2.2 SELECT and DON appropriate protective clothing and equipment as directed by the approved RWP.

4.2.3 ENSURE that the appropriate contamination surveys (e.g., swipe and direct frisk) have been completed in accordance with RP-OP-002 so that the contamination levels are known before decontamination efforts begin.

NOTE: This information is likely to be found in the RWP.

4.2.4 Decon will be performed only in approved locations. Typically, decon areas will be located on a flat surface covered with herculite.

4.2.5 For non-destructive spot removal decontamination work, PERFORM the following steps:

- MOISTEN a small portion of absorbent material with an approved cleaning agent (omit this step when performing dry decontamination). DO NOT apply the cleaning agent directly to the contamination.
- WIPE the surface using a small portion of absorbent material in a single direction.
- Fold the absorbent material so that the contamination is folded in on itself before wiping the area again with the same absorbent material.
- If employing a decontamination agent, AVOID touching the contaminated absorbent material to the decontamination agent container to prevent contaminating the agent.
- CLEAN the areas with lower contamination first proceeding towards areas with higher contamination.
- REPEAT this process as necessary and PROCEED to Step 4.2.6.

4.2.6 For other methods, ENSURE that the method is described in an approved RWP or Technical Work Document (TWD). It is best to start with the least aggressive method and progress to a more aggressive decontamination agent or method.

4.2.7 After surfaces have dried, PERFORM appropriate contamination surveys (e.g., swipe and direct frisk) to monitor contamination levels, and to determine progress.

4.2.8 REPEAT the process until no further contamination is removed by additional repetitive wipes.

4.2.9 DOCUMENT the final contamination survey results in accordance with RP-OP-002.

4.2.10 POST and/or LABEL the material, item, or surface/area, as appropriate, in accordance with RP-OP-005.

4.2.11 CLEAN UP the work area after decontamination activities are complete, and PLACE waste in the appropriate radiological waste container. SURVEY the work area, and decontaminate as necessary.

4.2.12 If necessary, ARRANGE for waste pick-up and disposal.

4.3 DECONTAMINATION OF RADIOLOGICAL SURVEY INSTRUMENTS

4.3.1 ENSURE that an approved RWP exists for the decontamination of radiological survey instruments.

4.3.2 SELECT and DON appropriate protective clothing and equipment as indicated in the approved RWP.

4.3.3 PLACE a sheet of plastic on the work area. An absorbent layer may be placed on top of the plastic layer.

4.3.4 SURVEY instrument prior to decontamination to determine location(s) and level(s) of contamination.

4.3.5 TAPE over any holes in the instrument case with duct tape to prevent liquids from entering the instrument and damaging electronic parts.

NOTE: If internal contamination is suspected, contact RPO supervision for guidance on disassembly and decontamination.

4.3.6 WIPE the instrument with absorbent material dampened with a decontamination agent (if necessary).

4.3.7 Allow the instrument to dry then SURVEY the instrument.

4.3.8 REPEAT cleanings until decontamination is complete, or as long as progress is being made.

4.3.9 If decontamination is unsuccessful or if internal contamination is involved, CONTACT RPO supervision for instructions.

NOTE: Instruments used in a radiological area posted for contamination control must be released for unrestricted use prior to their return to the offsite vendor for calibration or repair.

4.3.10 CLEAN UP the work area after decontamination activities are complete, and PLACE waste in the appropriate radiological waste container. SURVEY the work area, and decontaminate as necessary.

RESPONSE TO RADIOLOGICAL INCIDENTS

1.0 PURPOSE

To provide guidance to Radiological Protection Organization (RPO) personnel on the actions to be taken in response to a radiological incident, radiological situations outside the scope of normal operations, Technical Work Documents (TWD) or Radiological Work Permits (RWP).

SCOPE

Guidance and requirements contained in this procedure are applicable to RPO personnel responding to project-specific radiological incidents at project locations, but do not supersede site-specific and project-specific emergency response plans. Elements of this procedure may also be integrated with local emergency response procedures as appropriate.

The following activities are described in Section 4.0 of this procedure:

4.1 General

4.2 Personnel Contamination

4.3 Uncontrolled Radioactive Material

4.4 Uncontrolled Radioactive Contamination

4.5 Unanticipated Airborne Radioactivity Levels

4.6 Unanticipated Radiation Levels

4.7 Radiological Deficiency Reports

2.0 REFERENCES

10 CFR 20, *Standards for Protection against Radiation*

10 CFR 835, *Occupational Radiation Protection*

Tetra Tech (Tt) Radiation Protection Plan (RPP)

Site-Specific Health and Safety Plan (SSHASP)

United States Department of Energy, DOE O 232.1A and DOE M 232.1-1A, Occurrence Reporting and Processing of Operations Information

3.0 GENERAL

3.1 EQUIPMENT

- Personnel protective equipment (i.e., anti-contamination clothing, air purifying respirators, etc.).
- Portable radiation detection instrumentation.
- Radiological protection supplies (i.e., signs, swipes, portable air sample media, etc.).

3.2 SAFETY CONSIDERATIONS

Perform only actions you are qualified to perform.

3.3 RESPONSIBILITIES

3.3.1 RPO supervision is responsible for:

- Ensuring implementation of this procedure.
- Assisting in the notification, or activation of the following as necessary:
  - Site Radiological Protection Manager
  - Line Management.
  - Offsite Medical in accordance with SSHASP
  - Other organizations as necessary.
- Assisting in coordinating requests for additional personnel, equipment or resources.
- Ensuring radiation protection activities conducted during the incident are adequately documented and records are maintained.
- Assisting project management in developing and implementing any necessary recovery plans (including TWDs, RWPs, etc.).

3.3.2 RCTs are responsible for:

- Taking actions to identify, assess, and mitigate radiological incidents in accordance with this procedure or project-specific emergency plans if applicable.
- Assuming the lead role until relieved by appropriate emergency response personnel, RPO supervision, or responsible management.
- Providing technical advice, assistance and oversight of radiological response actions; prescribing the controls and personal protection necessary to mitigate the radiological hazards; and coordinating those actions with the Incident Commander (IC), if responding, and/or other responding personnel.
- Notifying RPO supervision and when an error in the procedure is identified, or when an improvement in radiation protection can be made.

3.4 PREREQUISITES

Not Applicable.

3.5 RECORDS

Radiological records generated by Radiation Protection personnel during a radiological incident will be maintained in accordance project records retention and storage requirements.

3.6 PRECAUTIONS AND LIMITATIONS

Radiological emergency response is for dynamic situation that requires good judgment and prompt actions. Quick response, protection of personnel, protection of property or the environment, mitigation of the incident, and maintaining exposures As Low As Reasonably Achievable (ALARA) are the priorities for responding personnel. Note that during the time critical response phase, some normal operational requirements may be postponed (such as posting, RWPs, etc.), but as soon as the time critical elements have been accomplished and recovery operations begin, normal operational requirements shall be followed.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Attachment 1 Decontamination of Personnel

Attachment 2 Radiological Deficiency Report Form

4.0 PROCEDURE

4.1 GENERAL

An unusual radiological incident is defined as an "out-of-the-ordinary" event or event in which contamination and/or radiation levels have exceeded RWP suspension guides, posting criteria, or may potentially exceed federal reporting levels.

The following is a list of other examples of events that would require notification to RPM.

- Any release to the environment.
- Any transportation incident/accident.
- Any radiological contamination on the following: skin, hair, personal effects, non-radiological PPE, clothing other than radiological PPE.
- Any contamination above RPP Table 2-2 limits discovered outside of a contamination area.
- Any airborne radioactivity results which indicate that respiratory protection should have been worn but was not worn.
- Any airborne radioactivity results which indicate that an airborne radioactivity area may exist.
- Any posting of an area as airborne radioactivity area, high radiation area, or very high radiation area.
- Any failure of a HEPA exhaust system, filter, or device.
- Any failure of a radiological container or containment.
- Discovery that a Radioactive Source is missing, lost or is not accounted for.
- Any highly visible situation that is ongoing.
- Any indication that uncontrolled radioactivity may exist outside radiological controlled areas.

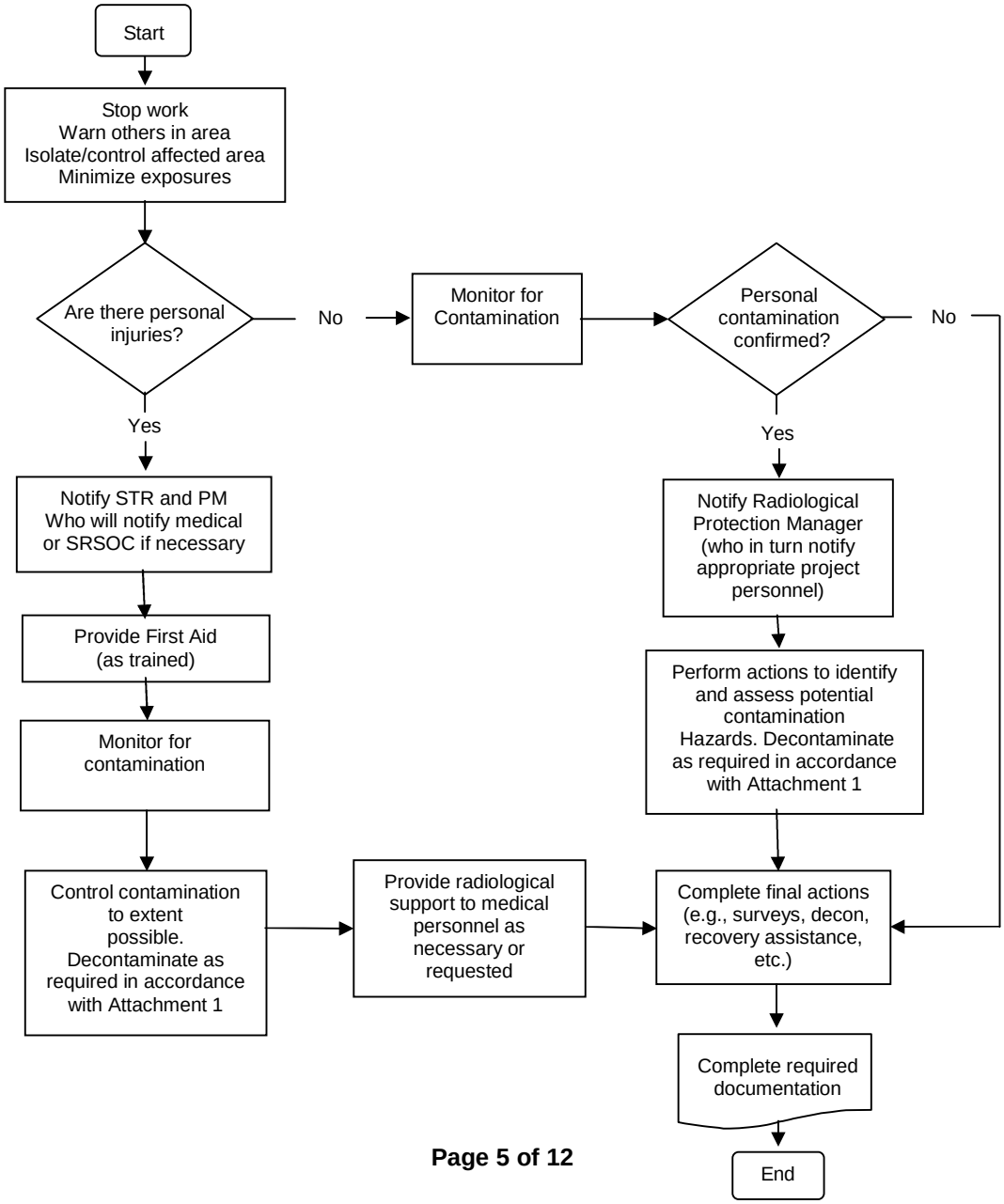
Radiation Protection personnel involved in a radiological incident should take the appropriate immediate initial actions in accordance with existing project-specific emergency plans or as indicated in subsequent sections to minimize the hazards to personnel, facilities equipment, and the environment during an incident unless such actions have already been accomplished. Responses for typical or common radiological incidents are presented in flow-chart format to simplify incident response actions while maximizing flexibility of response to specific incident situations and taking advantage of experience, training and the professional judgment of Project Management and RCTs.

Once the incident is stabilized, the “recovery” phase begins. Actions during the recovery phase may include:

- Promptly completing all survey reports and related documentation.
- Assisting in developing and implementing any necessary recovery plans (including TWDs, RWPs, etc.).
- Assisting in performing radiological recovery activities (e.g., facility or area decontamination).
- Assisting in completing any required incident reports, notifications, investigations, or reports.

4.2 PERSONNEL CONTAMINATION

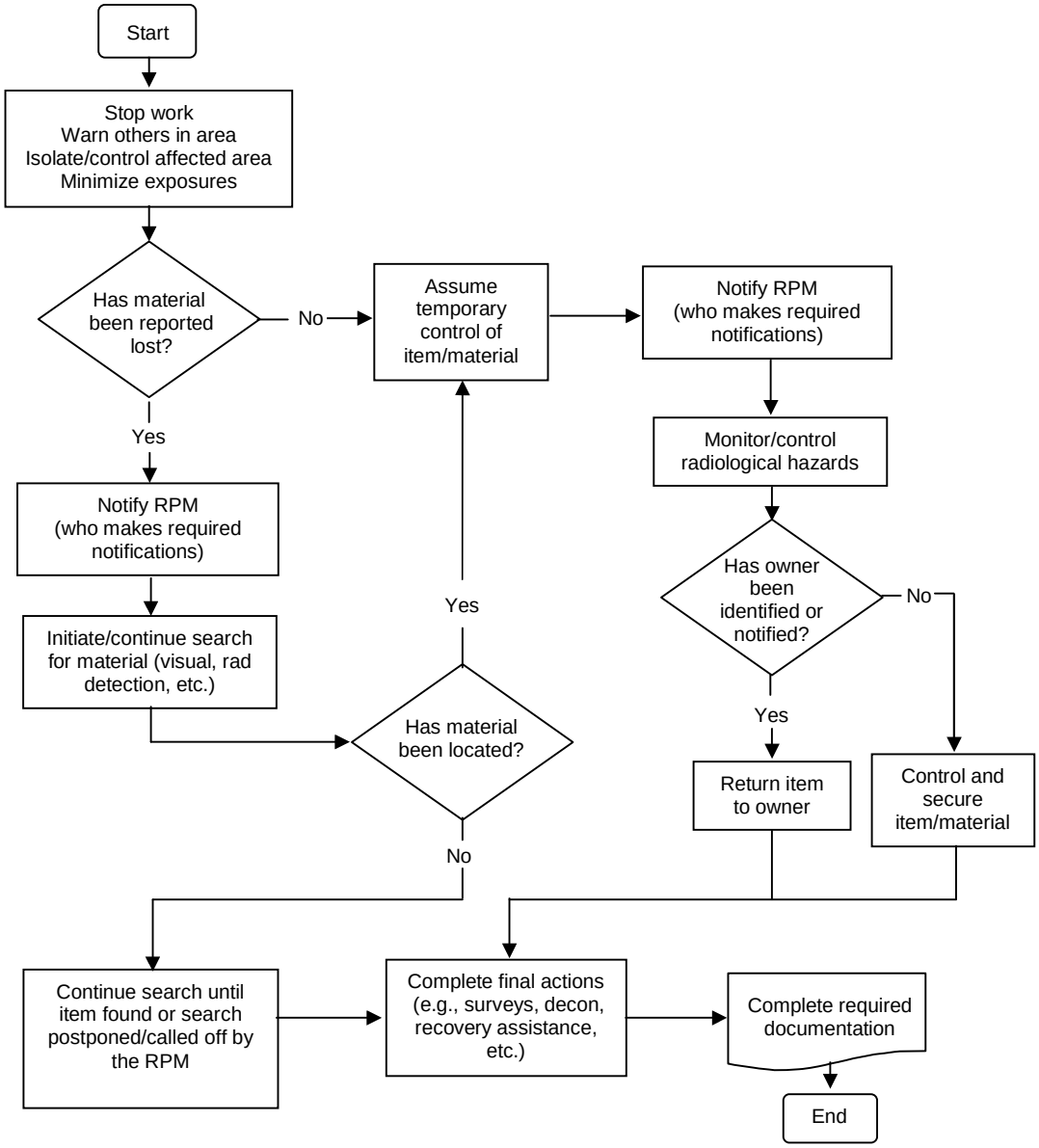
This Section applies to the handling of personnel with radioactively contaminated clothing (other than PPE), skin, and wounds or potential internal contamination. Medical treatment of injuries takes precedence over radiological considerations. As directed by medical, limited non-abrasive decontamination may be performed following Attachment 1. This procedure does not apply to personnel contaminated with hazardous chemical(s) or mixed materials.



RESPONSE TO RADIOLOGICAL INCIDENTS

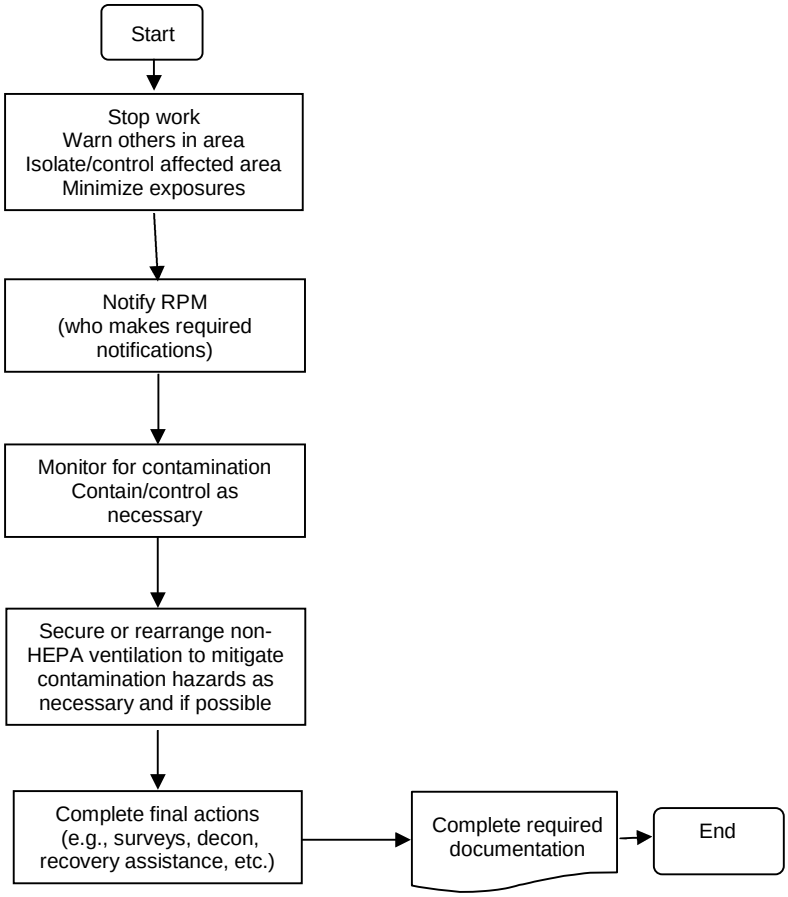
4.3 UNCONTROLLED RADIOACTIVE MATERIAL

This Section applies to radioactive materials, which may be lost or stolen or unaccounted for, and radioactive materials discovered or unattended in uncontrolled areas.



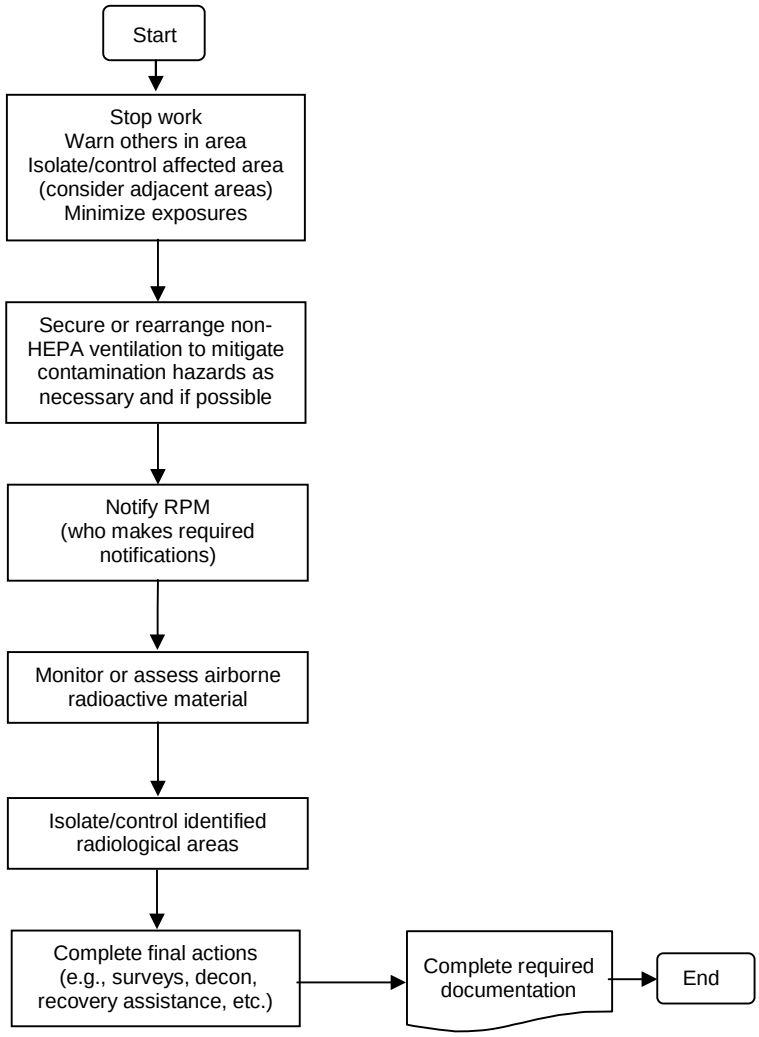
4.4 UNCONTROLLED RADIOACTIVE CONTAMINATION

This Section applies to the discovery of unexpected or unanticipated radioactive contamination (e.g., a damaged or “leaking” sealed source, spill of radioactive material, etc.).



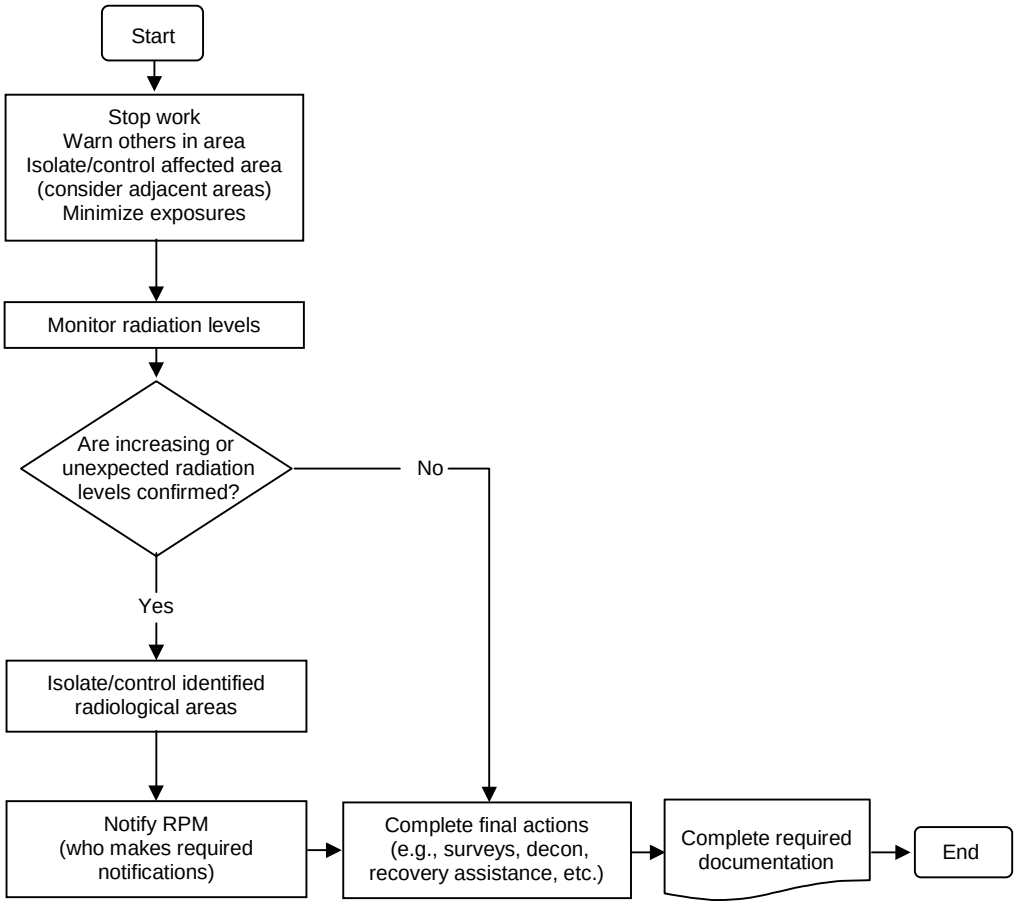
4.5 UNANTICIPATED AIRBORNE RADIOACTIVITY LEVELS

This Section is applicable when there is reasonable suspicion or expectation that airborne radiological levels exist outside the scope of the RWP or TWD; if radiological posting levels are exceeded which would add additional requirements; or any situation that the professional judgment of the RCT or RPO supervision dictates.



4.6 UNANTICIPATED RADIATION LEVELS

This Section is applicable when radiation levels exist outside the scope of the RWP or TWD, if radiological posting levels are exceeded which would add additional requirements, or any situation that the professional judgment of the RCT or RPO supervision dictates.



4.7 RADIOLOGICAL DEFICIENCY REPORTS

Radiological Deficiency Reports (RDR) are used to identify and document potential radiological deficiencies, problems, and improvement opportunities associated with project radiological operations. This process provides management with feedback and improvement data for continuous improvement of the Radiation Protection Program and increased workplace radiological awareness.

Any project personnel who observes or is aware of a potential radiological deficiency may initiate a RDR. Draft RDRs will be reviewed by RPO supervision to determine if final RDRs will be issued.

4.7.1 If a radiological deficiency is observed or discovered, the individual should INITIATE a draft RDR using Attachment 2.

4.7.2 DESCRIBE the deficiency, including observations, discoveries, and any additional personnel how should be contacted.

4.7.3 INCLUDE any immediate corrective actions taken to remedy the deficiency

4.7.4 NOTIFY RPM so that appropriate project notification can be made.

4.7.5 SIGN and FORWARD the completed draft RDR to RPO supervision for review.

4.7.6 RPO supervision should review the draft RDR to determine if the completion of the RDR is appropriate. The following examples are provided to assist in determining if an RDR should be issued. Individual circumstances should be evaluated when determining if an RDR should be issued.

- Noncompliance with Radiological Work Permit (RWP) requirements
- Procedure noncompliance affecting radiological control
- Radiological Incidents
- Required radiological routines, surveillances, instrument checks, and surveys not completed and surveys not just completed or documented in logbook as being justified in not being done
- Noncompliance with radiological controls, systems, or methods used to control contamination.
- Noncompliance with entry into radiological areas without the required training, dosimetry, Radiation Area/High Radiation Area (HRA) controls or authorization.
- Noncompliance with requirements to review/approve radiological work, planning radiological work, and required ALARA reviews.
- Poor radiological work practices requiring additional correction.
- Personnel contaminations.
- Noncompliance with program, methods, and techniques used to control radioactive material, storage, and packaging of radioactive material and sources.
- When directed by management.

4.7.7 If an RDR is not issued to final status, the Radiological Control Manager (RPM) will notify the originator in writing as to the reasons for non-issuance. : If the originator still believes there is a problem, the originator should discuss the issue with RPM. If the initiator still believes there is a problem, the issue should be raised to the next level of management. Copies of issued and non-issued RDRs will be maintained in the RDR Logbook.

4.7.8 RPO supervision should SIGN and DATE the RDR in the appropriate spaces and forward to the RPM for completion.

4.7.9 The RPM, with assistance from the Project Manager or designee, will determine who is responsible for completing the RDR. Once determined, the RDR will be forwarded to the responsible part for completion and resolution.

4.7.10 The responsible party will perform the following steps:

- Determine the root and contributing causes for the deficient condition.
- Determine appropriate corrective actions for correcting the deficient condition
- Document any lessons learned for the event
- Determine if any follow-up requirements (i.e., inspections, briefings, etc.) are required to assure that the deficiency has been corrected.

4.7.11 The responsible individual forwards the RDR back to the RPM for review and concurrence with identified corrective actions. If the RPM agrees with the corrective actions, the responsible individual is notified to implement. If the RPM disagrees with the corrective actions, the RDR is routed back to the responsible individual to resolve differences.

4.7.12 Once the approved corrective actions have been successfully implemented and any outstanding follow-up requirements have been completed, the RPM will sign and date the RDR as completed and place in RDR Logbook.

4.7.13 RDRs will be reviewed on a quarterly basis to determine any potential trends. Identified trends will be forwarded to the Project Manager to determine project corrective action strategies. The RPM will maintain a database for tracking and trending purposes and for the verification of corrective actions.

DECONTAMINATION OF PERSONNEL

NOTE: Decontamination of personnel shall only occur with the advice and consent of project management and is limited to non-abrasive methods. Discrete “hot particles” not directly associated with injuries should be removed immediately using tape or similar non-abrasive. All PPE, liquids, wipes, decontamination materials and material removed from the person shall be saved. These materials may be evaluated to perform a dose assessment. In all personnel contamination cases, the affected person(s) will not be released without RPM concurrence.

- Don appropriate PPE before starting.
- Establish and post a temporary Contamination Area, if necessary.
- Remove any contaminated PPE and personal clothing, as appropriate, and survey skin surfaces underneath. Be careful to prevent the spread of contamination when removing contaminated clothing to prevent cross-contamination of other body parts or surfaces. Control contaminated items for subsequent decontamination, disposition or disposal.
- Perform cursory decontamination of skin and/or hair:
    a. Ensure that all water, wipes, and other decontamination materials are collected for subsequent analysis, disposition or disposal, if necessary.
    b. Use only lukewarm (body temperature) water and mild soap to clean/decontaminate affected areas. As an alternative, alcohol-free baby wipes may be used or tape presses be used.

        NOTE: Extreme care should be taken to avoid abrading or breaking the skin. Brushing or rubbing the affected area(s) should be avoided.

    c. Gently pat dry the affected area(s) and resurvey for residual contamination.
    d. Repeat steps b. and c., as necessary. If contamination levels do not continue to decrease with repeated cleanings, or the affected areas become irritated, stop.
    e. Cover and identify (as appropriate) any contaminated skin/hair.
    f. Dress the individual in clean PPE, or her/his personal uncontaminated clothing.
- Transport the individual to the appropriate medical or decontamination facility further decontamination and follow-up if required. Accompany the individual.

Radiological Deficiency Report

Initiation		
Date of Event:	Time:	RDR #:
Description of Deficiency:		
Immediate Corrective Actions:		
Notifications:		
Initiator:	Date Submitted:	
RPO Review		
Program Reference:		
Comments:		
RDR Issued: ☐ Yes ☐ No		
Reviewed By:	Date:	
Corrective Actions / Resolution		
Root/Contributing Cause(s)		
Corrective Actions:		
Lessons Learned:		
Follow-Up Requirements:		
Corrective Actions Approved By:	Date:	
RDR Completed	Date	

TETRA TECH, INC

Procedure No: RP-OP-010 Rev 0

Water Sample Analysis

1.0 PURPOSE

To provide instructions for water sample preparation and analysis for alpha and beta-gamma contamination. This procedure implements 10 CFR 835 and 10 CFR 20

SCOPE

This procedure applies to Radiological Protection Organization (RPO) personnel preparing and analyzing water samples to determine the concentration of alpha and beta-gamma contamination on a timely basis.

The following sections are discussed in this procedure:

4.1 SAMPLE PROCESSING

4.2 SAMPLE PREPARATION

4.3 SAMPLE CALCULATIONS

2.0 REFERENCES

10 CFR 835, *Occupational Radiation Protection*

10 CFR 20, *Standards for Protection Against Radiation*

Waste Management Plan (WMP)

3.0 GENERAL

3.1 EQUIPMENT

3.1.1 Below is a list of materials required for the processing and analysis of water samples:

- tweezers
- alcohol
- 10-ml syringe
- stainless steel planchets (2 inch)
- hot plate or heat lamp
- indelible marker
- Radioactive Material labels
- alpha and beta counting system
- applicable portable survey instruments.

3.2 SAFETY CONSIDERATIONS

- Care should be taken when working with hot surfaces (e.g., hot plate, heated planchets). Allow adequate time for heated materials to cool down before handling.

3.3 RESPONSIBILITIES

RPO supervision:

- Responsible for the implementation of this procedure, for ensuring that radiological control technicians (RCTs) are qualified to perform this procedure and for documenting their qualifications.

Radiological Control Technicians are responsible for:

- Following this procedure when performing the sample analysis.
- Notifying RPO supervision and with concurrence, initiating a procedure change when an error in the procedure is identified or when an improvement in the radiation protection method can be made.

3.4 PREREQUISITES

- A Radiological Work Permit (RWP), as appropriate.
- Ensure that appropriate counting and survey instrumentation is available to monitor and analyze samples.
- Ensure that an adequate supply of appropriate materials is available.
- Ensure that containment has been certified for initial use and that before use inspections have been performed (see Attachment 2). The inspection checklist should be posted adjacent to the containment.
- Air exchange rate calculations shall be performed to ensure that a minimum of 10 containment air exchanges occur per hour.
- Certification of containment prior to placing into service will be performed by placing clean water in the bottom of the containment to verify seam seal integrity and by verifying air flow using irritant smoke. Certification will be documented on a Radiological Survey Form.
- Ensure that an area air sampler is running during all containment operations.

3.5 RECORDS

RPO sample analysis records are generated during implementation of this procedure. Records include the following forms:

- Water Sample Calculation Worksheet.
- Radiological Survey Form

Records are maintained in accordance with the RPO records management policy and applicable program and project requirements. The record copies are filed on site for the duration of the project.

3.6 PRECAUTIONS AND LIMITATIONS

None

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Attachment 1 Water Sample Calculation Worksheet

Attachment 2 Containment Inspection Log Sheet

4.0 PROCEDURE

4.1 SAMPLE PROCESSING

Note: Samples will be evaporated in a HEPA ventilated Containment (doghouse) as directed by RCM. Daily certification of the containment is performed using Attachment 2 when in use.

4.1.1 SURVEY the sample container with portable instruments.

4.1.2 IF a sample probes greater than background, THEN ENSURE safe preparation of sample (e.g., process sample in a manner that minimizes the potential for the spread of contamination).

4.1.3 IF the sample container probes < $1x10^3$ dpm beta-gamma, THEN PREPARE, AND ANALYZE a 10-mL sample.

4.1.4 IF the sample container probes ≥ $1x10^3$ dpm beta-gamma, THEN NOTIFY RPO supervision AND DETERMINE if analysis required. If not, DISPOSE of as contaminated waste in accordance with the WMP.

4.2 SAMPLE PREPARATION

4.2.1 WIPE a stainless steel planchet with alcohol.

4.2.2 MARK the sample number on the bottom of the planchet with an indelible marker.

4.2.3 ENSURE the pipette tip is changed between samples to prevent cross-contamination of samples.

4.2.4 To reduce potential for splattering sample on a hot planchet, USE the following techniques as applicable.

For 10-mL samples: PLACE planchet on hot plate or under heat lamp that is off, then TRANSFER 1-5 mL of the sample in cool planchet, and TURN on hot plate or heat lamp. TRANSFER the remainder of sample into planchet as it evaporates (never allowing the planchet to become dry) until the entire 10 mL has been dispensed.

4.2.5 REMOVE the planchet from the hot plate or heat lamp when evaporation of the sample is complete and ALLOW to cool.

4.2.6 PROBE the planchet with portable survey equipment for alpha and beta-gamma radiation.

4.2.7 IF the sample probes < $1x10^4$ dpm beta-gamma and < $1x10^3$ dpm alpha, THEN COUNT the sample in the appropriate counting system(s) for 10 minutes, AND RECORD the results (in cpm or dpm as appropriate) for the 10-minute period on the Water Sample Calculation Worksheet (Attachment 1).

4.2.8 IF the sample probes ≥ $1x10^4$ dpm beta-gamma or ≥ $1x10^3$ dpm alpha, do not place in a count room system, THEN USE portable beta-gamma and alpha instruments to count the sample, AND CALCULATE.

4.3 SAMPLE CALCULATIONS

4.3.1 ENSURE the counting system(s) are within their calibration period and that the daily source response and background checks have been completed.

4.3.2 RECORD the following counting system information based on the type of system used on Water Sample Calculation Worksheet (Attachment 1):

- Instrument Type and Serial number
- Calibration due date(s)
- Daily Minimum Detectable Activity (MDA) for the water sample geometry.

Note: Water sample MDAs will be calculated prior to processing samples in accordance with RP-OP-017. If the calculated MDA values are greater than the limits specified in section 4.3.8, count times will be increased to meet these values.

Note: Correction Factors (CF) will be posted on the scaler. CFs are calculated by taking the inverse of the instrument efficiency.

4.3.3 Using forceps/tweezers, PLACE the planchet containing the sample in the sample tray of the counting system being used.

4.3.4 PERFORM a 10 minute count of the sample for alpha and beta, determine the dpm/ml value for both alpha and beta using the following formula, and record on the Water Sample Calculation Worksheet (Attachment 1):

$$\text{ccpm} \times \text{CF} = \text{dpm} \div 10 \text{ ml (sample volume)} = \underline{\text{dpm/ml}}$$

4.3.5 For HandECounts, ENTER the dpm value in the formula and COMPLETE the calculations.

4.3.6 RECORD results for both alpha and beta analysis on Water Sample Calculation Worksheet (Attachment 1).

4.3.7 COMPLETE the required data on the appropriate Water Sample Calculation Worksheet (Attachment 1).

4.3.8 The final disposition of water collected during project activities is dependent on source and activity concentration. Disposition paths are listed below:

Source	Concentration (dpm/ml)	Disposition
Non-contact water	< 1 dpm/ml (gross α) <8 dpm/ml (non-volatile β)	Free released – contact project management and Waste Management Plan for disposition pathway
Contact Water	< 1 dpm/ml (gross α)	Consolidate with existing dry soil or use for dust control

	< 8 dpm/ml (non-volatile β)	within AOC (as defined in the Waste Management Plan)
Contact Water	< 3 dpm/ml (gross α) < 16 dpm/ml (non-volatile β)	Disposition per the Waste Management Plan

4.3.9 RETAIN all samples that calculate greater than 1 dpm/mL alpha and/or 8 dpm/mL beta-gamma. Also, RETAIN all samples that initially probed greater than background. DISPOSE of samples as directed by RPO supervision.

4.3.10 DOCUMENT results on Attachment 1, attach to Radiological Survey Form, and submit to supervisor for review.

Survey Number _____Pg___of___

Water Sample Calculation Worksheet

Sample(s) Location:		**Sample Date:**		**Sample Time:**	
Instrument Type	**Instrument No.**		**Cal Due**		
Beta MDA___dpm		Alpha MDA_____dpm			
Sample No.	Alpha Results (dpm/ml)	Beta-Gamma Results (dpm/ml)	Sample No.	Alpha Results (dpm/ml)	Beta-Gamma Results (dpm/ml)
RCT Performing Analysis:		Date:	Reviewed By:		Date:

Survey Number ________Pg___of___

Containment Inspection Log Sheet

Date	Time	Condition[1]	Ventilation[2]	DOP Due	Survey Number[3]	Approved	Comments	RCT
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		
		☐ Sat ☐ Unsat	☐ Sat ☐ Unsat			☐ Yes ☐ Not		

[1] General condition of the containment is acceptable, work area is uncluttered, and waste has not accumulated.

[2] HEPA vacuum is operating, flow across containment opening is evident by tell-tale indicator

[3] No transferable contamination in containment by smear survey

Reviewed By:____ Date:___________________

Radiological Qualification and Training

1.0 PURPOSE

The purpose of this procedure is to define the requirements for a comprehensive and effective training and qualification program for Tetra Tech (Tt) Radiation Protection staff.

The development and implementation of training and qualification materials for Radiation Protection personnel is the responsibility of the Radiation Protection Organization (RPO).

SCOPE

This procedure applies to the training and qualification of Tt RPO personnel. This procedure also addresses radiological training requirements for visitors and non-radiological workers to project areas.

The following activities are described in Section 4.0 of this procedure:

4.1 General

4.2 Radiological Control Technicians (RCTs)

4.3 RCT Continuing Training & Biennial Requalification

4.4 RPO Supervision/Lead RCTs

4.5 Oral Examination Boards

4.6 Radiological Engineers and RPO Program Staff

4.7 Radiological Control Manager

4.8 Additional Training

4.9 Visitor Orientation and Non-radiological Workers

4.10 Count Room Technician (CRT)

2.0 REFERENCES

U.S. Department of Energy, “Occupational Radiation Protection; Final Rule,” 10 CFR Part 835, November 1998.

U.S. Department of Energy, “Personnel Selection, Qualification, and Training Requirements at DOE Nuclear Facilities,” DOE Order 5480.20A, November 1994.

U.S. Department of Energy, “Guide to Good Practice in Radiation Protection Training,”ORAU 88 H-99, October 1988.

U.S. Department of Energy, “Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities,” DOE STD-1107-97.

U.S. Department of Energy, "Radiological Control Technician Training Program Management Manual," DOE/EH-0262T-1, May 1995.

Department of Energy, “Radiological Control Technician (RCT) Training,” DOEHDBK- 1122-99.

U.S. Department of Energy, "Radiological Control Standard," DOE-STD-1098-99, July 1999.

Nuclear Regulatory Commission, “Standards for Protection Against Radiation,” 10 CFR 20

3.0 GENERAL

3.1 EQUIPMENT

Not Applicable

3.2 SAFETY CONSIDERATIONS

Not Applicable

3.3 RESPONSIBILITIES

3.3.1 The Radiological Control Manager shall be responsible for:

a. qualifying RPO supervisors, Lead Techs, Radiological Support Staff members prior to assignment of duties;

b. approving Radiological Control Technician (RCT) qualifications;

c. designating board members and a chairperson for RCT Oral Examination Boards;

d. granting initial qualification to RCTs after completion of Phase III Training;

e. granting extensions to the 24-month requalification periods of individual RCTs,

f. ensuring that all RCTs are qualified in accordance with this procedure;

g. resolving problems pertaining to RCT training (e.g., violations of test integrity, trainee performance, etc.);

h. concurring on site-specific Radiation Protection Training materials used on this project

i. creating new and revised material for radiological training

3.3.2 RPO Supervisors & Lead Techs shall be responsible for:

a. ensuring that RCTs are qualified to perform their assigned duties and documented as such prior to assignment of those duties;

b. conducting area orientations with new RCTs;

c. determining required reading applicable to RCTs, beyond the minimum specified in this procedure;

d. requesting new RCT training materials/lessons, or revisions to existing RCT training materials/lessons.

3.3.3 Technicians shall be responsible for:

a. completing all required training, qualification, and requalification requirements in a timely manner and prior to assignment of duties;

b. refusing to perform tasks for which they are not trained and qualified; and

c. requesting new training materials/lessons, or revisions to existing training materials/lessons.

3.4 PREREQUISITES

Not Applicable.

3.5 RECORDS

RPO Training records are generated during the performance of this procedure to document training of RPO personnel. The original copies of the records are the record copies for the RPO Training program. The record copy is given to the Quality Control organization for processing, including arrangement and filing. Copies of the records may be made for information purposes and shall be stamped as such.

3.6 PRECAUTIONS AND LIMITATIONS

In instances where the developer of training material needs to be qualified to begin qualifying others, a documented exception will be provided. This documented exception will be placed in the RPO personnel's Training File.

3.7 REVISIONS

The review cycle for this procedure is three years, or as needed. Revisions to this procedure shall be controlled by the RPO.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Attachment 1 Radiological Control Technician/Lead Technician/Supervisor Qualification Record

Attachment 2 Radiological Control Management and Support Staff Training Record

Attachment 3 Continuing and Additional Training Record

Attachment 4 Required Reading Sheet

Attachment 5 Visitor Orientation Record

Attachment 6 Oral Examination Board Grading Form

Attachment 7 Project Radiological Authorization

Attachment 8 Count Room Technician Qualification Record

4.0 PROCEDURE

4.1 GENERAL

4.1.1 Because of the nature of their duties, RPO personnel (e.g., RCTs, Supervisors, Lead Techs, Radiation Protection Support staff, RPM) would generally be expected to have responsibility for implementing measures necessary for ensuring compliance with 10 CFR 835 and 10 CFR 20. Therefore, Radiation Protection personnel shall be subject to the education, training, and skills requirements of 10 CFR 835.103.

4.1.2 Training and qualification of Radiation Protection personnel should address routine operations and also focus on recognizing and handling situations in both normal and changing radiological conditions. Newly qualified personnel, as well as those still in training,

should be given the opportunity to work with qualified, experienced personnel to foster development.

4.1.3 Tt RPO employees shall meet all applicable employment requirements (e.g., Human Resources, Personnel Security, etc.) for their position in addition to the requirements of this procedure.

4.1.4 Subcontract employees shall meet all applicable contractual requirements in addition to the requirements of this procedure.

4.2 RADIOLOGICAL CONTROL TECHNICIANS (RCTs)

4.2.1 Candidates for RCT positions shall meet the following minimum entry requirements:

a. Education - High School graduate or GED equivalency.

b. Senior (Sr) RCT Experience - At least three years in operational radiation protection.

Junior (Jr) RCT Experience – At least two years of radiological work experience

NOTE: Degree in a related field will credit toward one year experience for Sr position and replace two year experience for Jr position.

c. Position Specific Training: - Completion of DOE RCT Core Training.

d. Special skills/Training - Demonstrated verbal and written communication skills. Physically capable of handling radiological protective equipment, and able to successfully complete respiratory protection training and fit-testing.

4.2.2 It is desirable that RCT candidates:

a. have completed advanced courses in math, physics, chemistry, and science.

b. have the ability to operate a personal computer operating with the Windows operating system.

4.2.3 Prior to hire, RCT candidates shall successfully pass the DOE CORE equivalency entrance examination or utility entrance examination. Successful completion of the entrance examination constitute Phase I of the RCT qualification process.

4.2.4 Required reading and site-specific training represent Phase II of the RCT qualification process. All required reading shall be completed prior to Phase III (Oral Examination Board).

Required reading consists of:

a. 10 CFR Chapter applicable to contract;

b. The Radiation Protection Implementation Plan (RPIP);

c. All current Radiation Protection Operations procedures;

d. The site-specific Health and Safety Plan;

e. Any other documents determined (by the applicable RPO management) to be necessary (e.g., lessons learned, waste management plans, etc.).

4.2.5 RCTs shall not be assigned tasks for which they are not qualified.

4.2.6 RCTs shall complete training on procedures specific to their job assignment.

4.2.7 Based upon assigned duties and responsibilities, individual RCTs may require additional training to enhance their overall performance and skills. These courses may include specialized training in respiratory protection, confined space entry, CPR, first aid, and hazardous material training, as appropriate. The Radiological Protection Manager (RPM) (in conjunction with RPO supervisor(s) and project management) shall determine the need for, and verify the satisfactory completion of, such additional training.

4.2.8 All RCTs are strongly encouraged to pursue registration through the National Registry of Radiation Protection Technologists (NRRPT).

4.2.9 Completion of RCT qualification requirements will be documented on Attachment 1.

4.3 RCT CONTINUING TRAINING & BIENNIAL REQUALIFICATION

4.3.1 Following initial qualification, an RCT shall begin a two-year cycle of Continuing Training to maintain and enhance his/her proficiency as an RCT. This training shall provide RCTs with a review of required knowledge/skills, introduction to new knowledge/skills, and lessons learned from others.

4.3.2 Required reading shall be included as part of RCT Continuing Training, and shall be documented using the Required Reading Sheet (Attachment 4).

4.3.3 Biennial RCT requalification shall be completed at an interval not to exceed every 24 months [10 CFR 835.901(e)], unless an extension has been granted. Extensions will require RPM approval.

4.3.4 Biennial RCT requalification shall encompass a representative cross section of DOE Core Training learning objectives, industry-wide changes in requirements, lessons learned from operations experience, operating procedures, and specific tasks.

4.3.5 Job-Specific requalification shall be completed at least every 24 months, and shall be accomplished during the off-year (i.e., during the year in which biennial RCT requalification is not required). RPO management shall determine job-specific requalification requirements for RCT(s).

4.3.6 Requalification includes the successful recompletion of the appropriate entrance examination and an oral examination board.

4.3.7 Completion of RCT requalification and continuing training requirements will be documented on Attachment 3.

4.4 RPO Supervisors/Lead RCTs

4.4.1 Candidates for the position of RPO Supervisor and Lead RCT approved by the project RPM.

4.4.2 Candidates for these positions shall meet the following minimum entry requirements:

a. Education - High School graduate or GED equivalency.

b. Experience - Five years in operational radiation protection.

c. Special skills/Training – Full qualification as an RCT. Demonstrated verbal and written communication skills. Demonstrated organizational, supervisory, and leadership capabilities to direct the work of RCTs; effectively interact with project management personnel, line supervisors, and professional staff. Demonstrated ability to respond to, and direct others in,

emergency and abnormal situations. Demonstrated interpersonal relationship skills to effectively interact with RP Program personnel.

4.4.3 It is desirable that RPO Supervisor and Lead RCT candidates complete advanced courses in math, physics, chemistry, and science.

4.4.4 RPO Supervisor and Lead RCTs shall meet and maintain all of the training/retraining, continuing training, and qualification/requalification requirements for the position of RCT.

4.4.5 The RPM shall have final approval authority for all personnel recommended for RPO Supervisor and Lead RCT positions.

4.4.6 RPO Supervisor and Lead RCT approval shall be documented on Attachment 1.

4.4.7 All RPO Supervisor and Lead RCTs are strongly encouraged to pursue registration under the National Registry of Radiation Protection Technologists (NRRPT). Registration by NRRPT provides equivalency to the education and experience requirements of Section 4.4.2.

4.4.8 Continuing training for RPO Supervisor and Lead RCTs should include a variety of topics, and should be offered frequently enough, to assist these personnel in remaining cognizant of changes to radiological facilities, operating experiences, lessons learned, Radiation Protection Program policies and operating procedures, and quality assurance requirements, as applicable. Completion of Lead RCT and Supervisor requalification and continuing training requirements will be documented on Attachment 3.

4.4.9 Completion of Lead RCT and Supervisor qualification requirements will be documented on Attachment 1.

4.5 ORAL EXAMINATION BOARDS

4.5.1 Phase III Training consists of an Oral Examination Board. Oral Boards should assess the candidate's response to normal and emergency situations. Questions should be of the type that are not normally covered in a written examination. Oral Examination Boards are designed to demonstrate an understanding of what the technician is expected to do. Specifically they should assess:

a. the qualification of candidates for applicable RPO positions,

b. the individual’s response to normal situations in the work place,

c. the individual's response to emergency situations.

4.5.2 Oral Board members and materials should be designated by the RPM.

4.5.3 Each board member should come to an independent assessment of the candidate.

a. It is permissible to ask other board members about the questions that were asked during the board for clarification purposes.

b. Questions between board members WILL NOT TAKE PLACE DURING THE BOARD. A "collaborative" effort to arrive at a grade is not acceptable.

4.5.4 During the board, the board members shall not indicate how well or how poorly the candidate is answering the question.

4.5.5 All questions should be clear, unambiguous, and based at the level of training the RCT or Lead/Supervisor Manager has received.

a. Leading questions shall not be asked.

b. The board member may clarify a question, as necessary, if the candidate does not understand it.

4.5.6 The length of time for the oral examination board should not exceed 1 hour.

4.5.7 The board members independently assess the RCT. The grading form found in Attachment 6 is used to combine these assessments. To avoid subjective errors, the grading sheet has been enhanced to foster objective judgment of the candidate.

4.5.8 The results of the Oral Board should be forwarded to the RPM for review and determination of qualification.

4.6 RADIOLOGICAL SUPPORT STAFF

4.6.1 Radiological Support Staff perform a variety of health physics, radiological engineering, procedure and policy development, independent oversight, and 10 CFR compliance verification functions for Tt projects. These personnel shall meet the following minimum entry requirements:

a. Education - B.S. or B.A. degree in health physics, or in a science or engineering subject, augmented by formal training in radiation protection.

b. Special skills/Training - Demonstrated verbal and written communication skills. Demonstrated interpersonal relationship skills to effectively interact with project personnel and RP Program professional staff.

4.6.2 Continuing training for Radiological Support Staff should include a variety of topics, and should be offered frequently enough, to assist these personnel in remaining cognizant of changes to radiological facilities, operating experiences, lessons learned, Radiation Protection Program policies and operating procedures, and quality assurance requirements, as applicable.

4.6.3 Pursuit of American Board of Health Physics certification for Radiological Engineers and RP Program Staff should be encouraged and supported.

4.6.4 Completion of Radiological Support Staff qualification requirements will be documented on Attachment 2.

4.7 RADIOLOGICAL PROTECTION MANAGER (RPM)

4.7.1 The RPM functions as the designated steward of the project RPIP. The RPM not only manages and coordinates the overall Program, but also acts as the Program interface with the facility representatives, The RPM shall meet the following minimum entry requirements:

a. Education - B.S. or B.A. degree in health physics, or in a science or engineering subject, augmented by formal training in radiation protection. Equivalency for related professional experience may be granted.

b. Experience - Ten years of professional-level experience in operational Health Physics, Nuclear Engineering, or a related field.

c. Special skills/Training - Demonstrated verbal and written communication skills. Demonstrated organizational, supervisory, and leadership capabilities to direct the work of professional staff and RCTs alike within the Radiation Protection Program. Demonstrated interpersonal

relationship skills and ability to effectively interact with project management personnel, other ES&H organizations and regulating officials.

d. Continuing training for the RPM is the same as for the Radiological Support Staff (4.5.2). This training will be documented on Attachment 3.

4.7.2 Completion of RPM training requirements will be documented on Attachment 2.

4.8 ADDITIONAL TRAINING

4.8.1 When additional radiation protection related training is accomplished, it shall be documented in the individual's training file. Additional training may include any radiological training conducted by Tt organizations, radiological short courses, radiological type drills participated in, etc.

4.8.2 A record of additional training completed shall be forwarded to the project Quality Assurance Manager for filing. Records may include a copy of attendance logs, certificates of completion, etc

4.9 VISITOR ORIENTATION

NOTE: A visitor is defined as a person requesting access to Controlled Areas who has not been trained to the level required to permit unescorted access (GET).

4.9.1 Visitors to project areas will only be allowed into Controlled Areas and will receive Visitor Orientation Training prior to entry into these areas. If entry into Radiological Buffer Areas, Radioactive Material Areas, or Radiological Areas to perform manual work is required, Visitor Orientation Training and a Project Radiological Authorization will be required prior to entry in accordance with Section 4.9.5 of this procedure.

4.9.2 Visitors who enter the Controlled Area will receive a radiological safety orientation that will include the following topics:

a. Basic radiation protection concepts

b. Risk of low-level occupational radiation exposure, including cancer and genetic effects

c. Risk of prenatal radiation exposure

d. Radiological protection policies and procedures

e. Visitor and management responsibilities for radiation safety

f. Adherence to radiological posting and labeling

g. Applicable emergency procedures

h. Current site operations and radiological conditions

4.9.3 Visitor Orientation Training will be documented on Attachment 5. Project Radiological Authorization will be documented on Attachment 7.

4.9.4 Visitors will be continuously escorted by qualified project personnel with the appropriate training to enter the area. Escorts will be briefed and approved by the RPM.

NOTE: A non-radiological worker is defined as a person requesting access to radiologically

controlled areas who has not been trained to the level required to permit unescorted access (RW I, RW II).

4.9.5 Non-radiological workers requiring access to RBA, RMA, URMA, SCA, CA, or RA to perform hands on work activities must complete the following for entry into these areas:

- Complete Project Radiological Authorization (Attachment 7)
- Be continuously escorted by a qualified project employee (approved by RPM) when entering areas
- Perform sign in/sign out activities on all appropriate RWPs (ProRad and/or written sign in, as appropriate).
- Comply with dosimetry requirements as specified in RWP and Section 4.9.6.

4.9.6 For non-rad workers expected to be on the project <10 days in the calendar year, individual dosimetry is required if entering an area requiring a TLD. Non-rad workers expected to be on site >10 days in the calendar year requesting entrance to areas requiring TLDs are required to obtain an individually assigned TLD. Non-rad workers are normally not required to participate in routine bioassay programs. If bioassay is required, Whole Body Count personnel should be contacted for completion of appropriate forms.

4.9.7 Non-radiological workers are not allowed to enter HCA, HRA, VHRA, or ARA.

4.10 COUNT ROOM TECHNICIAN

4.10.1 Candidates for CRT positions shall be approved by the project RPM and meet the following minimum entry requirements:

a. Education – High School graduate or GED equivalency.
b. Experience – At least 6 months in operational radiation work
c. Special Skills/Training –Must be able to pass examinations required for Advanced Radiological Worker II. Demonstrated organizational and computer skills.

4.10.2 Training on operating procedures will be documented on a CRT Qualification Record (Attachment 8).

The duties of the technician will include:

- Assisting RCT in collection of samples
- Preparing samples for counting
- Counting samples on scalers or Gamma Spectroscopy System
- Entering count results into a computerized calculating/tracking system
- Resolving missing and incorrect data on data sheets
- Reviewing data and notifying supervision of samples above limits

Radiological Control Technician/Lead Technician/Supervisor Qualification Card

Name:_____ **User ID:**_____

Phase I Qualification

RPM Resume Review and Approval Date: _____ _____ (Initials)

☐ Satisfactory ☐ Unsatisfactory

Entrance Examination Date: _____ Results: ☐ Satisfactory ☐ Unsatisfactory

Phase II Qualification

Document	Date	Signature of Trainee
10 CFR _____ (list appropriate chapter)		
Project RPIP		
SSHASP		
RP-OPs *		

*List each procedure separately

Phase III Qualification

Oral Board Date: _____ Results: ☐ Satisfactory ☐ Unsatisfactory

Project: ☐ RCT ☐ Lead/Supervisor

RPM Approval: _____ Date: _____

Radiological Control Management and Support Staff
Qualification Record

Name:_____ **User ID:**_____

Document	Date	Signature of Trainee
10 CFR 835		
Project RPIP		
SSHASP		
Waste Management Plan		
Sampling and Analysis Plan		
Project Quality Assurance Plan		
RP-OPs*		

*List each procedure separately

RPM Approval: _____ Date: _____

Continuing and Additional Training Record

Name:_____ **User ID:**_____

Topic	Date	Signature of Trainee

Required Reading Sheet

Topic:_____ **Due Date:**_____

Name	Date Assigned	Date Completed	Signature

Visitor Orientation Record

Date:_____ Performed By:_____

Topics covered:

- Basic radiation protection concepts
- Risk of low-level occupational radiation exposure, including cancer and genetic effects
- Risk of prenatal radiation exposure
- Radiological protection policies and procedures
- Visitor and management responsibilities for radiation safety
- Adherence to radiological posting and labeling
- Applicable emergency procedures
- Current site operations -_____

  _____
- Current radiological conditions - _____

_____

Printed Name	Signature	Company	SSN

Reviewed By:_____Date:_____

ORAL EXAMINATION BOARD GRADING FORM

Candidate: _____ Date: _____

Board Members: _____

Overall Grade (circle one): Satisfactory Unsatisfactory

Scenario Description: _____

Grading Form				
In addition to the scenario questions, board members will select a minimum of two (2) discussion topics for each oral examination board. Mark the selected topics with an "X"				
Discussion Topic		SAT	UNSAT	Comments/Strengths/Weaknesses
X	Scenario questions (required)*			
	1. Instrumentation			
	2. Air Sampling Program/Methods			
	3. Contamination Control Methods			
	4. Radiological Work Coverage			

General Radiological Controls Grading Form			
	SAT	UNSAT	Comments/Strengths/Weaknesses
Field Applications			
Generation and Disposition of Records			
Equipment			

Candidate (Print/Sign Name)_____Date_____

Board Member 1 (Print/Sign Name)_____Date_____

Board Member 2 (Print/Sign Name)_____Date_____

Date

Project Radiological Authorization

Personnel Information		
Name	ID Number (specify type)	Date From to
Description of Activity		

Visitor (Hands on Work)						
Visitor Orientation Briefing Complete ☐ Yes (attach) ☐ No						
Area to be Accessed ☐ RBA ☐ RMA ☐ URMA ☐ SCA ☐ CA ☐ RA						
RWP #	Authorization for TLD ☐ Yes ☐ No _____ Date		Authorization for Bioassay ☐ Yes ☐ No _____ Date		Assigned Escort (print)	
Project RCM or Deputy RCM (print/sign)				Date		

Non-Radiological Worker (Hands on Work)			
Area to be Accessed ☐ RBA ☐ RMA ☐ URMA ☐ SCA ☐ CA ☐ RA			
RWP #	Authorization for TLD ☐ Yes ☐ No	Assigned Escort (print)	
Project RCM or Deputy RCM (print/sign)			Date

Escort: I certify, by my signature below, that the individual that I am escorting has complied with the requirements TtFW, RP-OP-011 prior to entry. Futhermore, I am qualified to escort personnel in the areas entered.

Escort Name (Print/Sign)	Date
Escort Name (Print/Sign)	Date
Escort Name (Print/Sign)	Date

Count Room Technician Qualification Record

Name: _____User ID: _____

RPM Resume Review and Approval Date:_____Initials:_____

Document	Date	Signature

Qualification Complete - Results: ☐ Sat ☐ UnSat

RPM Approval: _____Date: _____

PRE-OPERATIONAL CHECKS FOR PORTABLE HAND HELD SURVEY INSTRUMENTS

1.0 PURPOSE

To provide instructions for the performance of pre-operational checks of portable hand-held radiation-monitoring instruments. Pre-operational checks are a critical part of the TtNUS Radiation Protection Organization (RPO) Radiation Protection Program quality assurance process and are mandated by requirements contained in 10 CFR 20.

SCOPE

This procedure applies to selected portable hand-held instruments. Specific instruments and probes are listed below. Equivalent instruments and/or probes may be substituted. This procedure shall also apply to future replacements for these instruments when such action(s) occur. Operating instructions for equipment can be found in the manufacturer's user manual

- Ludlum Model 19
- Ludlum Model 2360
- Ludlum Model 3 &12
- Ludlum Scaler Model 2224
- Ludlum Model 177 Rate meter (with alarm)
- Dual Alpha/Beta-Gamma Probe – Model 43-93
- Beta-Gamma Probe – Models 44-9
- Gamma Scintillation Probe – Model 44-10

The following activities are described in Section 4.0 of this procedure:

4.1 General Comments Regarding Pre-Operational Checks

4.2 Receipt of an Instrument From the vendor

4.3 Performing Prior-To-Use Response Checks

4.4 Return of Instruments

2.0 REFERENCES

10 CFR 20

TtNUS Radiation Protection Plan (RPP)

TtNUS Health and Safety Plan (HASP)

PRE-OPERATIONAL CHECKS FOR PORTABLE HAND HELD SURVEY INSTRUMENTS

3.0 GENERAL

3.1 EQUIPMENT

- Portable Instrument Pre-Operational Response Check Sheet". A sample check sheet is shown in Attachment 1.
- Applicable portable survey instruments
- Alpha/Beta/Gamma check sources as applicable (Attachment 2)
- DO NOT USE TAG (Attachment 4)
- Blank Sheet of Paper, as necessary
- Calculator, as necessary

3.2 SAFETY CONSIDERATIONS

- As specified in the applicable HASP, and/or Radiological Work Permit (RWP).
- Practice the principles of ALARA when using radioactive sources.

3.3 RESPONSIBILITIES

3.3.1 RPO supervision is responsible for assuring that users are qualified to perform this procedure. RPO supervision is also responsible for periodic review of documentation required by this procedure and for ensuring that completed response check sheets are reviewed and forwarded to Quality Assurance for filing as needed.

3.3.2 RCTs are responsible for complying with this procedure and exercising appropriate techniques in the handling and storage of sources.

3.3.3 In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The user of this procedure shall ensure that the instrument to be used is currently calibrated.

3.4.2 The user of this procedure shall ensure that the instrument is operated with the probe with which it was calibrated, as applicable.

3.4.3 The user of this procedure shall be knowledgeable in regards to the operation of each instrument he/she is using.

3.5 RECORDS

Portable Instrument Pre-Operational Response Check Sheet forms are generated during the performance of this procedure. Original records will be stored, arranged, indexed, retrieved, scheduled, retained, and disposed of in accordance with Quality Assurance requirements.

3.6 PRECAUTIONS AND LIMITATIONS

3.6.1 Direct contact with the surface of a plated-source can damage or disturb the protective coating and distribution of the radioactive material.

3.6.2 Changes in background count rates may be the result of a damaged or contaminated detector/probe, radiological source interference or radon.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

This procedure implements the requirements of 10 CFR 20.

3.9 ATTACHMENTS

Attachment 1 Portable Instrument Pre-Operational Response Check Sheet, (with instructions for initial response check)

Attachment 2 Source Recommendations For Response Checking

Attachment 3 Follow Up For Elevated Background Readings

Attachment 4 Do Not Use Tag

4.0 PROCEDURE

4.1 GENERAL COMMENTS

4.1.1 If at any time an instrument is damaged during use, fails any of the steps of this procedure, or is recalled, then return the instruments in accordance with Section 4.4.

4.1.2 Initial Response Check, initial background and the calculation for the ± 20% acceptable range shall be performed prior to initial use of a radiation survey instrument. Use the form in Attachment 1 for this purpose.

4.2 RECEIPT OF AN INSTRUMENT FROM THE VENDOR

NOTE: Steps 4.2.1 through 4.2.6 should be done soon after receipt of instrument(s).

4.2.1 Prior to placing the instrument in service, VERIFY that the instrument calibration label is in place, is current, and shows the detector efficiency (not applicable for dose rate instruments).

4.2.2 VERIFY that there is no physical damage to the instrument such as:

- Damage to body of instrument.
- Damage to detector cable.
- Damage to surface of detector such as light leaks (turning the mylar face of detector toward light source to check for response indicating a light leak), punctured GM tube, etc.

- Broken or loose fasteners, handles, switches.

4.2.3 VERIFY that the analog meter indicator reads zero when the power is off (if applicable).

4.2.4 VERIFY that the electrical condition of the instrument is acceptable such as:

- Battery self-test or check indication
- Instrument high voltage self-test indication
- Adjustment of electronic zero to zero

4.2.5 ADJUST the electronic zero of the instrument to zero when necessary.

4.2.6 If applicable, INFORM RPO supervision, and PLACE the instrument out of service in accordance with Section 4.4.

4.2.7 Prior to first use of the instrument(s), fill out a "Portable Instrument Pre-Operational Response Check Sheet" in accordance with instructions contained in Attachment 1. This first operational check of the instrument after receipt from the vendor is called an "Initial Response Check".

4.3 PERFORMING PRIOR-TO-USE RESPONSE CHECKS

NOTE: Performance of an initial response check is considered to be equivalent to a "Prior-to-use Response Check" on the day the initial response check was performed.

NOTE: The RCT is indicating that he/she has performed the Prior-To-Use Response Check each time he/she writes their initials in the "Initials" column of the "Portable Instrument Pre-Operational Response Check Sheet" (Attachment 1).

4.3.1 OBTAIN the "Portable Instrument Pre-Operational Response Check Sheet" assigned to the instrument to be used.

4.3.2 If the "Portable Instrument Pre-Operational Response Check Sheet" is to be continued on another check sheet, OBTAIN a blank check sheet, WRITE continuation or NA in the signature blank for the person who performed initial response check and TRANSFER the following information:

- Instrument Model.
- Instrument Serial Number.
- Probe Type.
- Probe Serial Number.
- Instrument Certification (Calibration) Date.
- Instrument Certification Expiration (Calibration Due) Date.
- Background at Time of Initial Response Check.
- Check Source(s) Identification Number

- Instrument Ranges.
- Reference (Average) Reading.
- Check Source Acceptable Range (-20% _____ +20% _____).

4.3.3 RECORD the date/time of the response check in the applicable block on the next available line of the current "Portable Instrument Pre-Operation Response Check Sheet."

4.3.4 OBTAIN a background reading and RECORD this value in the Background (Bkg) column of the check sheet.

4.3.5 OBTAIN the sources/jig identified on the "Portable Instrument Pre-Operation Response Check Sheet".

NOTE: The same source(s) used for the "Calculation of the ± 20% Acceptable Range" must be used for the "Prior To Use Response Check." A new form must be generated for calculations of a new acceptable range if the original source(s) cannot be used.

4.3.6 If applicable, SELECT the desired scale on the instrument. Instruments with dual probes will be source checked in the "Alpha Only" or "Beta Only" position.

4.3.7 SELECT the source assigned to the instrument.

4.3.8 PLACE the detector over the applicable source to provide a reproducible geometry.

4.3.9 TAKE a one-minute reading if the instrument operates in scaler mode or ESTIMATE readings from instruments without scaler mode based on continuous observation for a period long enough to obtain the reading (approximately 20 to 30 seconds).

NOTE: If the reading is outside of the acceptable ± 20% range, the response check may be repeated, but may not exceed three attempts and only one of the three readings is to be recorded on the check sheet.

4.3.10 RECORD the result in the "Reading" box corresponding with the "Date/Time" and "Bkg," box on the "Portable Instrument Pre-Operational Response Check Sheet" and CIRCLE unit. The Instruments with dual probes require one sheet for alpha check and one for beta check.

4.3.11 REMOVE the detector from the source.

4.3.12 If the reading recorded is outside of the acceptable range, then RECORD UNSAT in the "Issue SAT (√)" block, line through remaining lines, and WRITE "Tagged Out Of Service". Explain the problem(s) found on the Do Not Use tag.

4.3.13 REPEAT Steps 4.3.6 through 4.3.10 for all scales that are to be checked. Go to Step 4.3.15 if a reading falls outside of the acceptable range, otherwise proceed to Step 4.3.16.

4.3.14 For the Ludlum 177 alarming ratemeter (frisker), or equivalent, determine the ambient background by performing a phantom frisk of the area. Verify meter alarm by exposing the detector to a check source and observing meter reading at alarm. Set the meter alarm at 100 cpm above the average background reading where personnel monitoring will be performed.

The Ludlum 177 will be response checked to verify proper alarm setting on a weekly basis. Source checks, as described in steps 4.3.1 through 4.3.13 will not routinely be performed.

4.3.15 If an instrument with a dual probe (detects both alpha and beta-gamma) is being checked, two (2) “Portable Instrument Pre-Operational Response Check Sheets” will be used and response checks will be performed separately for alpha and beta-gamma.

4.3.16 INFORM RPO supervision of any instruments with readings, which fall outside of the acceptable range, and follow Section 4.4 regarding taking the instrument out of service.

4.3.17 PRINT and SIGN your name under the “Print/Sign” block for each row of readings you have recorded on the form.

4.3.18 If required by project work plans, REPEAT steps 4.3.5 thru 4.3.11. If the reading recorded is outside of the acceptable range, then RECORD UNSAT in the “Return SAT (√)” block, line through remaining lines, and WRITE “Tagged Out Of Service”. Explain the problem(s) found on the Do Not Use tag. If not required, WRITE “NA” in the “Return SAT (√)” block.

4.4 RETURN OF INSTRUMENTS

4.4.1 IF a portable radiation-monitoring instrument fails to pass a pre-operational check, breaks during use, or exceeds the certification expiration date, then TERMINATE use of the instrument by completing applicable parts of an “Do Not Use” tag (Attachment 4) and attach it to the instrument.

4.4.2 NOTIFY RPO supervision that the instrument needs to be returned to the vendor for repair or recalibration and .

4.4.3 TERMINATE all the associated “Portable Instrument Pre-Operational Source Check Sheets” and route to the RPO supervision for review and signature prior to routing to QA.

Portable Instrument Pre-Operational Response Check Sheet

Instrument Model:_____ Serial Number:_____

Probe Type:_____ Serial Number:_____

Instrument Calibration Date:_____ Calibration Expiration Date:_____

Check Source ID: _____Background At Time Of Initial Response Check_____

1st Instrument Scale: _____ Reference Reading/Unit:_____ -20%_____ +20%_____

2nd Instrument Scale:_____ Reference Reading/Unit:_____ -20%_____ +20%_____

3rd Instrument Scale:_____ Reference Reading/Unit:_____ -20%_____ +20%_____

Initial Response Check Performed By:

_____

Printed Name Signature Date

Date/Time	Bkgd.	Readings in cpm / mrem/hr / µR/hr (circle one) 1st scale	2nd scale	3rd scale	Issue SAT (√)	Return SAT (√)	Print/Sign

Reviewed By:_____ Date:_____

“Portable Instrument Pre-Operational Response Check Sheet”

Instructions For Completion Of Initial Response Check

A.1.1 IDENTIFY the sources/jigs to be used with the instrument. Attachment 2 provides a list of preferred sources that should be used, as applicable, for the type of radiation the instrument is calibrated to detect.

NOTE: If an instrument with a dual probe (detects both alpha and beta-gamma) is being checked, two (2) “Portable Instrument Pre-Operational Response Check Sheets” will be used and response checks will be performed separately for alpha and beta-gamma.

A.1.2 OBTAIN a blank “Portable Instrument Pre-Operational Response Check Sheet” and enter the following information:

- Instrument Model
- Instrument Serial Number
- Probe Type
- Probe Serial Number
- Instrument Certification (Calibration) Date
- Instrument Certification Expiration (Calibration Due) Date
- Check Source(s) Identification Number
- Background At Time Of Initial Response Check
- Name, Signature, initials, and Date of Person Performing Initial Response Check.

NOTE: The instrument background and data collection for the ± 20% acceptable range shall be performed in the area where the instrument will be background and response checked for each day of use.

A.1.3 SELECT the lowest scale (if applicable) on the instrument, which will allow a response from a normal background reading.

A.1.4 OBTAIN background for the instrument.

NOTE: Background for instruments that operate in the Ratemeter Mode only, may be estimated by the user based on the continuous observation of the meter needle (or digital readout) over a 20 to 30 second observation. For instruments capable of operating the Scaler Mode, count the background for 1.0 minute. The background for dose rate instruments which do not have a scale low enough to read an actual background should be written as less than (<) the lowest background reading obtainable by the instrument, i.e., < 0.1 mrem/hr.

A.1.5 RECORD the reading in the “Background at Time of Initial Response Check” space on the “Portable Instrument Pre-Operational Response Check Sheet” and proceed to Section A.1.6.

NOTE: IF the background is significantly higher than what is normal for a given instrument/probe, the RCT may, in exercising professional judgment, initiate the process outlined in Attachment 3 (Follow Up For Elevated Background Readings).

A.1.6 OBTAIN check sources/jigs, per Attachment 2. SELECT the appropriate source and/or filter position as applicable.

A.1.7 If applicable, SELECT the desired scale on the instrument.

A.1.8 PLACE the detector over the source to provide a reproducible geometry.

A.1.9 TAKE a one-minute reading if the instrument operates in scaler mode. Readings from instruments without scaler mode may be estimated based on continuous observation for a period long enough to obtain the reading (approximately 20 to 30 seconds).

NOTE: Result should be recorded on paper as a total of three readings will be obtained and averaged to determine the acceptable range for reproducibility of source readings.

A.1.10 REMOVE the detector from the source.

A.1.11 ALLOW the instrument to return to background and repeat Steps A.1.8 through A.1.10 two more times, using the same geometry as before, again recording the result on paper.

A.1.12 RETURN sources/jigs to their proper storage location.

A.1.13 CALCULATE the average of the three readings. This value will be the “Reference Reading”.

A.1.14 RECORD the Instrument Scale and Reference Reading in the appropriate space on the “Portable Instrument Pre-Operational Response Check Sheet.”

A.1.15 CALCULATE the value for ± 20% of the Reference Readings from Step A.1.13 and RECORD the calculated range in the applicable space on the “Portable Instrument Pre-Operational Response Check Sheet.” -20% = Average x 0.8 = low end of range +20% = Average x 1.2 = upper end of range

NOTE: If any two of the three readings obtained for determination of the average source count vary by 20% or more, (the lowest reading divided by the highest x 100) disregard these readings and take three new ones. If there is still a difference of 20% or greater, return the instrument per Section 4.4.

A.1.17 REPEAT Steps A.1.7 through A.1.16 for each scale of the instrument that is used.

NOTE: For instruments with digital readouts that have a keypad instead of a scale selection knob, scales are shifted electronically and only one response check for alpha, beta and/or gamma is necessary. Use professional judgment when determining the source activity to use based on the level of contamination you would expect to detect with the instrument or see RPO supervision for guidance.

Source Recommendations For Response Checking

Instrument Type	Source
Alpha Detectors	Th-230 or Pu-230
Beta-Gamma Detectors	Sr-90, SrY-90, or Cs-137
Alpha and Beta-Gamma Detectors	Th-230 or Pu-230 and Sr-90, SrY-90, or Cs-137
Gamma Detectors	Cs-137

FOLLOW-UP FOR ELEVATED BACKGROUND READINGS

CHECK the area around the background location for radiological sources (including contamination in area or on instrument , which could bias the background count rate.

IF a source is found that could be the cause of elevated background, SHIELD or REMOVE the source so that it cannot be a potential interference and restart at Step A.1.3 (Attachment 1).

IF there appears to be no source interference, PERFORM two additional background counts.

CALCULATE the average of the initial plus the two additional background counts.

RECORD the reading in the “Background at Time of Initial Response Check” space on the “Portable Instrument Pre-Operational Response Check Sheet,” and proceed to Section A.1.6 (Attachment 1) of this procedure.

If the background is still elevated above expected levels and is suspected to be due to radon, REFER to the section below titled “Radon As Source Interference.”

If the background is still higher than expected and is not suspected to be caused by radon, RECORD the reading in the “Background at Time of Initial Response Check” space on the “Portable Instrument Pre-Operational Response Check Sheet”. Make a comment regarding the problem on an additional sheet and attach to check sheet.

REMOVE instrument from service in accordance with Section 4.4 of this procedure and notify supervision.

RADON AS SOURCE INTERFERENCE

IF radon is suspected as the cause for elevated background readings, CONTACT RPO supervision before taking further action with the instrument.

With concurrence of the RPO supervision, the following steps are suggested for evaluation of radon problems:

a. EXAMINE Instrument Response Check Sheets for other instrument checks performed in the same area.

b. If other instruments checked out show trends of elevated background fluctuations on various days, this is an indicator that radon may be a problem.

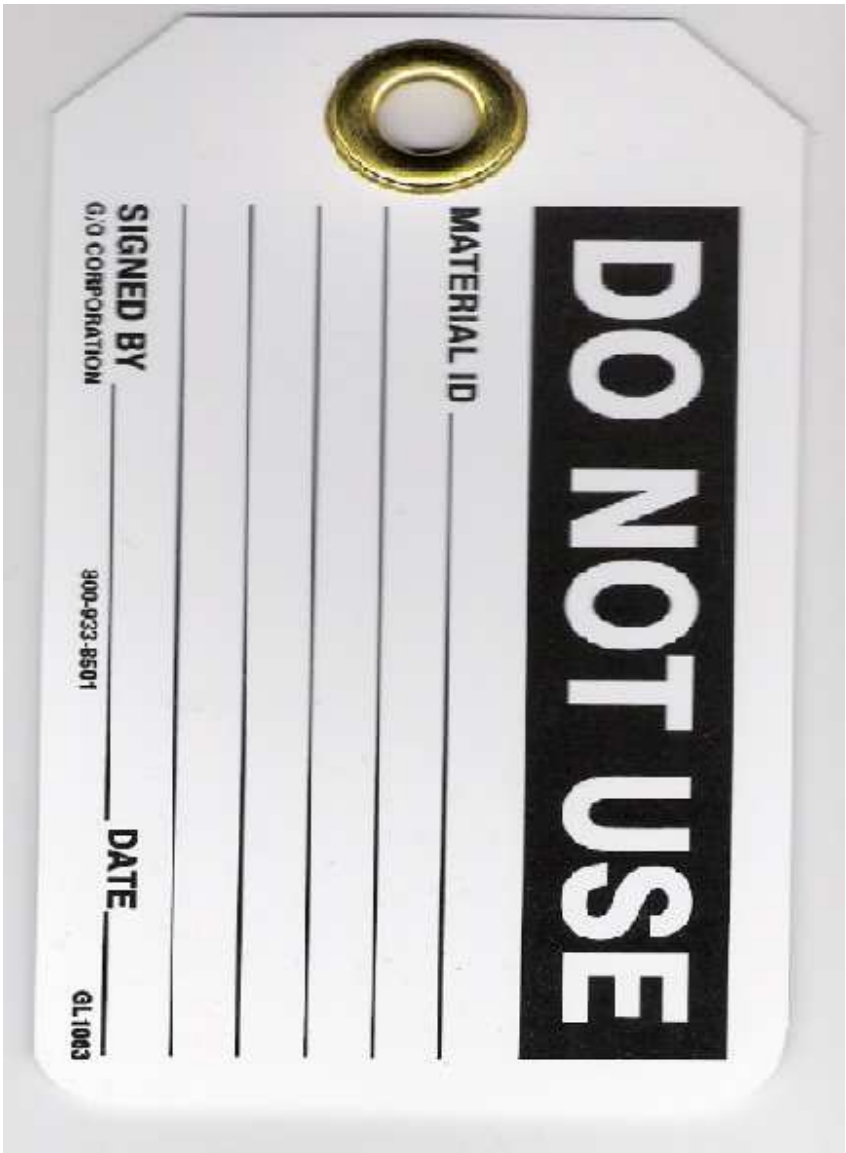
c. OBTAIN other instruments of the same type and ASSESS if their backgrounds are also higher than normal.

d. If the other instruments show higher than normal backgrounds, this is an indication that radon may be a problem.

IF radon does appear to be the problem, DISCUSS the results of the radon evaluation with RPO supervision prior to continuing any pre-operational activities.

IF radon does not appear to be a factor, TAKE the instrument out of service or discuss the problem with RPO supervision or the instrument vendor.

Do Not Use Tag



Soil Surveys for Radiological Control

1.0 PURPOSE

To provide comprehensive guidance for performing soil surveys, obtaining soil samples, and for determining the required radiological postings

SCOPE

Surveys of soil are required if a potential exists for residual activity to equal or exceed 100 pCi/g (gross beta activity), 250 pCi/g (gross alpha activity), or the sum of the fractions ≥ 1. Soil sampling should not be performed in Soil Contamination Areas, Contamination Areas, or High Contamination Areas, unless area remediation has been performed and postings need to be removed.

This procedure details the methods, documentation, and requirements for surveying and sampling soil.

The following activities are described in Section 4.0 of this procedure:

4.1 Types of Surveys

4.2 Survey Set-up

4.3 Gamma Surveys

4.4 Soil Sampling

4.5 In-Situ Surveys

4.6 Posting

4.7 Documentation

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

Tt Radiation Protection Plan (RPP)

Tt Radiation Protection Operations Procedures (RPOP)

ESH-HPT-2001-00231, Portable Survey Instruments – Soil Conversion Factors (U), Revision 0 (Savannah River Site Health Physics Technical Document)

3.0 GENERAL

3.1 EQUIPMENT

- Portable radiological survey equipment prepared for use per RP-OP-012
- Soil sampling equipment/cleaning supplies

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Soil sampling may involve remote areas, climbing, or other situations that are out of the ordinary. Personnel should maintain a high level of safety awareness when obtaining soil samples.

- All personnel shall be alert for dangerous wildlife or conditions in remote or overgrown areas. Snake boots should be worn as needed in season.
- Comply with applicable Radiological Work Permit (RWP).
- Surveys shall not be performed when inclement weather conditions make the task dangerous or may interfere with obtaining accurate survey results.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Approving any sampling generated in accordance with this procedure.
- Reviewing data related to possible contamination and determining possible radiological hazards/material that may be present.
- Ensuring that EH&S has been consulted regarding any potential industrial hygiene hazards, protective clothing, monitoring, and equipment requirements.
- Delegating performance of procedures to qualified personnel.

3.3.2 RCTs are responsible for:

- Properly surveying and documenting results of the radiological survey in compliance with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

None

3.5 RECORDS

Radiological survey records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project procedures. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

If alternative survey/sampling methods are required, note any deviations in the survey remarks.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite and thus no revision bars are included.

3.8 OTHER - Terms and Definitions

disturbed soil	soil that has been excavated, dug, scraped or otherwise mechanically cut or agitated by a work evolution
grid	System of lines used for locating points or coordinates of concern
sample container	sample bottle or bag used to contain the soil for transport to the counting facility
SAP	Project Sampling and Analysis Plan (this is a generic title - may be different for specific project)

3.9 ATTACHMENTS

None

4.0 PROCEDURE

This procedure assumes that RPO supervision has performed a review of the soil and identified that a potential exists for residual radioactivity ≥ 100 pCi/g (gross beta activity), 250 pCi/g (gross alpha activity), or the sum of the fractions ≥ 1. Soil with activity ≥100 ccpm alpha or ≥ 500 ccpm beta should not be transported to the lab.

4.1 Types of Surveys

4.1.1 Evaluation Surveys

This section provides guidance for survey/sampling techniques used to determine if existing controls are adequate or to determine the presence or absence of radiological hazards.

PERFORM In-Situ Surveys in accordance with Section 4.5.

If no activity above background is found and activity needs to be quantified, see Section 4.1.2.

4.1.2 Characterization Surveys

This section provides guidance on methods used to quantify radiological hazards in soil and/or vegetation at a known or suspected radiological site.

1. PERFORM Survey Set-up in accordance with Section 4.2
2. PERFORM Gamma Surveys in accordance with Section 4.3
3. PERFORM Soil Sampling in accordance with Section 4.4

4.1.3 Roll Back Surveys

This section provides guidance for radiation and contamination surveys of a site to verify contamination levels for the purpose of reducing or eliminating the radiological postings.

If the area was posted for potential prior to vegetation removal, remediation, or excavation/trenching, and review with RPO supervision concurrence indicates sufficient sampling/monitoring was performed during such activities that meet the intent of this procedure, then the posting can be removed or reduced to the original posting without further survey.

1. PERFORM Survey Set-up in accordance with Section 4.2
2. PERFORM Gamma Surveys in accordance with Section 4.3
3. PERFORM Soil Sampling in accordance with Section 4.4

NOTE: When soil sampling must be performed in Soil Contamination Areas, Contamination Areas, or High Contamination Areas that are thought to be uncontaminated, samples must be surveyed in accordance with RP-OP-19 prior to counting in count room.

4.1.4 Excavated Soil Surveys

This section provides guidance for surveying soil that has already been excavated (e.g. soil pile, soil in roll-off container) and of known or unknown origin.

If the soil was surveyed and sampled prior to excavation, and the condition of the soil has not changed since the survey and sampling were performed, and all soil results were less than Soil Contamination Area limits found in Section 4.6, and RPO review indicates sufficient sampling was performed that meets the intent of this procedure, then SCA posting of the area is not required.

1. PERFORM Survey Set-up in accordance with Section 4.2
2. PERFORM Gamma Surveys in accordance with Section 4.3
3. PERFORM Soil Sampling in accordance with Section 4.4

4.2 Survey Set-up

A Survey Set-up, under the approval of RPO supervision shall be developed for all soil survey or sampling activities excluding site evaluation surveys. The total number and depth of samples required will depend on the size, geometry, and history of the area. When it is anticipated that > 50 soil samples will be required, consideration should be given to the development of an alternate sampling method using the MARSSIM (Multi-Agency Radiation Survey and Site Investigation Manual) approach, SAP, and/or alternate analysis technology.

Maps, drawings, diagrams, or data sheets prepared/developed specifically for the activity should be used in developing the sampling plan using the following guidance.

1. DETERMINE the size of the area to be surveyed

   NOTE: Determine amount and dimensions for excavated soil.

2. DRAW the location of the area or soil on a map or diagram, including the site area and landmarks, as necessary. If excavated soil is in a labeled container (i.e. roll-off), RECORD container ID number on drawing.
3. IF grids are to be used, THEN

DETERMINE the scale of the grids (e.g., 1 block = 100 sq. ft.).

NOTE: Samples should be collected at a minimum of

- every 100 sq. ft. for Roll-back Surveys
- 500 sq. ft. for excavated soil

- Each of the 4 quadrants from the surface of the soil to the bottom of the container, in 12 inch increments for roll-offs.

4.3 Gamma Survey

1. OBTAIN a Ludlum Model 19, or equivalent, and OBTAIN a general area background reading outside the area to be surveyed (Normal terrestrial background ranges from 7 to 15 µrem/hr).

2. For Walkover Survey,

   PROCEED to the site to be surveyed and OBTAIN a minimum of 20 readings per acre for sites greater than or equal to one acre in size. For sites less than one acre, SURVEY the entire site. All readings should be obtained at approximately waist level.

   For Excavated Soil or Container Survey,

   SURVEY the area using the Model 19 approximately 1 foot from all accessible surfaces of the excavated soil.

3. RECORD all dose rates on the maps, drawings, diagrams, or data sheets.

IF exposure rates are >20 µrem/hr above background, CONTACT RPO supervision to determine requirements for additional survey/sampling. The possibility of an underground source may also need to be considered.

IF exposure rates are ≥50 µrem/hr above background, CONTACT RPO supervision and POST in accordance with Section 4.6.

4.4. Soil Sampling

Samples should be collected from areas with the highest potential for contamination.

NOTE: A composite sample for a single sample location may be allowed, however technique/methodology shall be specified in an approved soil sampling plan.

1. OBTAIN alpha and/or beta-gamma survey instrument and PLACE the detector as close as possible to the surface of the soil to be sampled.

2. SURVEY the entire surface area of the soil, ALLOW the instrument to stabilize, and SUBTRACT background.

   NOTE: Since all soil will contain a small amount of natural radioactivity, it is impractical to use "free-air" background as the control measurement when measuring soil. To minimize this problem, perform background on the ground outside the area of concern.

   - IF soil probes **< 100 ccpm alpha and < 500 ccpm beta-gamma**,

     COLLECT soil and PLACE in sample container. The soil sample must contain no more than 50% vegetation, small stones, or gravel.

     SURVEY sample inside container. If soil still probes < 100 ccpm alpha and < 500 ccpm beta-gamma,

     RECORD the appropriate sample identification number on the container.

OBTAIN a GPS coordinate or MARK the ground at the sample point with the appropriate sample identification number.

NOTE: GPS and markers are not required for excavated soil and roll-off containers.

SURVEY the sampling equipment to verify "ND" alpha or beta-gamma contamination above instrument background. CLEAN equipment as necessary.

ANALYZE sample in accordance with RP-OP-019 and

POST the area in accordance with Section 4.6, as necessary.

- IF soil probes **≥ 100 ccpm alpha and/or ≥ 500 ccpm beta-gamma**,

  PERFORM In-Situ Survey in accordance with Section 4.5 and

  POST the area in accordance with Section 4.6, as necessary.

  If sample was being taken for a Roll Back Survey, NOTIFY RPO supervision

4.5 In-Situ Surveys

1. OBTAIN alpha and/or beta-gamma survey instrument and PLACE the detector as close as possible to the surface of the soil.

   NOTE: ESH-HPT-2001-00231, which was used as a reference in this procedure, calls for a mound of soil to be created. This procedure uses a more conservative approach by surveying soil in place ("In-situ"). Soil to be monitored should already be loosened in some manner, an area larger than the size of the probe used, and at least ¼" to ½" thick.

2. SURVEY the entire surface area to determine the area with the highest levels ALLOW the instrument to stabilize, and SUBTRACT background.

   NOTE: Since all soil will contain a small amount of natural radioactivity, it is impractical to use "free-air" background as the control measurement when measuring soil. To minimize this problem, perform background on the ground outside the area of concern.

3. If soil surface measurements are above background for alpha and/or beta-gamma, then use the appropriate correction factor specified below to convert results from ccpm to pCi/g.

Instrument	CF for ccpm to pCi/g
Ludlum w/43-5/44-9, or equivalent	5 α and 5 $\beta\gamma$
Electra GM Plus 1B, or equivalent	1.0 α and 0.1 $\beta\gamma$

4. RECORD all readings on the maps, drawings, diagrams, or data sheets and POST area, as appropriate, per Section 4.6.

NOTE: For large areas, gamma surveys in accordance with Section 4.3 may be performed in lieu of or in addition to In-Situ Surveys, as directed by RPO Supervision.

4.6 Posting

The following table is a summary of the limits used for posting areas with soil radioactivity:

Summary of Soil Contamination Limits

Soil Contamination Area (SCA)	
Radiation	Limit
Gross β-γ activity (pCi/g)	$\geq$ 100 pCi/g but $\leq$ 2500 pCi/g
Total gross β-γ and α activity	Sum of fractions $\geq$ 1 For calculating the sum of the fractions, use 250 pCi/gm for the alpha value.

Contamination Area

Radiation	Limit
Gross β-γ activity	>2500 pCi/gm but $\leq$ 250,000 pCi/g
Gross α activity	> 250 pCi/g but $\leq$ 25,000 pCi/g

High Contamination Area

Radiation	Limit
Gross β-γ activity	> 250,000 pCi/g
Gross α activity	> 25,000 pCi/g

In addition to these posting limits, areas shall be posted as CAs or HCAs if monitoring shows that radioactive contamination can be transferred from the area at levels greater than the levels specified in RPP Table 2-2.

Controlled Area

Radiation	Limit
Gamma Survey	≥50 µrem/hr above background in high occupancy area

Additional Guidance for Roll Back of Areas

IF any results are greater than or equal to the established limits for a Soil Contamination Area, BUT less than the limits established for a Contamination Area, THEN

DETERMINE the average concentration (pCi/gm) for each 1000 sq. ft. of the sampled area using the following formula:

$$\text{Average} = \frac{(\text{sample 1 pCi/gm}) + (\text{sample 2 pCi/gm}) \ldots (\text{sample 10 pCi/gm})}{10}$$

IF the area being surveyed is < 1000 sq. ft. (10 grids), THEN

CALCULATE the average concentration by substituting the total number of 100 sq.

ft. grids for 10 in the above formula.

NOTE 1: Soil sample results may be averaged from sample areas with a geometry based on grids of < 100 sq. ft, as long as the total area averaged does not exceed 1000 sq. ft.

NOTE 2: Averaging applies to adjacent grids only. Unassociated grids may not be averaged together.

IF the average concentration (pCi/gm) of the area is greater than or equal to the established limits, then POST per this section.

IF the average concentration (pCi/gm) of the area is greater than or equal to 50% of the established limits for either alpha or beta-gamma, THEN

CALCULATE the Total Concentration (TC) for the sum of the fractions using the following formula:

$$TC = \frac{\text{average beta concentration (pCi/gm)}}{\text{beta limit (100 pCi/gm)}} + \frac{\text{average alpha concentration(pCi/gm)}}{\text{alpha limit (250 pCi/gm)}}$$

IF the TC is ≥ 1, THEN

POST the area per this section.

If the TC is < 1, then the SCA posting is not required.

4.7 Documentation

DOCUMENT all survey results on a Radiological Survey Form and ATTACH maps, drawing, diagrams, or data sheets generated by this procedure.

NOTE: Soil sample locations are identified on Survey Form by placing a pentagon around the sample number.

TETRA TECH, INC

Procedure No: RP-OP-014 Rev 0

Internal and External Dosimetry Program

1.0 PURPOSE

The purpose of this procedure is to identify responsibilities in the implementation of the Tetra Tech (Tt) Internal and External Dosimetry Programs.

SCOPE

This procedure applies to all Tt and subcontractor personnel who are required to participate in the Internal and External Dosimetry Program.

The following activities are described in Section 4.0 of this procedure:

4.1 General

4.2 External Dosimetry

4.3 Internal Dosimetry

2.0 REFERENCES

10 CFR 20, Standards for Protection against Radiation

10 CFR 835, Occupational Radiation Protection

Tt Radiation Protection Plan (RPP)

Tt Radiation Protection Operations Procedures (RPOP)

3.0 GENERAL

3.1 EQUIPMENT

Not Applicable

3.2 SAFETY CONSIDERATIONS

Not Applicable

3.3 RESPONSIBILITIES

3.3.1 The Radiological Protection Manager shall be responsible for:

a. ensuring that the need for internal and external program participation by personnel is clearly defined in project technical work documents (TWD);

b. maintaining an interface with the dosimetry vendors.

3.3.2 RPO Supervisors shall be responsible for:

a. ensuring that appropriate workplace characterization is performed so that dosimetry requirements can be identified and incorporated into TWDs.

3.3.3 Radiological Workers shall be responsible for:

a. ensuring that prescribed personnel dosimetry is worn as required by TWDs;

b. ensuring that the prescribed bioassay program is followed when entering radiological areas.

3.4 PREREQUISITES

Not Applicable.

3.5 RECORDS

Radiological records, including vendor records, are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project guidance. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

Not Applicable.

3.7 REVISIONS

The review cycle for this procedure is three years, or as needed. Revisions to this procedure shall be controlled by the RPO.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Attachment 1 Occupational Radiation Exposure History Record

Attachment 2 Exposure Investigation Form

4.0 PROCEDURE

4.1 GENERAL

All dosimetry services for radiological operations will be provided by accredited vendors. Dose assessment results shall be provided in terms of rem or millirem [see 835.2(b), dose term definitions, and 835.4]. It is the responsibility of the RPO to maintain an effective interface with the appropriate vendor to ensure that all requirements are met. This includes obtaining appropriate information from vendor verifying credentials, ensuring that personnel report for dosimetry activities (i.e., WBC, dosimetry issue/exchange, submittal of bioassay samples), verifying that personnel are trained for properly wearing assigned dosimetry, and performing any investigations that might be required as the result of a radiological incident (i.e., lost/damaged dosimetry, personnel contamination, positive bioassay, etc.).

Before being allowed to enter areas that are controlled for radioactive materials, personnel shall complete an Occupational Radiation Exposure History form (Attachment 1)

4.2 EXTERNAL DOSIMETRY

The following actions should be taken to ensure that Tt and subcontractor personnel take all necessary steps required to comply with this program. RPO Management, as described in the appropriate TWD, establishes appropriate participation and frequencies for monitoring with external dosimetry.

4.2.1 Personnel dosimetry (including neutron dosimetry where appropriate) shall be provided to and used by individuals as follows:

a. Radiological workers who are likely to receive from external sources an effective dose equivalent of 100 millirem or more in a year or a dose equivalent to the extremities, lens of the eye, or skin of 10 percent or more of the corresponding limits specified in Table 2-1 of the Tt RPP [see 835.402(a)(1)]

b. Declared pregnant workers who are likely to receive from external sources a dose equivalent of 50 millirem or more to the embryo/fetus during the gestation period [see 835.402(a)(2)]

c. Occupationally exposed minors likely to receive from external sources an exposure in excess of 50 millirem in a year [see 835.402(a)(3)]

d. Members of the public who enter a controlled area and are likely to receive an effective dose equivalent in excess of 50 millirem in a year [see 835.402(a)(4)]

e. Individuals entering a high or very high radiation area [see 835.402(a)(5)].

4.2.2 Dosimeters should be issued only to individuals knowledgeable of their proper use and worn only by those to whom the dosimeters were issued.

4.2.3 Primary dosimetry (typically thermoluminescent dosimeter [TLD]) should be worn in the chest area, on or between the waist and neck, or in the manner designated in TWDs.

4.2.4 Individuals should not wear dosimeters issued by Tt while being monitored by a dosimeter at another nuclear facility unless authorized by RPO Management. Individuals should not expose their dosimeters to security X-ray devices, excessive heat, or medical sources of radiation.

4.2.5 RPO should be informed of any non-occupational radiation exposure that might affect the monitoring program (i.e., medical procedures involving radiopharmaceuticals). RPO Management is to be notified as soon as possible of any exposures not associated with project for which dosimetry was assigned.

4.2.6 Lost or damaged dosimetry should be immediately reported to RPO and. An individual whose dosimeter becomes lost, damaged, or contaminated should place work in a safe condition, immediately exit the area, and report the occurrence to the radiological protection organization. The individual should be restricted from entry into radiological areas until a review has been conducted, an Exposure Investigation Form (Attachment 2) is completed, and RPO management has approved reentry.

4.2.7 Electronic dosimetry, with appropriate range, is required when entering high/very high radiation areas or when individuals could receive greater than 10 percent of the administrative control level in 1 work day. They should be worn in conjunction with a primary dosimeter and read periodically during use to ensure 75 percent of full scale is not exceeded. Readings should be tracked and compared with primary dosimeter results.

4.2.8 Area monitoring will be perform as required by RPM in accordance with RPP Article 514.

4.2.9 Individuals working in facilities with fissile materials in quantities that could create a critical mass are required to use nuclear accident dosimeters in accordance with RPP 515.

4.3 INTERNAL DOSIMETRY

The following actions should be taken to ensure that Tt and subcontractor personnel take all necessary steps required to comply with this program. RPO Management, as described in the appropriate TWD, establishes appropriate participation and frequencies for the collection of bioassay samples, such as urine or fecal samples, and bioassay monitoring, such as whole body or chest counting.

The following individuals shall participate in an internal dosimetry program:

a. Radiological workers who are likely to receive a committed effective dose equivalent of 100 millirem or more from all occupational radionuclide intakes in a year [see 835.402(c)(1)]

b. Declared pregnant workers likely to receive intakes resulting in a dose equivalent to the embryo/fetus in excess of 50 millirem during the gestation period [see 835.402(c)(2)]

c. Occupationally exposed minors likely to receive a committed effective dose equivalent in excess of 50 millirem from all radionuclide intakes in a year [see 835.402(c)(3)].

d. Members of the public who enter a controlled area and are likely to receive an intake resulting in a committed effective dose equivalent exceeding 50 millirem in a year [see 835.402(c)(4)].

4.3.1 Baseline bioassay monitoring of individuals who are likely to receive intakes resulting in a committed effective dose equivalent greater than 100 millirem in a year should be considered for personnel who are likely to have had prior internal exposure before they begin work that may expose them to internal radiation exposure.

4.3.2 Bioassay analyses should be performed when any of the following occurs:

a. Facial or nasal contamination is detected that indicates a potential for internal contamination exceeding any monitoring threshold established in RPP Article 521.

b. Airborne monitoring indicates the potential for intakes exceeding 100 millirem committed effective dose equivalent

c. Upon direction of the Project RPM.

4.3.3 In-vitro bioassay samples for individuals whose routine duties involve exposure to radionuclides readily absorbed through the skin, such as tritium, should be provided on a routine basis as designated by the RPM.

4.3.4 In-vitro bioassay samples should be taken to RPO as required by TWDs on the assigned frequency. RPO may require non-routine in-vitro bioassay samples as follow-up to incidents or follow-up to routine bioassay submittals.

4.3.5 A preliminary assessment of any intakes detected should be conducted prior to permitting an employee to return to radiological work where it is likely that an additional intake could occur.

4.3.6 The estimation of internal dose shall be based on bioassay data rather than air concentration values unless one of the following conditions exists [see 835.209(b)]:

a. bioassay data are unavailable

b. bioassay data are inadequate

c. internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.

4.3.7 RPO Management should be informed of any non-occupational radiation exposure that might affect the monitoring program (i.e., medical procedures involving radiopharmaceuticals) or any exposures not associated with assigned project.

4.3.8 Individuals should be notified promptly of positive bioassay results and the results of dose assessments and subsequent refinements.

4.3.9 Follow-up bioassay monitoring should be performed when routine bioassay results indicate an intake in the current year with a committed effective dose equivalent of 100 millirem or more.

4.3.10 Bioassay programs implemented at the discretion of Tt (i.e., for personnel monitoring that is not required by Article 521.1) must periodically reassess monitored individuals to determine that they do not fall under the monitoring requirements of 10 CFR 835.402 (that is, these individuals are not “likely” to receive 100 mrem in one year). Dose results for individuals monitored under the discretionary program must be recorded in accordance with 10 CFR 835.702.

4.3.11 Termination bioassay monitoring is required when an individual who participated in the bioassay program terminates employment or concludes work involving the potential for internal exposure.

Occupational Radiation Exposure History Record

Name: _____

DOB: _____ **Age:** _____

Social Security Number: _____

Permanent Address: _____

_____

___ **To the best of my knowledge, I have never been exposed to occupational ionizing radiation.**

___ **To the best of my knowledge, I have not been exposed to occupational ionizing radiation during the current calendar year.**

___ **I have been exposed to occupational ionizing radiation (complete the following)**

Name of Facility	Location	Dates of Exposure	Exposure Received

I certify, by my signature below, the above information is true and complete to the best of my knowledge.

_____ _____

Signature **Date**

Do Not Write Below Line

To Be Completed by RPO

Assigned TLD #: _____ Quarter: 1 2 3 4

Dosimetry Vendor:_____

Project Name: _____

Exposure Investigation Form

TETRA TECH, INC

Procedure No: RP-OP-015 Rev 0

Radiological Records

1.0 PURPOSE

This procedure describes the process for maintenance and retention of radiological records associated with Tetra Tech (Tt) projects.

SCOPE

This procedure applies to records generated in support of work involving the use and/or handling of radioactive material or work in areas controlled for the purposes of radiation protection.

The following activities are described in Section 4.0 of this procedure:

4.1 Creation of Radiological Records

4.2 Records Retention

4.3 General Provisions

4.4 Radiological Units

4.5 Individual Monitoring

4.6 Other Monitoring Records

4.7 Administrative Records

2.0 REFERENCES

10 CFR 20, *Standards for Protection against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiological Protection Implementation Plan (RPIP)

TtNUS Quality Assurance Program (QAP)

3.0 GENERAL

3.1 EQUIPMENT

Not Applicable

3.2 SAFETY CONSIDERATIONS

Not Applicable

3.3 RESPONSIBILITIES

3.3.1 Project management is responsible for ensuring that adequate storage is available for radiological records.

3.3.2 RPO personnel are responsible for generating, storing, safeguarding, and disposing of radiological records in accordance with this procedure.

3.4 PREREQUISITES

Not Applicable

3.5 RECORDS

No radiological records are generated during the process of implementing this procedure.

3.6 PRECAUTIONS AND LIMITATIONS

Not Applicable

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

None

4.0 PROCEDURE

4.1 CREATION OF RADIOLOGICAL RECORDS

4.1.1 Radiological records shall be accurate and legible. The records should include:

- Identification of facility, specific location, function and process
- Signature or other identifying code of the preparer and date
- Legible entries in black or blue-black ink
- Corrections identified by a single line-out, initialed and dated
- Supervisory signature to ensure review and proper completion of forms

Once a record has been created, reviewed, and signed by appropriate supervision, the record is considered complete and shall not be modified. Subsequent errors identified in a completed record may be corrected by creating a supplemental record that included traceability for the correction.

4.2 RECORDS RETENTION

Radiation protection records will be retained by the Quality Assurance Manager or designee in accordance with the TtNUS Quality Assurance Program (QAP). All radiological records generated for this project will be retained on site for the duration of the project then moved to TtNUS-Aiken for final disposition.

4.3 GENERAL PROVISIONS

Records will be maintained to document compliance with this procedure and all other project radiation protection procedures.

Each record required by this procedure must be legible throughout the specified retention period. The record may be stored in electronic media with the capability of producing legible, accurate, and complete records during the required retention period. Records, such as letters, drawings, and specifications, must include pertinent information, such as stamps, initials, and signatures. Adequate safeguards must be maintained against tampering with or loss of records. Records

containing information covered under the Privacy Act will be maintained in a fireproof lockable cabinet. Access to records will be controlled as required in accordance by the QAP.

4.4 RADIOLOGICAL UNITS

Unless otherwise specified, the quantities used in the records required by this program will be clearly indicated in units of curie, rad, roentgen, or rem, including multiples and subdivisions of these units.

4.5 INDIVIDUAL MONITORING

Records for personnel whose occupational dose is monitored will be maintained and controlled by the providing vendor. Copies will be maintained by TtNUS Aiken.

4.6 OTHER MONITORING RECORDS

The following other information will be documented and maintained:

- Results of radiological surveys as specified in RP-OP-002
- Results of air sampling/monitoring as specified in RP-OP-003
- Results of pre-operational checks of portable survey equipment as specified in RP-OP-012
- Technical work documents, such as ALARA Reviews, Radiation Work Permits, and Work Packages
- Results of laboratory counting operations
- Results of maintenance and calibration of survey and laboratory counting equipment.

A complete list of radiological records is contained in Chapter 7 of the Tt RPIP.

4.7 ADMINISTRATIVE RECORDS

Administrative records to be maintained will include the following:

- Training records, as necessary, to demonstrate compliance with RP-OP-011
- Actions taken to maintain occupational exposures ALARA
- The results of internal audits and other reviews of program content and implementation
- Changes in equipment, techniques, and procedures used for monitoring
- Logbooks, log-sheets, and narrative documents
- Sealed source leak check results and inventory records.

A complete list of radiological records is contained in Chapter 7 of the Tt RPIP.

SOURCE CONTROL

1.0 PURPOSE

This procedure details the requirements for the control and accountability of radioactive sources. This procedure implements the requirements of 10 CFR 20 and 10 CFR 835.

SCOPE

This procedure applies to all Tetra Tech (Tt) and subcontractor personnel who are involved in the requisition, inventory, storage, control, use of exempt and accountable radioactive sources. This procedure applies to other subcontractor personnel to the extent specified in subcontract documents. It does not apply to devices containing radioactive material as an integral part of their function [i.e., smoke detectors, emergency exit markers, welding rods, and such items as are generally licensed by the Nuclear Regulatory Commission (NRC)(except measuring gauging or controlling devices)] or to radioactive material, analytical samples and radioactive waste.

The following activities are described in Section 4.0 of this procedure:

4.1 General Requirements

4.2 Inventory

4.3 Leak Test

2.0 REFERENCES

10 CFR 20, *Standards for Protection against Radiation*

10 CFR 835, *Occupational Radiation Protection*

Tt RPP

3.0 GENERAL

3.1 EQUIPMENT

- Radiological Survey and Counting Instruments
- Contamination Survey Supplies (i.e., smears, etc)

3.2 SAFETY CONSIDERATIONS

Not Applicable

3.3 RESPONSIBILITIES

3.3.1 RPM is responsible for:

- ensuring that adequate storage is available for radioactive sources
- maintaining control and accountability of sealed sources
- conducting inventories of sealed sources at least every six months
- requesting RPO to perform leak test and radiation surveys, as appropriate, on all accountable radioactive sources
- designate authorized radioactive source users.

3.3.3 Source users are responsible for:

a. Using and controlling all sealed radioactive sources as specified in this procedure.

b. Complying with applicable RWP requirements.

c. Maintaining current Radiological Worker training.

d. Notifying the RPM of suspected physical damage to a sealed radioactive source.

e. Maintaining positive control (i.e., continuous possession, line of sight) over all sealed radioactive sources in use as defined in this procedure.

f. Notifying the RPM of lost sealed radioactive sources.

3.4 PREREQUISITES

Non-RPO source users must maintain current Radiological Worker Training.

3.5 RECORDS

Sealed source records, including procurement records, survey records, and lists of authorized sealed source users will be retained in accordance with RP-OP-015.

3.6 PRECAUTIONS AND LIMITATIONS

When not in use all sources will be in locked storage in the Project RPO Office.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Attachment 1 Source Inventory Log

4.0 PROCEDURE

4.1 GENERAL REQUIREMENTS

4.1.1 The acquisition and receipt of radioactive sources must be approved by the project Radiological Protection Manager (RPM).

4.1.2 After receiving approval from the RPM, sources may be procured and accepted. Receipt surveys are not required for exempt sources.

4.1.3 Once the source has been accepted, it will be entered into the source inventory and placed in the approved storage location.

4.1.4 The RPM is the person responsible for assuring and performing proper:

- Labeling,
- Inventory, and
- Leak testing.

4.1.5 The RPM assures that source storage locations meet the requirements of this procedure and is responsible for the proper routine source use functions of source storage and source sign

out when removed from storage. An alternate may be designated to assist in these responsibilities.

4.1.6 When not in use or when authorized users are not present, sources will be stored in a locked cabinet. This cabinet will be posted as Radioactive Material.

4.1.7 Sealed radioactive sources will be used, handled, and stored in a manner commensurate with the hazards associated with operations involving sources.

4.1.8 Only users authorized by the RPM may sign radioactive sources out of storage locations. This will be done using the Radioactive Source Sign-Out Log. This log will consist of a bound journal with numbered pages. This is not required when sources are being used in the RPO office where the sources are stored.

4.1.9 Sources should only be removed from the storage location when needed to perform approved activities. Once these activities have been performed, sources should be immediately returned to the storage location.

4.1.10 Values for establishing sealed source accountability and radioactive material posting and labeling requirements can be found in RPP, Appendix 4A.

4.2 INVENTORY

4.2.1 Each accountable and exempt sealed radioactive source will be inventoried at intervals not to exceed six months using the Source Inventory Log (Attachment 1). The inventory will:

- Establish physical location of each sealed radioactive source;
- Verify the presence and adequacy of associated postings and labels; and
- Establish the adequacy of storage locations, containers, and devices.

4.2.2 An accountable sealed radioactive source is not subject to periodic source leak testing if that source has been removed from service. Such sources will be stored in a controlled location, subject to periodic inventory at intervals not to exceed six months, and subject to source leak testing prior to being returned to service.

4.2.3 An accountable sealed radioactive source is not subject to periodic inventory and source leak test if that source is located in an area that is unsafe for human entry or otherwise inaccessible. This determination will be made by the RPM.

4.3 LEAK TEST

4.3.1 Except for sealed radioactive sources consisting solely of gaseous radioactive material or tritium, each accountable sealed radioactive source will be subject to a source leak test upon receipt, when damage is suspected, and at intervals not to exceed six months.

4.3.2 Source leak tests will be capable of detecting radioactive material leakage equal to or exceeding 0.005 microcuries (~11,000 dpm).

4.3.3 The active surface of electroplated sources should not be touched, rubbed, or smeared. The interior of the storage box and the other surfaces of the source should be smeared.

4.3.4 An accountable sealed radioactive source found to be leaking material will be removed from service and controlled in a manner that minimizes the spread of radioactive contamination at the direction of RPM.

Source Inventory Log

Source Model	Serial Number	Nuclide	Activity	Storage Location	Leak Test Date/Result	Storage Adequate? (yes/no)	Posting and Labeling Correct? (yes/no)	Custodian Initials

Reviewed By:_____Date:_____

OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER

OPERATION OF THE LUDLUM MODEL 2929 DUAL SCALER

1.0 PURPOSE

This procedure provides instructions for the operation of the Ludlum 2929 Dual Scaler used in support of Tetra Tech, Inc. (Tt) projects. This instrument is used primarily for alpha and beta radioactivity measurements of dry filter media (surface swipes, dried water, and air samples) and soil.

SCOPE

This procedure applies to the use of the Ludlum 2929 Dual Scaler, used in conjunction with the Ludlum Model 43-10-1 alpha-beta sample counter. This procedure does not apply to other filter sample counting equipment.

The following activities are described in this procedure:

4.1 Pre-Operational Checks

4.2 Initial Source Check

4.3 Background Check

4.4 Source Check

4.5 Instrument Use

4.6 Determination of Instrument Minimum Detectable Activity

2.0 REFERENCES

10 CFR 20

TtNUS RPP

TtNUS RP-OP

Instruction Manual, Ludlum Model 2929 Dual Channel Scaler, Ludlum Measurements, Inc.,

Instruction Manual, Ludlum Model 43-10-1 Alpha-Beta Sample Counter, Ludlum

Measurements, Inc.

3.0 GENERAL

The Ludlum Model 43-10-1 is an alpha-beta sample counter capable of holding up to a 2-inch diameter filter or planchet. The sample drawer, when fully closed strikes a micro switch to allow high voltage (HV) to be applied to the photomultiplier tube (PMT). The sample drawer is locked in the closed position by rotation of a slide lever mounted on the side of the instrument. The Ludlum Model 2929 dual channel scaler provides the necessary circuitry for simultaneous alpha-beta counting.

ZnS (Ag) is used for alpha radiation detection and a plastic scintillator material for beta radiation detection. The scintillation material is covered by 0.4 mg/cm2 metalized mylar to reduce light response (excessive background).

3.1 EQUIPMENT

- Ludlum Model 2929 Dual Channel Scaler
- Ludlum Model 43-10-1 Alpha-Beta Sample Counter
- Check sources

3.2 SAFETY CONSIDERATIONS

Due to the presence of 110V AC, electrical shock is a potential hazard if proper care is not exercised during the operation of the equipment.

Use care when handling radioactive sources or samples to prevent personal contamination or contamination of the sample tray or detector.

3.3 RESPONSIBILITIES

3.3.1 Radiological Protection Organization (RPO) supervision is responsible for:

- Implementing this procedure.
- Ensuring that RCTs are qualified to perform this procedure.

3.3.2 Radiological Control Technicians (RCTs) are responsible for:

- Following this procedure in the performance of duties associated with the Ludlum 2929.
- Notifying the RPO supervision and with concurrence, initiating a procedure change notice when an error in this procedure is identified or when an improvement in radiation protection methods can be made.

3.4 PREREQUISITES

Not Applicable

3.5 RECORDS

3.5.1 RPO survey records are generated during the implementation of this procedure. The original is the record copy for the Radiation Protection Program and is transmitted for processing in accordance with RP-OP-015.

3.5.2 Records are prepared by RCTs and reviewed and approved by RPO supervision. Completed and approved records are to be forwarded to Quality Assurance.

3.6 PRECAUTIONS AND LIMITATIONS

3.6.1 The Ludlum Model 2929 is semi-portable and requires 110-volt AC to operate.

3.6.2 Only thin samples of diameter no larger than 2 inches (5 cm) may be counted.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

Not Applicable

3.9 ATTACHMENTS

Attachment 1 Ludlum Model 2929

Attachment 2 Ludlum Model 43-10-1

Attachment 3 Ludlum 2929 Pre-Operational Check Worksheet

4.0 PROCEDURE

4.1 PRE-OPERATIONAL CHECKS

PERFORM pre-operational checks at the beginning of each workday prior to counting any samples

4.1.1 OBTAIN the Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3) for the instrument to be used.

4.1.2 If this is an initial source check of an instrument then go to Section 4.2, INITIAL SOURCE CHECK.

4.1.3 If all lines on the worksheet are filled:

a. OBTAIN a new worksheet and transfer the information from the top portion of the completed worksheet to the new worksheet.

b. OBTAIN appropriate review and approval signature on the completed worksheet.

c. FORWARD the completed and approved worksheet to QA.

4.1.4 VERIFY that the instrument number and probe number match the numbers on the form.4.1.5 EXAMINE the instrument calibration sticker on the instrument:

a. If the present date is after the “EXPIRES” (or equivalent) date on the sticker, then NOTIFY RPO supervision to return the instrument to the vendor for calibration.

b. If the calibration data are current, then PROCEED.

4.1.6 PLACE ON/OFF toggle switch into the ON position.

4.1.7 With the sample drawer closed, CHECK the high voltage.

NOTE: The high voltage should be set to the potentiometer value listed on the calibration sticker on the instrument.

4.1.8 PERFORM a background check in accordance with Section 4.3 of this procedure.

4.1.9 PERFORM a source check in accordance with Section 4.4 of this procedure.

4.2 INITIAL SOURCE CHECK

4.2.1 OBTAIN a copy of Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3).

4.2.2 OBTAIN an appropriate alpha and beta calibration source.

4.2.3 EXAMINE the instrument calibration sticker on the instrument:

a. If the present date is after the "EXPIRES" (or equivalent) date on the sticker, RETURN the instrument to the vendor for calibration;

b. If the calibration data are current, PROCEED.

4.2.4 COMPLETE the top portion of the form. Provide information for the following:

- Instrument #
- Probe Type
- Probe #
- Calibration Expires
- Alpha Source Nuclide
- Alpha Source ID#
- Calibrated Instrument Efficiency with Alpha Source
- Beta Source Nuclide
- Beta Source ID#
- Calibrated Instrument Efficiency with Beta Source

4.2.5 PLACE ON/OFF toggle switch into the ON position.

4.2.6 With the sample drawer closed, CHECK the high voltage.

NOTE: The high voltage should be set to the potentiometer value listed on the detector or calibration sticker.

4.2.7 LOG high voltage reading on the Ludlum 2929 Pre-Operational Check Worksheet.

4.2.8 REMOVE any source, sample, or planchet from the counting drawer.

4.2.9 OBTAIN a clean planchet.

4.2.10 PLACE the clean planchet in the sample drawer.

4.2.11 CLOSE and LOCK the sample drawer.

4.2.12 PREPARE instrument to perform a 10-minute (minimum) timed background count cycle. A longer background counting time may be used to obtain a lower MDA value, if desired.

a. SET the counting time in minutes using the thumb wheel.

b. SET the count time multiplier setting (typically X1) with the rotary switch.

4.2.13 PRESS the "COUNT" button. The red light emitting diode (LED) counting lamp should come on. When the red counting lamp goes off, the count cycle is finished.

4.2.14 REPEAT the background count cycle for three successive trials.

4.2.15 LOG background measurement results for alpha and beta measurements on top of the Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3).

4.2.16 CALCULATE the average alpha and beta background count rate.

4.2.17 LOG average values on top of the Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3).

4.2.18 Calculate the -20% to +20% background range.

4.2.19 LOG the -20% to +20% background range on top of the Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3).

4.2.20 PLACE the alpha or beta source in an empty counting planchet.

4.2.21 OPEN the sample drawer and PLACE the source/planchet in the sample drawer.

4.2.22 CLOSE and LOCK the sample drawer in the count position.

4.2.23 PREPARE instrument to perform a timed count cycle. The count time should be long enough to accumulate 10,000 counts, in order to reduce statistical error.

a. SET the appropriate counting time in minutes using the thumb wheel switch.

b. SET the count time multiplier setting (typically X1) with the rotary switch.

4.2.24 PRESS the "COUNT" button. The red light emitting diode (LED) counting lamp should come on. When the red counting lamp goes off, the count cycle is finished.

4.2.25 REPEAT the source count cycle for three successive trials.

4.2.26 LOG source count measurement results on top of the Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3).

4.2.27 CALCULATE the average source count rate.

4.2.28 CALCULATE the -20% to +20% range.

4.2.29 LOG the average and -20% to +20% range on top of the Ludlum 2929 Pre-Operational Check Worksheet (Attachment 3).

4.2.30 REPEAT Steps 4.2.20-4.2.29 for the other source.

4.2.31 PERFORM MDA calculation using the equation found in Section 4.6.2 with the “+20%” background count rate and 1 minute sample count time. If MDA is ≥20 dpm alpha and ≥200 dpm beta, increase sample count time until MDA is <20 dpm alpha and <200 dpm beta and record required sample count time.

4.3 BACKGROUND CHECK

4.3.1 REMOVE any source, sample, or planchet from the counting drawer.

4.3.2 OBTAIN a clean planchet.

4.3.3 PLACE the clean planchet in the sample drawer.

4.3.4 CLOSE and LOCK the sample drawer.

4.3.5 PREPARE instrument to perform a 10 minute (minimum) timed count cycle. A longer background counting time may be used to obtain a lower MDA value, if desired.

a. SET the counting time in minutes using the thumb wheel.

b. SET the count time multiplier setting (typically X1) with the rotary switch.

4.3.6 PRESS the "COUNT" button. The red light emitting diode (LED) counting lamp should come on. When the red counting lamp goes off, the count cycle is finished.

4.3.7 RECORD the date/time and alpha and beta results, in cpm, in the "BKGD (CPM)" column on the Ludlum 2929 Pre-Operational Check Worksheet.

4.3.8 If either the alpha or beta background count indicate a high background (>+20% of initial check background range for alpha or beta) then contamination of sample drawer or planchet should be suspected.

a. Clean the sample drawer and recheck the background.

b. Replace the clean planchet and recheck the background.

4.3.9 If high background problems cannot be resolved, CONTACT RPO supervision.

4.4 SOURCE CHECK

Perform the following source check with both alpha and beta check sources.

4.4.1 RETRIEVE from storage the appropriate check sources identified in the alpha and beta "SOURCE ID #" spaces at the top of the Ludlum 2929 Pre-Operational Check Worksheet.

4.4.2 PLACE the source in an empty counting planchet.

4.4.3 OPEN the sample drawer and PLACE the source/planchet in the sample drawer.

4.4.4 CLOSE and LOCK the sample drawer in the count position.

4.4.5 PREPARE instrument to perform a timed count cycle. The count time should be long enough to accumulate 10,000 counts, in order to reduce statistical error.

a. SET the appropriate counting time in minutes using the thumb wheel switch.

b. SET the count time multiplier setting (typically X1) with the rotary switch.

NOTE: For initial source check following issuance or return from calibration, obtain at least three source counts, take an average, and establish a -20% to +20% range. Record the results and average of three trials on the Ludlum 2929 Pre- Operational Check Worksheet (Attachment 3).

4.4.6 RECORD the result of the source count in the appropriate "SOURCE CK (CPM)" column of the form.

4.4.7 If the source count is not within the range of count rates shown in the "SOURCE RANGE" (see below), take the following actions:

a. REPEAT the count; RECORD the result on the form;

b. If the second count is within the acceptable range, NOTE "Repeat source count required" (or similar) in the "COMMENTS" column of the form; and

c. If the second count is not within the acceptable range, NOTE "Failed source check," (or similar) in the "COMMENTS" column of the form. NOTIFY RPO supervision to resolve issue.

CAUTION: Two or more incidents, in which repeat source counts were required, on the same Attachment 3, may indicate a problem with counter reproducibility. Rechecking the calibration is highly recommended, but not required.

4.4.8 SIGN the appropriate "PERFORMED BY" column. FILE the form in an appropriate location close to the instrument (if possible).

4.4.9 RETURN the check sources to their designated storage locations.

4.4.10 FORWARD completed forms to RPO supervision for review, approval/signature, and filing.

4.5 INSTRUMENT USE

CAUTION: Samples that indicate greater than 200 cpm alpha or 5000 cpm beta from a field scan should not be counted on the Ludlum 2929 due to the possibility of contaminating the detector.

4.5.1 Sample Loading:

a. TURN lock handle toward the front of the instrument.

b. OPEN drawer slowly.

c. PLACE sample/planchet in the center of the drawer.

d. CLOSE drawer slowly.

e. LOCK drawer in the counting position by turning the lock handle toward the back of the instrument. Apply only enough torque to hold the drawer against the switch inside the drawer housing.

CAUTION: Unless the drawer is locked closed, the probe will receive no high voltage and the instrument will register no counts. The scaler will cycle through the counting process regardless of drawer position.

4.5.2 PREPARE instrument to perform a timed count cycle.

a. SET the appropriate counting time in minutes using the thumb wheel switch.

b. SET the count time multiplier setting (typically X1) with the rotary switch.

4.5.3 PRESS the "COUNT" button. The red light emitting diode (LED) counting lamp should come on. When the red counting lamp goes off, the count cycle is finished.

4.5.4 RECORD results on appropriate forms.

4.5.5 REMOVE sample/planchet and close sample drawer.

4.5.6 DISPOSE of sample properly (i.e., storage or disposal).

4.6 INSTRUMENT MINIMUM DETECTABLE ACTIVITY

4.6.1 Use the following equation to determine the MDA of the Ludlum 2929 where the sample and background count times are identical. This value can be used to verify the instrument's ability to distinguish sample activity from background activity.

$$MDA = \frac{2.71 + 4.65\,[R_b * t_s]^{1/2}}{t_s * E}$$

Where,

MDA = Activity level in disintegrations/minute

R_b = Background rate in counts per minute

t_s = Sample count time in minutes

E = Detector efficiency in counts per disintegration

4.6.2 Use the following equation to determine the MDA of the Ludlum 2929 where the background is counted longer than the sample. This value can be used to verify the instrument's ability to distinguish sample activity from background activity.

$$MDA = \frac{2.71 + 3.29\,[(R_b * t_s)(1 + t_s/t_b)]^{1/2}}{t_s * E}$$

Where,

MDA = Activity level in disintegrations/minute

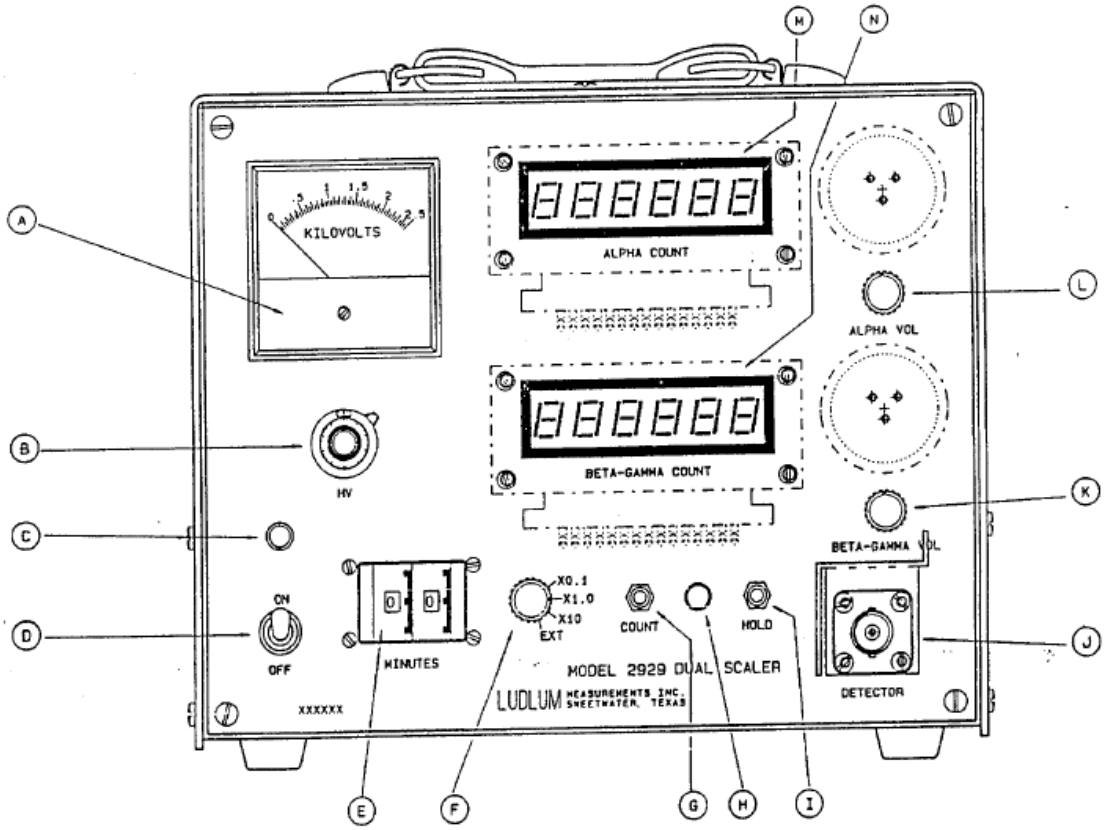
R_b = Background rate in counts per minute

t_s = Sample count time in minutes

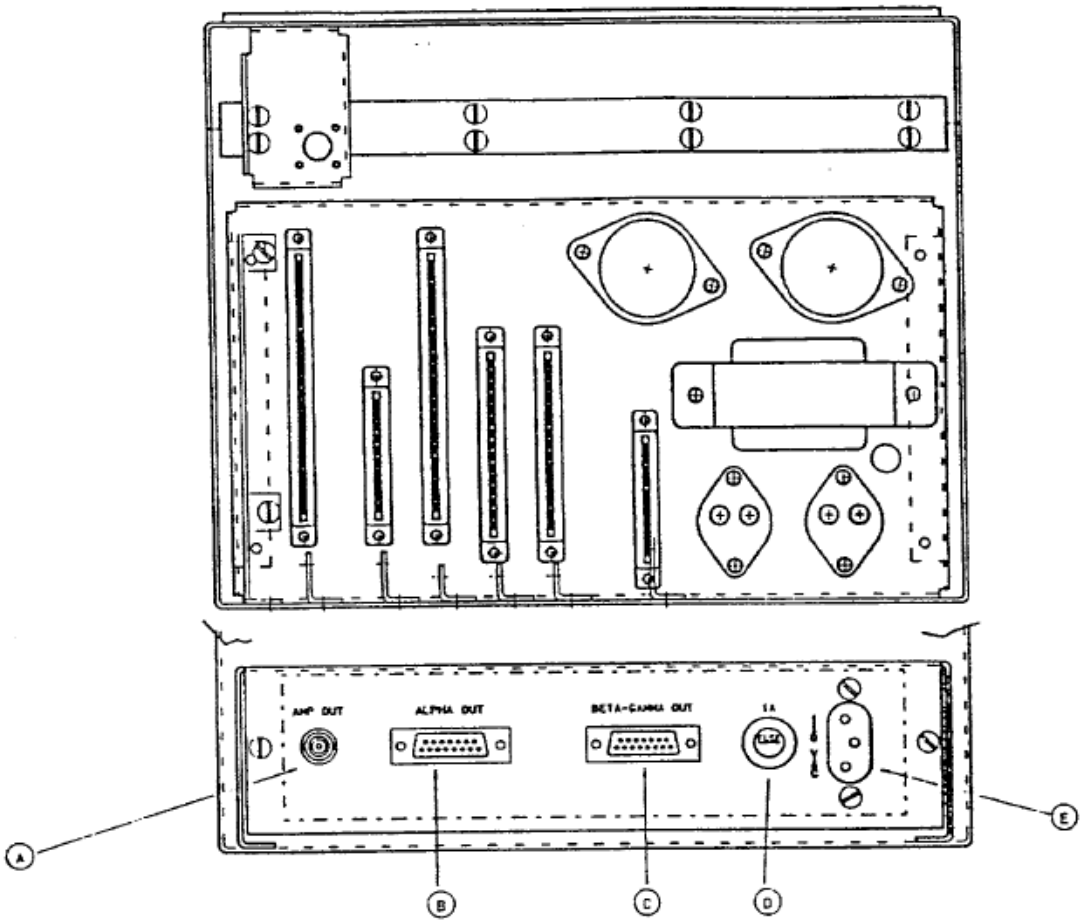
t_b = Background count time in minutes

E = Detector efficiency in counts per disintegration.

Ludlum Model 2929 (Front View)



Ludlum Model 2929 (Rear View)



DESCRIPTION OF FRONT PANEL CONTROLS - LUDLUM MODEL 2929

A High Voltage Readout - a 2.5-inch panel meter displaying the high voltage setting continuously.

B HV - a ten-turn dial used to adjust the detector high voltage.

C Pilot - a neon lamp indicating the instrument is turned on and AC power is present.

D ON/OFF - a toggle switch used to apply power to the instrument when in the "ON" position.

E MINUTES - a two-digit thumb-wheel switch used to dial in the count time. This switch is used in conjunction with the Multiplier switch located to the right.

F Multiplier - a rotary switch allowing selection of count time multipliers of 0.1, 1.0, 10, and EXT position for timing using external clock sources.

G COUNT - a push button switch used to initiate a count cycle. This button will also reset the two counters when depressed.

H Counting Lamp - a LED lamp indicating that a count cycle is in progress.

I HOLD - a push button switch used to stop a count cycle. The counters will hold the value present at the time this button is depressed.

J DETECTOR - a series "C" connector used to supply the detector with its bias voltage and also to return the signal from the detector.

K BETA-GAMMA VOL - a rotary control used to vary the audio output of the beta-gamma channel from off to full volume.

L ALPHA VOL - a rotary control used to vary the audio output of alpha channel from off to full volume.

M ALPHA COUNT - a six digit LED readout indicating counts received in the alpha counting channel.

N BETA-GAMMA COUNT - a six-digit LED readout indicating counts received in the beta counting channel.

DESCRIPTION OF REAR PANEL CONTROLS - LUDLUM MODEL 2929

A AMP OUT - a "BNC" connector which provides access to the final amplifier stage. The pulse is positive going with a maximum amplitude of approximately 22 volts.

B ALPHA OUT - a 15 pin "D" type connector used as a data output for the alpha counter. See pinout listed below.

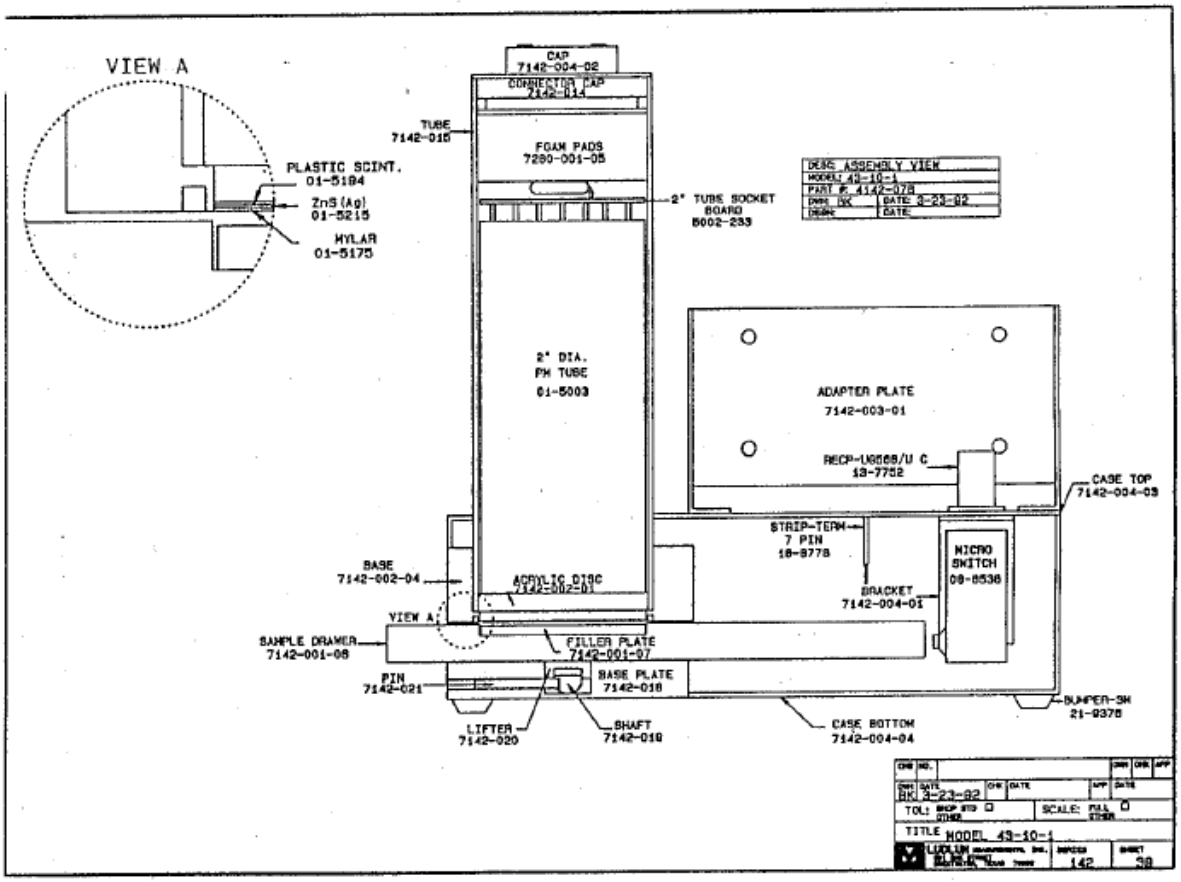
C BETA-GAMMA OUT - a 15 pin "D" connector used as a data output for the beta-gamma counter. See pinout listed below.

PIN	FUNCTION
1	Count complete
2	Printer ready
3	Load printer
4	Printer clock
5	Ground
6	Count
7	Hold
8	+5 VDC
9	NC
10	NC
11	Blanking
12	bit 1
13	bit 2
14	bit 3
15	bit 4

D FUSE - provides protection to the instrument in case of internal electrical failure. Use a 1 amp fast blowing fuse.

E 110V AC - a connector used to apply line power to the instrument.

Ludlum Model 43-10-1



Ludlum 2929 Pre-Operational Check Worksheet

Instrument #	Cal. Expires	Probe type:	Probe #
α Source nuclide	Source #	Instrument α eff.	
β Source nuclide	Source #	Instrument β eff.	
High Voltage:			

Initial Background Check				**Initial Source Check**			
Trial 1 α	cpm	Trial 1 β	cpm	Trial 1 α	cpm	Trial 1 β	cpm
Trial 2 α	cpm	Trial 2 β	cpm	Trial 2 α	cpm	Trial 2 β	cpm
Trial 3 α	cpm	Trial 3 β	cpm	Trial 3 α	cpm	Trial 3 β	cpm
Average	cpm	Average	cpm	Average	cpm	Average	cpm

Initial Background Check -20% to +20% Range					**Initial Source Check -20% to +20% Range**				
Alpha		To		cpm	Alpha		To		cpm
Beta		To		cpm	Beta		To		cpm

Required Sample Count Time:	RCT Performing Initial Check:	Date:

PRE-OPERATIONAL CHECKS

Date/Time	**Bkgd (CPM)**		**Source Ck (CPM)**		**Comments**	**Performed By (Signature)**
	α	β	α	β		

Reviewed By:_____ Date:_____

TETRA TECH, INC

Procedure No: RP-OP-018 Rev 0

AIR SAMPLER OPERATION

1.0 PURPOSE

To provide basic instructions for Radiological Control Technicians (RCT) on the operation of low-volume, high-volume, and personal air samplers associated with the Tetra Tech (Tt) projects.

SCOPE

This procedure describes the operation of the following types of air samplers for the purpose of obtaining continuous particulate air samples:

- Low-Volume Air Samplers (F&J LV-1e, LV-14ME or equivalent)
- High-Volume Air Samplers (F&J HV-1E or equivalent)
- Personal Air Samplers (MSA Escort or equivalent)

The following activities are described in Section 4.0 of this procedure:

4.1 Creation of Radiological Records

4.2 Records Retention

4.3 General Provisions

4.4 Radiological Units

4.5 Individual Monitoring

4.6 Other Monitoring Records

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS RPP

TtNUS Quality Assurance Program (QAP)

G-10 CFR835/E2 - Rev. 1, Implementation Guide for Use with 10CFR835, “Workplace Air Monitoring,” September 1994

3.0 GENERAL

3.1 EQUIPMENT

- Low-Volume Air Samplers (F&J LV-1e, LV-14ME or equivalent)
- High-Volume Air Samplers (F&J HV-1E or equivalent)
- Personal Air Samplers (PAS) (MSA Escort or equivalent)
- Battery Charger
- Primary Flow Calibrator (Model M-5 Mini-Buck Calibrator or equivalent)
- Calibrator Bubble Soap Solution

- Filter Paper. Glassine fiber, 47 mm, 37 mm or 25 mm Diameter, or equivalent.

3.2 SAFETY CONSIDERATIONS

The low and high-volume portable air samplers are AC operated units only. It shall only be plugged into an appropriate outlet or approved extension cord.

3.3 RESPONSIBILITIES

3.3.1 RPO supervision is responsible for: implementation of this procedure, ensuring that RCTs are qualified to perform this procedure, ensuring that all survey documentation is reviewed.

3.3.2 RCTs are responsible for: complying with this procedure, exercising appropriate contamination control techniques in the performance of radiological surveys, and while handling sample media, complying with entry requirements for the areas to be surveyed.

3.4 PREREQUISITES

An evaluation should be performed based on the requirements specified in RP-OP-003 determining the need and placement of air samplers.

3.5 RECORDS

RPO survey records are generated during the implementation of this procedure. The original copy is the record copy for the Radiation Protection Program and is transmitted for processing to Quality Assurance Manager.

3.6 PRECAUTIONS AND LIMITATIONS

All air monitoring and sampling equipment that has the potential for being contaminated internally shall be properly labeled (e.g., “Caution: Internal Contamination” or “Potential Internal Contamination”) and treated/handled with caution, using good contamination control techniques.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate.

3.8 OTHER

None

3.9 ATTACHMENTS

Attachment 1 Personal Air Sampler Flow Check Log Sheet

Attachment 2 Do Not Use Tag

4.0 PROCEDURE

4.1 LOW-VOLUME AIR SAMPLERS

4.1.1 OBTAIN needed equipment. (See Section 3.1)

4.1.2 PERFORM a pre-operational check of the air sampler. This includes the following:

a. INSPECT the sampler, including power cord for physical damage. If damage is found, DO NOT use the sampler.

b. VERIFY current calibration from the attached calibration sticker. If the sticker is missing or is beyond the indicated expiration date, DO NOT use the sampler.

c. INSPECT the rubber O-rings on the sampler. If damaged or missing, DO NOT use the sampler.

d. INSPECT the sampler-head filter-backing screen for damage. If damaged excessively, REPLACE the sampler head.

e. If the sampler does not pass the pre-operational check for any reason, TAG it with a Do Not Use tag (Attachment 2) and RETURN it to the vendor for repair and/or calibration. The tag should contain the Material ID, a description of the problem, the name of the individual placing the tag, and the date.

4.1.3 INSTALL the appropriate filter media, (see Section 3.1) in the sampler head, if applicable.

4.1.4 ATTACH the head to the sampler.

4.1.5 ADJUST the telescoping tube, if necessary, to the desired height.

NOTE: ADJUST the packing gland O-ring by hand. DO NOT use the brass packing gland itself to move the O-ring. This could damage the O-ring and lead to an incomplete seal along the telescoping tube.

4.1.6 CONNECT the sampler to power supply.

4.1.7 TURN the power switch ON.

4.1.8 OBSERVE the flow rate indicator. The flow rate should read approximately 60 lpm. RECORD the beginning flow rate and start time on the filter envelope. If the flow rate is too high (> 75 lpm) or low (<45 lpm), do NOT use the sampler. TAG the sampler out of service.

4.1.9 At the end of the sampling interval, OBSERVE the flow rate indicator and RECORD the ending flow rate on the filter media envelopes. RECORD the end time on the filter media envelopes.

4.1.10 TURN the sampler off. REMOVE the filter media. SUBMIT the media to a counting laboratory for analysis.

4.1.11 DOCUMENT air samples in accordance with RP OP-003.

4.2 HIGH-VOLUME AIR SAMPLERS

4.2.1 OBTAIN needed equipment. (See Section 3.1)

4.2.2 PERFORM a pre-operational check of the air sampler. This includes the following:

a. INSPECT the sampler, including power cord for physical damage. If damage is found, DO NOT use the sampler.

b. VERIFY current calibration from the attached calibration sticker. If the sticker is missing or is beyond the indicated expiration date, DO NOT use the sampler.

c. INSPECT the rubber O-rings on the sampler. If damaged or missing, DO NOT use the sampler.

d. INSPECT the sampler-head filter-backing screen for damage. If damaged excessively, REPLACE the sampler head.

e. If the sampler does not pass the pre-operational check for any reason, TAG it with a Do Not Use tag (Attachment 2) and RETURN it to the vendor for repair and/or calibration. The tag should contain the Material ID, a description of the problem, the name of the individual placing the tag and the date.

4.2.3 INSTALL the appropriate filter media, (see Section 3.1) in the sampler head, if applicable.

4.2.4 ATTACH the head to the sampler.

4.2.5 CONNECT the sampler to power supply.

4.2.7 TURN the power switch ON.

4.2.8 OBSERVE the flow rate indicator. Using the variable motor speed controller, adjust the flow rate to read between 6 and 10 CFM. RECORD the beginning flow rate and start time on the filter envelope.

4.2.9 At the end of the sampling interval, OBSERVE the flow rate indicator and RECORD the ending flow rate on the filter media envelopes. RECORD the end time on the filter media envelopes.

4.2.10 TURN the sampler off. REMOVE the filter media. SUBMIT the media to a counting laboratory for analysis.

4.2.11 DOCUMENT air samples in accordance with RP OP-003.

4.3 PAS PRE-OPERATIONAL FLOW-RATE DETERMINATION

4.3.1 ENSURE battery is fully charged.

4.3.2 EXAMINE the sampler for physical damage. If damaged, affix Do Not Use Tag and turn in for repair.

4.3.3 CHECK that a current calibration sticker is affixed to the calibrator. If the calibration is expired (more than 1 year since the last calibration date), DO NOT USE.

4.3.5 ADD soap solution, if needed, to the Flow Cell Assembly at the air inlet while fully pressing and holding the bubble initiate button. Add soap only to the bottom of the bubble generator ring.

4.3.6 CONNECT the PAS to the air outlet on the calibrator using Tygon tubing.

4.3.7 CONNECT the filter cassette to the air inlet on the calibrator. Use the same filter that is to be used for sampling. Make sure this is done outside the potential airborne area.

4.3.8 TURN on the sampler. SET the sampler flow rate at 3.5 to 4.0 liters/minute using the flow adjust screw (clockwise to increase flow & counter clockwise to decrease flow).

4.3.9 DEPRESS the bubble initiate button on the calibrator and release the button to let the bubble travel up the flow tube. If no bubble travels up the chamber you may have to prime the chamber by depressing the bubble initiate button several times. REPEAT this process to

obtain a minimum of 5 timed bubbles through the calibrator. The flow rate for each bubble used to calculate the average flow rate should agree within + 5% of each other.

4.3.10 TURN off the sampler.

4.3.11 RECORD information for input on the Airborne Radiological Survey Form, using the Personal Air Sampler Flow Check Log Sheet (Attachment 1)

4.4 PERSONAL AIR SAMPLER OPERATION

4.4.1 OBTAIN as much information as possible about the expected contaminants prior to initiating sampling. EXPLAIN the purpose of the sampling to the individual(s) who will wear the air sampler(s). INSTRUCT the worker(s) not to remove, turn off, or attempt to adjust the sampler unless authorized to do so by RPO personnel.

4.4.2 CLIP the filter cassette to the individual's lapel or collar in the vicinity of the nose and mouth. The filter should be facing slightly downward to prevent settling or fallout of contamination on the filter. POSITION the tubing so as not to interfere with work. Placing the sampler on the opposite side of the worker's body from the filter, and running the tubing across the individual's back, is one method of doing this. If personnel to be monitored are in a cab for operating equipment, sampler and filter cassette may be clipped to equipment close to breathing zone of operator.

4.4.3 START the sampler when the individual is ready to enter the work area. OBSERVE the sampler to insure that it is functioning properly.

4.4.4 RECORD information for input on the Airborne Radiological Survey Form:

- Air sample number.
- Sampler model and serial number.
- Wearer's name and ID#.
- Respirator and cartridge type, if used.
- Start time.
- All times sampler is stopped and restarted (i.e., breaks, lunch, etc.) so that total run time of the sampler will be known.
- Names of all individuals working in the area during sampling to facilitate possible follow-up (either record in the remarks section or through the use of an RWP sign-in sheet).

4.5 POST-OPERATIONAL FLOW-RATE DETERMINATION

4.5.1 ADD soap solution, if needed, to the Flow Cell Assembly (per Section 4.3.5).

4.5.2 CONNECT the PAS and the filter cassette to the calibrator (per Sections 4.3.6 - 4.3.7).

4.5.3 DETERMINE the average bubble flow rate (per Sections 4.3.8 - 4.3.11).

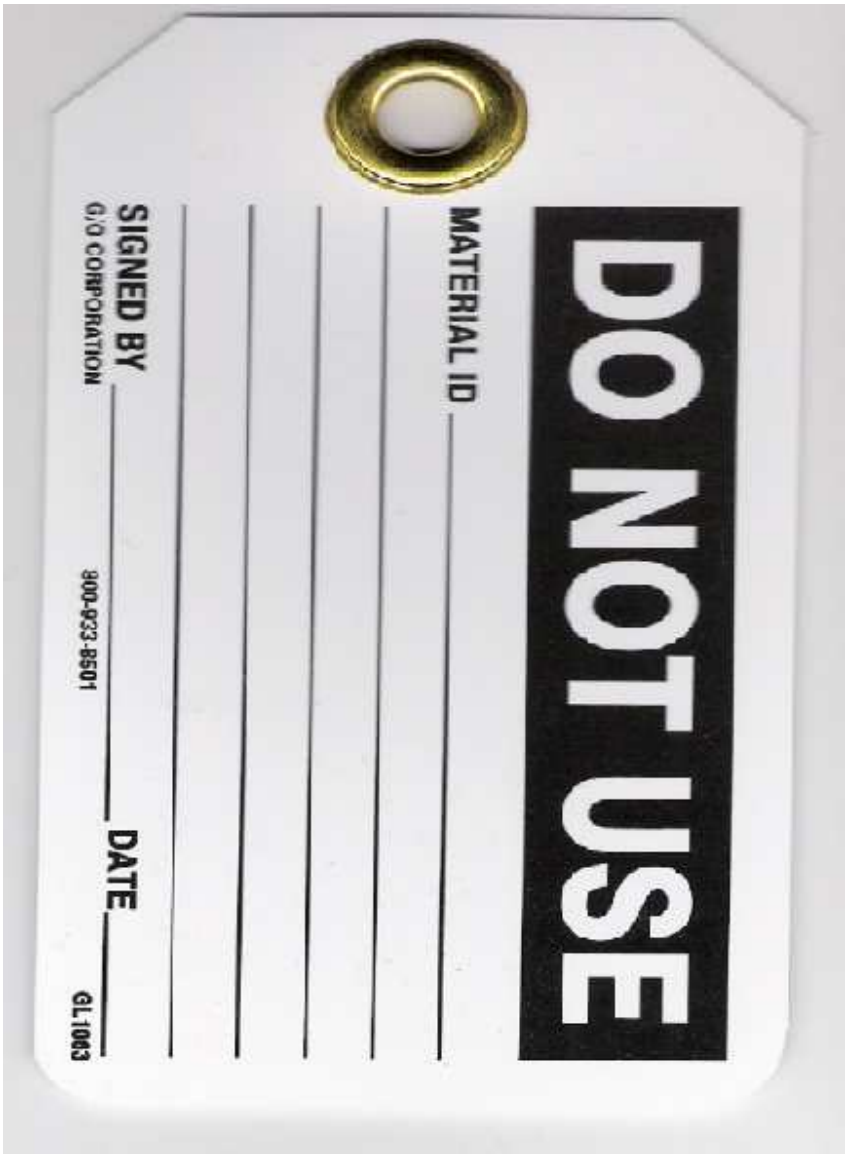
4.5.4 RECORD information for input on the Airborne Radiological Survey Form, using the Personal Air Sampler Flow Check Log Sheet (Attachment 1)

Personal Air Sampler Flow Check Log Sheet

Date:	PAS #	Calibrator #	Cal. Due Date:	RCT:		
Beginning Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Ending Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Date:	PAS #	Calibrator #	Cal. Due Date:	RCT:		
Beginning Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Ending Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Date:	PAS #	Calibrator #	Cal. Due Date:	RCT:		
Beginning Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Ending Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Date:	PAS #	Calibrator #	Cal. Due Date:	RCT:		
Beginning Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Ending Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Date:	PAS #	Calibrator #	Cal. Due Date:	RCT:		
Beginning Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.
Ending Flow (flow rates in lpm)						
PAS Flow:	1st	2nd	3rd	4th	5th	Avg.

Reviewed By:____ Date:______________________

Do Not Use Tag



TETRA TECH, INC

Procedure No: RP-OP-019 Rev 0

ANALYSIS OF SOIL SAMPLES

1.0 PURPOSE

This procedure provides instructions for Tt RPO personnel to perform the analysis of soil samples for gross alpha and beta-gamma contamination, and to report the sample results. This procedure implements 10 CFR 835 and 10 CFR 20 requirements.

SCOPE

This procedure details sample preparation, sample analysis, and the required documentation to be used when analyzing and reporting soil samples. This procedure does not include the methods to be used in obtaining samples. REFER to RP-OP-013.

The following activities are described in Section 4.0 of this procedure:

4.1 Acceptance Criteria

4.2 Soil Sample Tracking

4.3 Individual Sample Analysis

2.0 REFERENCES

10 CFR 20, *Standards for Protection against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

Westinghouse Savannah River Site ESH-HPT-94-0302, Determination Of Minimum Detectable Concentration Levels and Self Absorption of the Soil Using SRS Equipment (U), R.A. Kellner, Dated 12-16-94

3.0 GENERAL

3.1 EQUIPMENT

- spatula
- planchet, 1.5 inch
- drying dish
- mortar with pestle
- heat lamp, specially designated microwave or hot plate
- forceps
- portable alpha and beta-gamma count rate instruments
- laboratory / count room alpha, beta-gamma counting systems.

ANALYSIS OF SOIL SAMPLES

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Comply with applicable Radiological Work Permit (RWP).

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for delegating performance of procedures to qualified personnel. Also responsible for arranging procedure training, monitoring implementation, ensuring "in-use" procedures are current, and taking corrective action as needed.:

3.3.2 RCTs are responsible for:

- Properly surveying and documenting results of the radiological survey in compliance with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

The user of this procedure shall ensure that the Soil Analysis Calculation Sheet computer database is available and open.

3.5 RECORDS

Radiological survey records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project guidance. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

Handle all samples with appropriate radiological controls based on the location from which samples were obtained.

The minimum level of detection (pCi/g) is dependent on the background count rate, CF of the counting system, and the CF for soil.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite and thus nor revision bars are included.

3.8 OTHER

Terms and Definitions

CF	A correction factor used to account for sample geometry, scaler efficiency, and soil self absorption during activity calculations.

Sample number	A unique tracking number from a numbering system
Originator	Personnel who obtained the sample.

3.9 ATTACHMENTS

NONE

4.0 PROCEDURE

This procedure assumes that the soil samples submitted for analysis have been obtained in accordance with approved sampling methods.

4.1 Acceptance Criteria

- Sample analysis has been completed.
- All documentation has been properly completed per this procedure.
- All documentation has been reviewed and approved by supervision.

4.2 Soil Sample Tracking

1. RPO shall track soil samples. Soil samples shall have consecutive numbers in the format YY-facility identifier-##### (e.g., 96-HRB-00001). The number serves as an internal tracking number for retention of samples and for records administration.
2. The Originator should assign the next consecutive sample number to each sample. Number should be obtained from the Soil Sample binder.
3. LABEL each sample container with the tracking number using a permanent marker.

4.3 Individual Sample Analysis

4.3.1 Sample Preparation

1. TRANSFER enough soil to a drying dish to fill the drying dish approximately 3/4 full. When feasible, no vegetation or stones should be transferred to the drying dish.

   NOTE 2: For microwave use, fill one glass bowl half way with soil and one glass bowl with water. Place both bowls in microwave, set power to “Med” setting, and set timer for five (5) minutes. Open door and remove bowl of soil (use oven pad if necessary). Repeat process with timer set for two (2) minutes, if necessary.

2. DRY until no moisture is visible in the sample. Verification that the sample is dry may require stirring or turning of the sample.

   NOTE: The hot plate may be located inside the count room containment, as applicable. Instructions for use of the containment are contained in RP-OP-010.

3. ALLOW samples to cool and SURVEY the soil in the drying dish

- IF ≥100 ccpm alpha or ≥500 ccpm beta-gamma, RETURN soil to container, and contact Originator. Originator must record/report survey results on the appropriate Radiological Survey Form.
- IF <100 ccpm alpha or <500 ccpm beta-gamma, PROCEED to Step 4.

4. TRANSFER the dried sample to a mortar.

CAUTION

Vegetation, small stones, or pebbles should be removed from the sample prior to crushing to prevent damage to the mortar and pestle.

5. Using a mortar and pestle, CRUSH the sample until a consistent, fine particle size is obtained.

6. FILL a planchet with sufficient sample such that the sample contents are level with the top of the planchet.

7. SURVEY all reusable lab ware for fixed and removable contamination.

IF contamination is detected, THEN

DECONTAMINATE the lab ware, AND

RESURVEY.

IF contamination cannot be removed, THEN

DISPOSE of the lab ware, AND

OBTAIN replacement(s).

8. PROCEED to Section 4.3.2.

4.3.2 Sample Counting

1. ENSURE the counting systems are within their calibration period and the daily source response and background checks have been completed.

2. ENTER the following alpha and beta-gamma counting system information into Soil Analysis Calculation Sheet computer database.

- Date/Time
- Laboratory / Count Room Instrument number
- Calibration due date
- Counting System CF.

SOIL CORRECTION FACTORS *
ALPHA = 26.12
BETA-GAMMA = 1.82
* Correction Factors are derived from the results of ESH-HPT-94-03025

- Daily background count time and count rate
- Sample count time

  Count time for sample should be 2 minutes.

  VERIFY MDA is is ≤ 100 dpm/g for the beta-gamma, AND

  ≤ 250 dpm/g for the alpha.

  IMPORTANT - IF the calculated MDA is > 100 dpm/g for the beta-gamma, OR > 250 dpm/g for the alpha, INCREASE the count time until the desired MDA is reached.

7. Using good radiological practices, PLACE the planchet containing the sample in the appropriate counting system.
8. PERFORM a count of the sample planchet for both alpha and beta-gamma for the required count time as determined in Step 2.
9. ENTER the sample number and gross alpha and beta-gamma counts into the database.

   Sample activity is calculated using the following:

   Activity (dpm/g) = (Sample cpm - Daily background cpm) x CF_{soil} x CF_{scaler}

   Where:

   CF_{soil} = Soil correction factor for self absorption {(dpm/g)/dpm}

   CF_{scaler} = Scaler correction factor for efficiency of scaler (dpm/cpm)

$$Activity\ (pCi/gm) = \frac{Activity\ (dpm/gm)}{2.22}$$

   Where: 2.22 = the number of dpm/pCi
10. RETURN the sample from the planchet, and any uncounted soil from the drying dish, to the original sample container.
11. VERIFY the sample number is marked on the outside of the sample container and PLACE in a designated sample storage area.
12. REPEAT until desired group of samples has been counted.
13. PRINT results, REVIEW for completeness and accuracy,
14. NOTIFY Originator of sample results. Sample numbers should be referenced on the appropriate Radiological Survey Form by the Originator.
15. SIGN printout, and forward to RPO supervision for review.
16. DISPOSE of sample per RPO direction.

TETRA TECH, INC

Procedure No: RP-OP-020 Rev 0

QUALITY CONTROL OF THE RAPID ANALYSIS SYSTEM

1.0 PURPOSE

This procedure provides instructions for daily quality control checks of the Rapid Analysis System. The checks are to ensure background, gain, zero, and amplifier performance remain within limits. Exceeding the limits result in inoperability of the system.

SCOPE

This procedure details quality control protocols for the Rapid Analysis System.

The following activities are described in Section 4.0 of this procedure:

4.1 General Requirements

4.2 Establishing the QC Database and Settings

4.3 Verify Spectrum

4.4 Calibrate Energy and FWHM

4.5 Calibrate Efficiency

4.6 Performing Daily QC Checks

4.7 Performing Long Background Counts

2.0 REFERENCES

10 CFR 20*, Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

Sampling and Analysis Plan (SAP)

ORTEC, ScintiVision™-32 for Windows® 95, 98, NT®, 2000, and XP® MCA Emulation and Analysis Software for Scintillation Detector Spectra, A35-B32, Advanced Measurements Technology, Oak Ridge Tennessee.

3.0 GENERAL

3.1 EQUIPMENT

- Gamma Spectroscopy System
- NIST Traceable Calibration Source

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Comply with applicable Radiological Work Permit (RWP).

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for delegating performance of procedures to qualified personnel. Also responsible for arranging procedure training, monitoring implementation, ensuring "in-use" procedures are current, and taking corrective action as needed.

3.3.2 RCTs are responsible for:

- Properly performing and documenting results of the quality control checks in compliance with this procedure.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The individual performing this procedure must be trained in accordance with RP-OP-011, which includes instruction specific to this procedure.

3.4.2 All equipment used in this procedure must be installed and operable in accordance with RP-OP-021, Startup of the Rapid Analysis System.

3.4.3 A NIST-traceable calibration standard in a simulated soil matrix is required. The standard shall contain between 0.2 and 1.0 microcuries of Cs-137 in a 1 liter Marinelli beaker. The standard shall also contain Co-60 in approximately equal amount as the Cs-137.

3.5 RECORDS

Radiological Quality Control records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project guidance. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

None

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite, and thus no revision bars are included.

3.8 OTHER

None

3.9 ATTACHMENTS

Attachment 1 – Job Stream Definition – Daily QA Check

4.0 PROCEDURE

4.1 General Requirements

4.1.1 The Rapid Analysis System shall not be used to count samples until the daily checks prescribed in this procedure have been performed and all the parameters have passed.

4.1.2 The Daily QC checks shall be performed after loss of power or any time the detector high voltage has been turned off, the computer shut-down, or the USB cable disconnected.

4.1.3 The Daily QC check shall be performed if the temperature in the counting room varies as much as 20 degrees F between Daily QC checks.

4.1.4 Ensure that the detector voltage is turned on prior to beginning any counting operations. From the Acquire pull-down menu, choose MCB Properties.

4.1.4.1 Select the High Voltage tab

4.1.4.2 Ensure that the voltage is turned on.

4.2 Establishing the QC Database and Settings

NOTE

This section is normally performed only at start-up of the system or after major shutdown and repairs on the system.

NOTE

The QA database is already established in the ScintiVision 32 files. To erase the contents of the database or to list data in the database, it can be accessed through Microsoft Access in C:\User\svqa32.mdb, Table M1. It was created in Access 97 and may need conversion to a newer version before it can be modified.

NOTE

If the QA Database needs to be started afresh (no entries), any old data may need to be archived to another file before erasing the data.

4.2.1 From the Acquire pull-down menu, choose QA, Settings.

NOTE

The following settings are temporary until at least 20 measurements can be established over a 7-day period. At the completion of the 20 measurements, mean and standard deviation will be used to set the limits.

4.2.2 In the BACKGROUND Acquisition/Count rate Limits section of the Quality Assurance Settings page, set Live to 300 seconds, Min to 0, Low to 0, High to 1,000 and Max to 1,000.

4.2.3 Check the boxes Create Background Report and Print on Completion.

4.2.4 In the SAMPLE Type/Analysis Settings section of the Quality Assurance Settings page, press Browse and select Daily QC.svd.

4.2.5 Check the box “Lock Acquire on Violation,” enter “QA” for QA File Prefix, and set the QA File Sequence to 0. Do not check any other boxes.

NOTE

The following settings are temporary until at least 20 measurements can be established over a 7-day period. At the completion of the 20 measurements, mean and standard deviation will be used to set the limits.

4.2.6 In the SAMPLE Analysis Parameter Limits section of the Quality Assurance Settings page, place checks in all three boxes and fill in the following input:

	Min	Low	High	Max
Total Activity (Bq)	0	0	1E6	1E6
Av Peak Shift (keV)	-100	-100	100	100
Av FWHM Ratios	0	0	10	10

4.2.7 Press OK

4.2.8 Ensure that the detector is operable and clear of any source or contamination, and select the Acquire pull-down menu.

4.2.9 Choose QA, Measure Background and Press OK - - Start. Do not check the box.

4.2.10 When acquisition has stopped, place the calibration source on the detector and select the Acquire pull-down menu.

4.2.11 Choose QA, Measure Sample and Press OK - - Start. Do not check the box.

4.2.12 Place the resulting report in the counting room files.

4.2.13 Repeat steps 4.2.7 through 4.2.11 at least three times per day for seven days (need not be consecutive days). The operator should attempt to spread the QC counts out over the entire shift.

4.2.14 When a minimum of 20 repetitions of steps 4.2.7. through 4.2.10 have occurred (more is better), then retrieve all the QA Reports for both background and samples.

NOTE

The entries in the database should be correlated with the QA reports retrieved from the files. Measurement type 0 is for background counts and Measurement Type 1 is for QC standard counts.

4.2.15 Open the Microsoft Access database in C:\USER\svqa32.mdb and calculate mean and standard deviation for Background, Total Activity, Av Peak Shift, and Av FWHM Ratios.

4.2.16 Repeat steps 4.2.1 through 4.2.7 with the following changes:

a. Set the Min for each parameter as mean minus three standard deviations.

b. Set the Low for each parameter as mean minus two standard deviations.

c. Set the High for each parameter as mean plus two standard deviations.

d. Set the Max for each parameter as the mean plus three standard deviations.

4.3 Verify Spectrum

4.3.1 Place the calibration standard on the detector and close the shield door.

4.3.2 Clear the detector/buffer with the Clear Detector/Buffer button.

4.3.3 Start acquisition with the Start Acquisition button (GO) and ensure that the Cs-137 peak becomes identifiable and well shaped.

4.3.4 Verify that the Cs-137 peak centroid is located around the channel 331 marker. If the centroid has shifted in either direction, adjust the voltage gain to move the peak to the correct region.

4.3.5 To make gross adjustments to the High Voltage, select MCB Properties from the Acquire pull-down menu and select the High Voltage tab. Iteratively increase or decrease the High Voltage in 25 volt increments to move the spectrum to the correct marker region. Clear the spectrum with the Clear Detector/Buffer button after each adjustment

4.3.6 On the Amplifier tab, the Fine Gain should be set between 0.4500 and 0.5500.

4.3.7 Adjust the fine gain up or down to move the Cs-137 peak centroid to channel 331 by performing the following steps iteratively, as needed:

a. Press ALT SHIFT + to increase fine gain, moving the peak to the right.

b. Press ALT SHIFT – to decrease fine gain, moving the peak to the left.

c. Clear the spectrum with the Clear Detector/Buffer button after each adjustment

4.3.8. When the centroid of the Cs-137 peak is in channel 331, stop acquisition with the Stop Acquisition button (STOP).

4.3.9 Remove the calibration standard and store it in an appropriately posted location away from the detector.

4.4 Calibrate Energy and FWHM

4.4.1 Energy and efficiency calibrations must be performed after any voltage adjustments.

4.4.2 Place calibration standard on detector.

4.4.3 From the Acquire pull-down menu, choose Start/Save/Report.

4.4.4 When prompted for Load Sample Type File, press Browse, select Calibration, and press OK.

4.4.5 When prompted for Sample Description, enter “1L Marinelli Calibration Standard” and press OK.

4.4.6 When prompted for Sample Size, enter 1 (no units) and press OK.

4.4.7 Examine the display to ensure that counts are acquiring and peaks are beginning to develop.

4.4.8 When the counting has finished, check the Identified Peak Summary on the printed report to ensure that the expected peaks for Cs-137 and Co-60 are present.

NOTE

ROI is Region of Interest. It can be set by dragging a “rubber rectangle” over the desired channels, pressing the right mouse button, and selecting Mark ROI. The ROI should include several background channels on either side of the peak.

4.4.9 Set an ROI in the Co-60 1173 keV peak.

4.4.10 From the Library pull-down menu, choose Select File, select the Calibration Library, and press OK.

4.4.11 From the Library pull-down menu, choose Select Peak.

4.4.12 From the Calibrate pull-down menu, choose Energy.

4.4.13 Select the Windows icon to the left of the word “Calibration” and then press “Destroy.”

4.4.14 When a popup entitled Initial FWHM Estimate Needed appears, press OK

4.4.15. Set an ROI in the Cs-137 keV peak and the Co-60 1332 keV peak. Be sure to leave one channel unselected in the region between the two Co-60 ROIs.

4.4.16 Place the cursor in the Cs-137 peak and highlight the 661.62 line in the Library List. Press Enter multiple times (approximately 2 – 3) until the channel number displayed stops changing or 4 times at most.

4.4.17 Place the cursor in the Co-60 1173 keV peak and highlight the equivalent line in the Library List. Press Enter multiple times (approximately 2 – 3) until the channel number displayed stops changing or 4 times at most.

4.4.18 Place the cursor in the Co-60 1332 keV peak and highlight the equivalent line in the Library List. Press Enter until the channel number displayed stops changing or 4 times at most.

4.4.19 Ensure that the Deltas are small (less than 10 percent) in the Energy Table. If not, repeat the calibration with expert help.

4.4.20 Select the FWHM radio button on the Calibration sidebar.

4.4.21 Ensure that the Deltas are small (less than 25 percent) in the FWHM Table. If not, contact RPO supervision.

4.4.22 Save the Calibration Table by pressing the Save button in the Calibration sidebar. Enter the name, “GSA Energy.”

4.4.23 Close the Calibration sidebar by pressing “X”.

4.4.24 Save the Calibration to disk by selecting the Calibrate pull-down menu, then selecting “Save Calibration File.” Provide the name “1L Marinelli” and press Save For the calibration description, provide the standard certificate number.

4.5 Calibrate Efficiency

4.5.1 Energy and efficiency calibrations must be performed after any voltage adjustments.

NOTE

The efficiency calibration will use the same spectrum as acquired for the energy calibration.

4.5.2 From the Calibrate pull-down menu, choose Efficiency.

4.5.3 Select the Windows icon to the left of the word “Calibration” in the Calibration sidebar and then press “Destroy.”

4.5.4 From the Library pull-down menu, choose “Select File” and select the Calibration Library.lib file.

4.5.5 From the Library pull-down menu, choose “Select Peak.”

4.5.6 On the Library List box, double click the 662 keV Cs-137 peak and press the Calculate button on the Calibrate sidebar to open the Efficiency Calculation Worksheet.

4.5.7 On the worksheet, enter the date and time of the calibration standard certificate.

4.5.8 Enter the µCi in the standard for Cs-137, ensuring that the µCi units are selected.

4.5.9 Enter the uncertainty percent from the calibration standard certificate.

4.5.10 Ensure that the From Library box is checked.

4.5.11 Press Calculate Efficiency, then OK

4.5.12 Repeat steps 4.5.6 through 4.5.11 once for each of the two Co-60 peaks.

4.5.13 Select the Interpolative mode in the Calibration sidebar then Close the Calibration sidebar.

4.5.14 Save the Calibration to disk by selecting the Calibrate pull-down menu, then selecting “Save Calibration File.” Select the file “1L Marinelli” already named in the energy calibration and press Save.

4.6 Performing Daily QC Checks

NOTE

At the direction of RPO supervision, steps 4.6.1 through 4.6.5 may alternatively be performed using a job stream provided in Attachment 1.

4.6.1 Perform the following checks once at the beginning of each day shift and once after power disruption or system maintenance.

4.6.2 Ensure that the detector is operable and clear of any source or contamination, and select the Acquire pull-down menu.

4.6.3 Choose QA, Measure Background and Press OK - - Start. Do not check the box regarding Overwrite (repeat) previous.

NOTE

When acquisition is stopped, a warning will be issued if needed.

a. If background count rate is above High or Max values, detector or shield contamination may be present. Decontaminate the detector/shield or move sources in the counting room away from the shield and repeat the count.

b. If background count rate is below Low or Min values, check connections and detector voltage and repeat the count.

c. If out-of-control conditions persist, contact RPO supervision. For the next QC count only, check the box, when prompted, to Overwrite (repeat) previous.

4.6.4 Place the calibration source on the detector and select the Acquire pull-down menu.

4.6.5 Choose QA, Measure Sample and Press OK - - Start. Do not check the box regarding Overwrite (repeat) previous.

a. If any parameter is above the High value or below the Low value, repeat the count. If still above High or below Low, contact RPO supervision and perform a recalibration in accordance with Sections 4.4 and 4.5 of this procedure. If the second count is within the control limits, then the daily check passes.

b. If any parameter is above the Max value or below the Min value, further acquisition will be locked out. Contact the RPO Supervisor. For the next QC count only, check the box, when prompted, to Overwrite (repeat) previous.

4.6.6 After all checks have been completed and found to be within the control limits, examine the control charts for all four QC parameters.

a. From the Acquire pull-down menu, choose QA, Control Chart.

b. For each parameter, check the Month and Quarter scales by selecting from the Scale pull-down menu.

c. Select all four parameters from the Plot Variable pull-down menu.

d. On each control chart look for trends up or down or distributions that are too tight (not spread with approximately two-sigma variation). If anything unusual appears, contact RPO supervision.

4.6.7 File the QC Report in the counting room files.

4.7 Performing Long Background Counts

NOTE:

This is an optional activity that is recommended to be performed approximately once per month during periods of low sample throughput or whenever background problems occur in the daily background check.

4.7.1 From the Acquire pull-down menu of the ScintiVision-32 software, choose Start/Save Report.

4.7.2 In the Load Sample Type File box, press Browse and select Background.svd and press OK.

4.7.3. In the Sample Description box, enter “Long Background” and press OK.

4.7.4 In the Sample Size box enter “1 ct” and press OK.

4.7.5 In the Sample Collection Date/Time box, enter the current date and time and press OK.

4.7.6 When the acquisition stops, collect the printout from the printer.

4.7.7 Look for peaks and compare to the initial long background.

4.7.8 File the report in the counting room files.

Job Stream Definition – Daily QA Check

ask_description
ask_confirm “Ensure there is no source or sample on the detector an close the shield door.”
set_detector 1
wait 1
stop
wait 1

qabackground
wait 1
wait
wait_QA
wait 2

ask_confirm “Place the calibration standard on the detector and close the shield door.”
qasample
wait 1
wait
wait_QA
wait 2
quit

STARTUP OF THE RAPID ANALYSIS SYSTEM

1.0 PURPOSE

This procedure provides instructions for setting up hardware, installing software, preparing files, and calibrating the NAI gamma spectrometer to be used for rapid analysis of Cs-137. While the procedure is intended to be performed sequentially, after the initial setup, sections 4.1 through 4.7 may be performed, as needed, in any order.

SCOPE

This procedure details the setup and calibration of the gamma spectrometer.

The following activities are described in Section 4.0 of this procedure:

4.1 Hardware Installation

4.2 Software Installation

4.3 Detector Configuration

4.4 Create Radionuclide Library

4.5 Set Up Acquisition and Analysis Parameters

4.6 Calibrate Energy and FWHM

4.7 Calibrate Efficiency

4.8 Perform a Long Background Count

2.0 REFERENCES

10 CFR 20*, Standards* for Protection against Radiation

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

Sampling and Analysis Plan (SAP)

ORTEC, ScintiVision™-32 for Windows® 95, 98, NT®, 2000, and XP® MCA Emulation and Analysis Software for Scintillation Detector Spectra, A35-B32, Advanced Measurements Technology, Oak Ridge Tennessee.

3.0 GENERAL

3.1 EQUIPMENT

- Gamma Spectroscopy System
- NIST Traceable Calibration Source

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Comply with applicable Radiological Work Permit (RWP).

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for delegating performance of procedures to qualified personnel. Also responsible for arranging procedure training, monitoring implementation, ensuring "in-use" procedures are current, and taking corrective action as needed.

3.3.2 RCTs are responsible for:

- Properly performing and documenting results of the startup protocol in compliance with this procedure.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The individual performing this procedure must be trained in accordance with RP-OP-011, which includes instruction specific to this procedure.

3.4.2 All equipment used in this procedure must be available including the detector shield, Bicron 3 by 3 NaI detector Model 3M3/3-X, ORTEC digiBASE™, digiBASE™ to USB cable, 1 liter Marinelli calibration standard containing Cs-137 and Co-60, computer with Microsoft Windows 2000 or XP operating system and having a USB connection and CD-ROM drive.

3.4.3 The Rapid Analysis System shall be set-up in a temperature controlled environment typical of that found in a field office with an operating HVAC system.

3.4.4 A NIST-traceable calibration standard in a simulated soil matrix is required. The standard shall contain between 0.2 and 1.0 microcuries of Cs-137 in a 1 liter Marinelli beaker. The standard shall also contain Co-60 in approximately equal amount as the Cs-137.

3.5 RECORDS

Radiological records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project guidance. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

None

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite, and thus no revision bars are included.

3.8 OTHER

None

3.9 ATTACHMENTS

None

STARTUP OF THE RAPID ANALYSIS SYSTEM

4.0 PROCEDURE

4.1 Hardware Installation

4.1.1 Connect the digiBASE™ to the Model 3M#/3-X sodium iodide detector. Ensure that the pins and key slot align before pushing the units together.

NOTE

The digiBASE™ contains the preamplifier, amplifier, analog-to-digital converter, high-voltage power supply, and multichannel analyzer.

4.1.2 Mount the detector/digiBASE™ combination into the shield with the flat side on top and projecting approximately 3.5 inches into the interior of the shield. Ensure that the detector is fixed so that it does not readily move.

NOTE

Detector must be fixed to ensure constant geometry as samples are placed on and removed from the detector.

4.1.3 Connect the digiBASE™ connector labeled USB to the USB port on the computer using the cable provided.

NOTE

The ENABLE INPUT connection will not be used.

4.2 Software Installation

4.2.1 Begin installation of the ScintiVision-32 software by ensuring that the USB port on the computer is enabled. To do this, go to Windows Settings, Control Panel, Systems and click on the Hardware tab. On the Hardware tab, click on the Device Manager button. At the bottom of the list it should show that the “Universal Serial Bus controller” is present. If not, use the PC BIOS setup in accordance with the computer manufacturer’s instructions.

4.2.3 Insert the ScintiVision-32 CD-ROM.

4.2.4 If ScintiVision-32 does not autorun, use the computer’s Run command in the Start menu. The program is setup.exe.

4.2.5 Enter the User Name assigned to the project (i.e. “GSA Rapid Analysis”) and the Company Name as “Tetra Tech.” The serial number is “1”. Click Next.

4.2.6 Accept the defaults on the Choose Destination Location page. Click Next.

4.2.7 Choose Typical installation. Click Next.

4.2.8 On the Setup Type page, ensure that only the box for “USB (digiBASE™, digiDart, DSPEC Jr).” is checked Click Next.

4.2.9 On the Select Program Folder page, accept the default folder, “ScintiVisioin 32” and press Next.

4.2.10 On the Start Copying Files page, press Next.

4.2.11 When asked if you want to configure the detector, answer Yes.

4.2.12 Remove the ScintiVision-32 CD-ROM and store in a safe place.

4.2.13 When asked if you want to restart the computer, answer, “Yes, I want to restart my computer now.” and press Finish.

4.3 Detector Configuration

4.3.1 From the computer’s Start Menu (or the equivalent desktop icon), select Programs, ScintiVision 32, ScintiVision.

4.3.2 From the Acquire pull-down menu, select MCB Properties.

4.3.3 On the ADC tab, set the Gate to Off, Lower Level Disc to 50, Upper Level Disc to 1023.

NOTE

The digiBASE™ operates at a conversion gain of 1,024 only.

4.3.4 On the High Voltage tab, set the Target to 1,000 volts and turn voltage On.

4.3.5 On the Amplifier tab, set Fine Gain to 0.4960 and Shaping Time to 0.75, and press Close.

NOTE

With these settings, a spectrum derived from a source containing Cs-137 and Co-60 should have one lower energy peak (661.62 keV) near channel 300 and two higher energy peaks from Co-60 (1173 and 1332 keV).

4.3.6 Place the calibration standard on the detector and close the shield door.

4.3.7 Clear the detector/buffer with the Clear Detector/Buffer button.

4.3.8 Start acquisition with the Start Acquisition button (GO) and ensure that the Cs-137 peak becomes identifiable and well shaped.

4.3.9 Adjust the fine gain up or down to move the Cs-137 peak centroid to channel 331 by performing the following steps iteratively, as needed:

a. Press ALT SHIFT + to increase fine gain, moving the peak to the right.

b. Press ALT SHIFT – to decrease fine gain, moving the peak to the left.

c. Clear the spectrum with the Clear Detector/Buffer button after each adjustment

4.3.10. When the centroid of the Cs-137 peak is in channel 331, stop acquisition with the Stop Acquisition button (STOP).

4.3.11 Remove the calibration standard and store it in an appropriately posted location away from the detector.

4.4 Create Radionuclide Library

4.4.1 From within ScintiVision program, select the Library pull-down menu and choose Select File.

4.4.2 From the dialog box select the library Null.lib and press Open.

4.4.3 From the Library pull-down menu, select Edit, ScintiVision Editor.

4.4.4 Click the Windows icon on the title bar, select Show Master Library, select Lib0.lib, and press Open.

4.4.4 From the Master Library, double click Cs-137.

4.4.5 Highlight Cs-137 in the left side of the Editing dialog box and on the right side of the dialog box highlight the three low energy peaks and delete them by pressing Cut.

4.4.6 From the Master Library, double click Co-60

NOTE

Be sure to not overwrite the Null library.

4.4.7 Delete the Dummy entry by highlighting it and clicking Cut.

4.4.8 Click the Windows icon, select Save Library As, enter “Calibration Library.lib”, and press Save.

4.4.9 Exit the dialog box.

4.4.10 Repeat steps 4.4.1 through 4.4.5 and 4.4.7 through 4.4.9 and save this library containing only Cs-137 as the name assigned to the project ending in Analysis.lib (i.e. “GSA Analysis.lib).

4.5 Set Up Acquisition and Analysis Parameters

4.5.1 From the Acquire pull-down menu, choose Acquisition Settings.

NOTE

The file prefix should indicate which operable unit is currently being counted. For example “WP” could be chosen while working Warner’s Pond. When moving to the next operable unit, another prefix should be chosen and the file number restarted at 1.

4.5.2 In the Start/Save/Report section of the box, check Clear at Start and Auto-Increment with the Save File Number selected as 1. An appropriate File-Prefix should be selected.

4.5.3 In the Ask at Start Options section of the box, check Sample Type, Sample Description, and Sample Size. Leave Acquisition Presets and Collection unchecked. Leave the text boxes unchanged and press OK.

4.5.4 From the Analyze pull-down menu, select Settings, Sample Type.

4.5.5 On the Sample tab, provide the following inputs:

File: Soil Analysis; Press Save As then Save to save the file.

Description: Soil sample in 1L Marinelli

Decay Correction: no boxes checked

Analysis Range: From 260 to 400

Background Type: select the 5-pt radio button

Nuclide Library: Uncheck the Internal box, press Browse, select project library (i.e. GSA Analysis.lib), and press Open.

STARTUP OF THE RAPID ANALYSIS SYSTEM

NOTE

If the energy and efficiency calibration has not yet been performed (sections 4.6 and 4.7), skip the specification in the calibration file in the next substep.

Calibration: Uncheck the internal box and press Browse then select 1L Marinelli and press OK.

4.5.6 Press the Presets button and then on the Standard Presets tab set Live Time to 300. Press OK.

4.5.7 On the System tab, provide the following inputs:

Laboratory Name: Rapid Analysis

Operator: Tetra Tech

In the Library section: Match Width = 0.75; Fraction Limit = 0.0

In the Units section: Select the µCi radio button; Divisor = 1E-6; Activity = pCi; Size = 1 g

In the PEAK SEARCH SENSITIVITY section select the 3 radio button.

4.5.8 On the Report tab, provide the following inputs:

Reporting Options: check only the Nuclide Abundance box.

Uncertainty Reporting: select Percent and Total radio buttons

Confidence Level: select the 1-sigma radio button

Output: select the Printer radio button only and ensure the Display Analysis Results box is not checked.

4.5.9 On the Analysis tab, Analysis Method section, select the desire analysis (i.e. “GSA Analysis”) from the pull-down menu.

4.5.10 On the Analysis tab, Analysis section, enter the following inputs:

Decay Limit = 12

Ensure the Directed Fit box is not checked.

Ensure the Library-Based Peak Stripping box is not checked.

Maximum Unknown Peaks = 200 (default)

MDA Factor = 2.530

FWHM Variation % = 50

Linear Background: select the Auto radio button

Error Limits: select the Critical Level radio button

4.5.11 On the Corrections tab, leave both boxes unchecked.

4.5.12 Press OK.

4.5.13 Answer Yes to the Save inquiry.

4.5.14 Answer Yes to the Save with Detector inquiry.

4.5.15 From the Analyze Menu, select Settings, Sample Type, Press Browse, and select Soil Analysis.svd.

a. On the Sample tab change:

File to Calibration and Press Save As to save file.

Description to 1L Marinelli Calibration

Decay Correction – add check to Collection box and date from the calibration source certificate

Analysis Range: 260 to 720

Nuclide Library: Uncheck the Internal box, press Browse, select Calibration Library, and press Open.

Change preset Live Time to 300.

b. On the System tab, for the Units section select the µCi radio button; Divisor = 1; Activity = uCi; Size = 1 (no units).

c. Press OK and answer Yes to the two Save inquiries.

4.5.16 From the Analyze Menu, select Settings, Sample Type, Press Browse, and select Soil Analysis.svd.

a. On the Sample tab change:

File to Daily QC and press Save As to save the file.

Description to “Daily QC Check”

For the Decay Correction – add check to Collection box and date from the calibration source certificate

b. On the System tab, for the units section, select the Bq radio button; Mutiplier = 1; Activity = Bq; Size = 1 (no units).

c. Press OK and answer Yes to the two Save inquiries.

4.5.17 From the Analyze Menu, select Settings, Sample Type, Press Browse, and select Soil Analysis.svd.

a. On the Sample tab change:

File to Background and press Save As to save the file.

Description to Long Background

Analysis Range: 50 to 1023

Nuclide Library: Lib0.lib

Change preset Live Time to 1,200 seconds.

b. On the System tab, change Units = Bq; Multiplier = 1; Activity = Bq; Size = 1 cnt

c. Press OK and answer Yes to the two Save inquiries.

4.6 Calibrate Energy and FWHM

4.6.1 Ensure steps 4.1 through 4.5 have been completed.

NOTE

The calibration standard should be NIST traceable and contain, at a minimum, Co-60 and Cs-137.

4.6.2 Place calibration standard on detector.

4.6.3 From the Acquire pull-down menu, choose Start/Save/Report.

4.6.4 When prompted for Load Sample Type File, press Browse, select Calibration, and press OK.

4.6.5 When prompted for Sample Description, enter “1L Marinelli Calibration Standard” and press OK.

4.6.6 When prompted for Sample Size, enter 1 (no units) and press OK.

4.6.7 Examine the display to ensure that counts are acquiring and peaks are beginning to develop.

4.6.8 When the counting has finished, check the Identified Peak Summary on the printed report to ensure that the expected peaks for Cs-137 and Co-60 are present.

NOTE

ROI is Region of Interest. It can be set by dragging a “rubber rectangle” over the desired channels, pressing the right mouse button, and selecting Mark ROI. The ROI should include several background channels on either side of the peak.

4.6.14 Set an ROI in the Co-60 1173 keV peak.

4.6.9 From the Library pull-down menu, choose Select File, select the Calibration Library, and press OK.

4.6.10 From the Library pull-down menu, choose Select Peak.

4.6.11 From the Calibrate pull-down menu, choose Energy.

4.6.12 Select the Windows icon to the left of the word “Calibration” and then press “Destroy.”

4.6.13 When a popup entitled Initial FWHM Estimate Needed appears, press OK

4.6.15. Set an ROI in the Cs-137 keV peak and the Co-60 1332 keV peak. Be sure to leave one channel unselected in the region between the two Co-60 ROIs.

4.6.16 Place the cursor in the Cs-137 peak and highlight the 661.62 line in the Library List. Press Enter multiple times (approximately 2 – 3) until the channel number displayed stops changing or 4 times at most.

4.6.17 Place the cursor in the Co-60 1173 keV peak and highlight the equivalent line in the Library List. Press Enter multiple times (approximately 2 – 3) until the channel number displayed stops changing or 4 times at most.

4.6.18 Place the cursor in the Co-60 1332 keV peak and highlight the equivalent line in the Library List. Press Enter until the channel number displayed stops changing or 4 times at most.

4.6.19 Ensure that the Deltas are small (less than 10 percent) in the Energy Table. If not, repeat the calibration with expert help.

4.6.20 Select the FWHM radio button on the Calibration sidebar.

4.6.21 Ensure that the Deltas are small (less than 25 percent) in the FWHM Table. If not, contact RPO supervision.

4.6.22 Save the Calibration Table by pressing the Save button in the Calibration sidebar. Enter the project name followed by “Energy” (i.e. “GSA Energy”).

4.6.23 Close the Calibration sidebar by pressing “X”.

4.6.24 Save the Calibration to disk by selecting the Calibrate pull-down menu, then selecting “Save Calibration File.” Provide the name “1L Marinelli” and press Save for the calibration description, provide the standard certificate number.

4.7 Calibrate Efficiency

4.7.1 Ensure steps 4.1 through 4.6 have been performed.

NOTE

The efficiency calibration will use the same spectrum as acquired for the energy calibration.

4.7.2 From the Calibrate pull-down menu, choose Efficiency.

4.7.3 Select the Windows icon to the left of the word “Calibration” in the Calibration sidebar and then press “Destroy.”

4.7.4 From the Library pull-down menu, choose “Select File” and select the Calibration Library.lib file.

4.7.5 From the Library pull-down menu, choose “Select Peak.”

4.7.6 On the Library List box, double click the 662 keV Cs-137 peak and press the Calculate button on the Calibrate sidebar to open the Efficiency Calculation Worksheet.

4.7.7 On the worksheet, enter the date and time of the calibration standard certificate.

4.7.8 Enter the µCi in the standard for Cs-137, ensuring that the µCi units are selected.

4.7.9 Enter the uncertainty percent from the calibration standard certificate.

4.7.10 Ensure that the From Library box is checked.

4.7.11 Press Calculate Efficiency, then OK

4.7.12 Repeat steps 4.7.6 through 4.7.11 once for each of the two Co-60 peaks.

4.7.13 Select the Interpolative mode in the Calibration sidebar then Close the Calibration sidebar.

4.7.14 Save the Calibration to disk by selecting the Calibrate pull-down menu, then selecting “Save Calibration File.” Select the file “1L Marinelli” already named in the energy calibration and press Save.

4.7.15 Update the analysis settings from the Analyze pull-down menu and choosing Settings, Sample Type.

4.7.16 At the top of the Sample tab, press Browse, select the previously saved file Soil Analysis.svd and press Open.

4.7.17 In the Calibration section, uncheck the box Internal, press Browse, and select 1L Marinelli.cls. Press Open, then OK.

4.7.18 Repeat steps 4.7.15 through 4.7.17 once for each of the following analysis type files: Calibration.svd, Daily QC.svd, and Background.svd.

4.8 Perform a Long Background Count

NOTE

This count will take one-half hour to acquire.

4.8.1 From the Acquire pull-down menu of the ScintiVision-32 software, choose Start/Save Report.

4.8.2 In the Load Sample Type File box, press Browse and select Background.svd and press OK.

4.8.3 In the Sample Description box, enter “Long Background” and press OK.

4.8.4 In the Sample Size box enter “1 cnt” and press OK.

4.8.5 When the acquisition stops, collect the printout from the printer.

4.8.6 Look for peaks and attempt to understand their origin and mitigate their magnitude.

4.8.7 File the report in the counting room files.

TETRA TECH, INC

Procedure No: RP-OP-021 Rev 0

SAMPLE ANALYSIS USING THE RAPID ANALYSIS SYSTEM

1.0 PURPOSE

This procedure provides instructions for performing Rapid Analysis of soil samples using the NAI gamma spectrometer. It is only applicable to soil samples in 1 liter Marinelli beakers collected in accordance with the Sampling and Analysis Plan.

SCOPE

This procedure details sample receiving, analysis and disposition, and the required documentation to be used when analyzing and reporting soil samples. This procedure does not include the methods to be used in obtaining samples.

The following activities are described in Section 4.0 of this procedure:

4.1 Sample Receiving

4.2 Sample Analysis

4.3 Disposition of Samples

2.0 REFERENCES

10 CFR 20*, Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

Sampling and Analysis Plan (SAP)

ORTEC, ScintiVision™-32 for Windows® 95, 98, NT®, 2000, and XP® MCA Emulation and Analysis Software for Scintillation Detector Spectra, A35-B32, Advanced Measurements Technology, Oak Ridge Tennessee.

3.0 GENERAL

3.1 EQUIPMENT

- Gamma Spectroscopy System

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Comply with applicable Radiological Work Permit (RWP).

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for delegating performance of procedures to qualified personnel. Also responsible for arranging procedure training, monitoring implementation, ensuring "in-use" procedures are current, and taking corrective action as needed.:

3.3.2 RCTs are responsible for:

- Properly performing and documenting results of the radiological sample analysis in compliance with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological sample analysis and while handling sample media.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The individual performing this procedure must be trained in accordance with RP-OP-011, which includes instruction specific to this procedure.

3.4.2 All equipment used in this procedure must be installed and operable in accordance with RP-OP-021, Startup of the Rapid Analysis System.

3.4.3 The detector system shall have been checked for operability within the last 24 hours (or since last power-up, whichever is the shorter duration) in accordance with RP-OP-020, “Quality Control of the Rapid Analysis System.”

3.4.4 Ensure that the detector voltage is turned on prior to beginning any counting operations. From the Acquire pull-down menu, choose MCB Properties.

3.4.4.1 Select the High Voltage tab

3.4.4.2 Ensure that the voltage is turned on and reading 1000 volts.

3.5 RECORDS

Radiological records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project guidance. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

Handle all samples with appropriate radiological controls.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite and thus nor revision bars are included.

3.8 OTHER

None

3.9 ATTACHMENTS

Attachment 1 – Job Stream Description – Soil Analysis

4.0 PROCEDURE

4.1 Sample Receiving

NOTE

Samples shall not be allowed into the counting room until they have been decontaminated and exterior surfaces verified clean of removable radioactivity.

4.1.1 As samples are received, log them into an electronic logbook, recording sample number, sample date and time, and sample coordinates.

4.1.2 Obtain the net mass the sample on the analytical balance, recording the mass in grams in the electronic logbook and on the sample label.

4.1.3 Place the sample in the staging area awaiting analysis. The staging area shall be as far as possible from the detector. No more than 10 samples may be staged within the counting room.

NOTE

Dry storage for unprocessed, uncounted samples should be provided to ensure that the number of samples in the counting room awaiting analysis are as few as feasible.

4.2 Sample Analysis

4.2.1 Place the sample on the detector and close the shield door.

NOTE

At the direction of RPO supervision, steps 4.2.2 through 4.2.5 may alternatively be performed using a job stream provided in Attachment 1.

4.2.2 From the Acquire pull-down menu of the ScintiVision-32 software, choose Start/Save Report.

4.2.3 In the Load Sample Type File box, press Browse, select Soil Analysis, and press Open, then OK.

4.2.4 In the Sample Description box, enter “Soil Sample – [#]”, where [#] is the sample number and press OK.

4.2.5 In the Sample Size box enter the mass of the sample in grams and press OK.

4.2.6 When the acquisition stops, collect the printout from the printer.

4.2.7 Examine the printout for any irregularities.

4.2.8 Record the Cs-137 concentration in pCi per gram in the electronic logbook, verifying that the sample number of the printout matches the sample number in the logbook.

4.2.9 If the Cs-137 concentration exceeds limits stated in the SAP, notify RPO supervision immediately.

4.2.10 Remove the sample from the detector and place it in the staging are for completed analyses.

4.2.11 Sign the hardcopy analysis results and place in the supervisor’s inbox for review.

4.3. Disposition of Samples

4.3.1 Counted samples shall not be stored in the counting room, except that one-half day collection of samples may be staged in the counting room, as far as possible from the detector, until they can be removed for storage.

4.3.2 Counted samples shall be stored in an appropriate, dry location until the final operable unit analysis report is delivered or as directed by RPO Management. The storage area shall be radiologically posted in accordance with TtNUS RPOPs.

4.3.3 Samples shall be disposed in the same manner that soil from the collection point is disposed.

Job Stream Description – Soil Analysis

```
ask_confirm "Place the sample on the detector and close the shield door."
set_detector 1
stop
wait 1
clear
wait 1
start
wait 2
wait
save $(autofile)
analyze
wait 1
wait "[project name].exe"    (example “gsa.exe”)
wait 2
quit
```

ELECTRA PLUS / SELECTRA PLUS / ELECTRA GM PLUS RATEMETERS

1.0 PURPOSE

To provide instructions for operating the Electra Plus, portable rate meter with use of various GM and Scintillation probes for the measurement of Radioactive Contamination and Radiation.

To provide instructions for operating the Selectra Plus, portable rate meter with the Thermo range of 'intelligent' GM and Scintillation 'I' series probes for the measurement of Radioactive Contamination and Radiation.

The 'Plus' variants are to provide enhanced features such as data-logging, integration to a specified precision, sampler mode, peak hold, integrated dose and reset functions.

SCOPE

This procedure applies to all personnel qualified and required to operate the Electra / Selectra Plus rate meter for measurement of Radioactive Contamination and Radiation.

2.0 REFERENCES

10 CFR 20, *Standards for Protection against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

Electra/Selectra Plus Ratemeter Owners Manual (January 2004)

3.0 GENERAL

3.1 EQUIPMENT

- Portable Instrument Pre-Operational Response Check Sheet". A sample check sheet is shown in Attachment 1.
- Applicable portable survey instruments
- Alpha/Beta/Gamma check sources as applicable
- DO NOT USE TAG (RP-OP-012, Attachment 5)

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Comply with applicable Radiological Work Permit (RWP).

3.3 RESPONSIBILITIES

3.3.1 RPO supervision is responsible for assuring that users are qualified to perform this procedure. RPO supervision is also responsible for periodic review of documentation required by this procedure and for ensuring that completed response check sheets are reviewed and forwarded to Quality Assurance for filing.

3.3.2 RCTs are responsible for complying with this procedure and exercising appropriate techniques in the handling and storage of sources.

3.3.3 In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

3.4.1 The user of this procedure shall ensure that the instrument to be used is currently calibrated.

3.4.2 The user of this procedure shall ensure that the instrument is operated with the probe with which it was calibrated, as applicable.

3.4.3 The user of this procedure shall be knowledgeable in regards to the operation of each instrument he/she is using.

3.5 RECORDS

RPO survey records are generated during the implementation of this procedure. The original copy is the record copy for the Radiation Protection Program and is transmitted for processing to Quality Assurance Manager. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

3.6.1 Direct contact with the surface of a plated-source can damage or disturb the protective coating and distribution of the radioactive material.

3.6.2 Changes in background count rates may be the result of a damaged or contaminated detector.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite and thus nor revision bars are included.

3.8 TERMS/DEFINITIONS

Electra Plus	Portable count rate/integrate survey instrument capable of detecting both alpha and beta-gamma radiation.
Electra GM Plus	Portable count rate/integrate and dose rate survey instrument capable of detecting alpha and beta-gamma radiation and gamma dose rates.
DP68D/E	Alpha, Beta-gamma probe
kdpm	one thousand dpm

3.9 ATTACHMENTS

Attachment 1 – Electra Plus Source Response Check Form

Attachment 2 – Electra GM Plus Source Response Check Form

Attachment 3 – Initial Instrument Setup for the Electra With DP6DB Probe

4.0 PROCEDURE

4.1 Switch-On

The ON/OFF key is top left of the keys upon the front panel.

When the ELECTRA PLUS is switched ON the unit will perform a display test with all LCD segments lit. After a few seconds, when the unit has performed its self checks, the display will show 'Plus' and then revert to normal RATE monitoring mode in the units selected prior to switch off.

4.2 Internal Geiger/External Probe Toggle

Pressing the ▼ key twice within one second will cause the unit to toggle between internal and external probe operation. The display will show dashes for several seconds while the high voltage settles.

The unit may be used in internal Geiger mode with external probe attached.

CAUTION: Do not remove the external probe unless the unit is switched off.

4.3 Ratemeter Mode (RATE)

When this option is selected the display will show the units appropriate to the operational state set under the SET UP key. After switch ON, the unit will perform its self checks and after a few seconds will revert to normal RATE monitoring mode. After a second of monitoring in RATE mode, the ELECTRA PLUS/ELECTRA GM PLUS will display the rate, corrected for deadtime, in the units selected. It will continue to display rate with the value being updated at one second intervals.

4.4 Specifications

4.4.1 Performance

1) High Voltage

Nominal range 400V – 1400 V in 5 V steps

Absolute value + 2.5 V

Maximum load 66 MΩ + 10 µA @ 1400 V

40 µA @ 900 V

2) Charge Sensitivity

Lower threshold - 1.7 x 10^{-11} C (100 mV) + 1% (FIXED)

Upper threshold – 2.6 x 10^{-11} C to 5.1 x 10^{-10} C

(150 mV to 3.00 V in 50 mV steps)

Accuracy: + 1% or + 15 mV which ever is the least.

3) Overload Protection

Pre-settable overload protection is based on excess current from the High voltage supply.

Nominal range is 0.00 µA to 40.00 µA in 0.25 µA steps (range dependent on probe type).

4) Dead Time Correction

Pre-settable value is for dead time correction.

Range 0 µs (OFF) to 250 µs in 1 µs steps.

5) Response

a) Automatic Response Mode

1 second basic counting period, with averaging up to 16 seconds and thereafter a rolling average over 16 seconds is maintained for steady count rates and for count rates below 6 counts per second.

The response time will be less than 2 seconds for significant changes, i.e. > 3 sigma above 6 cps and 11 seconds to 63 % for lower rates and for smaller changes.

Reset

NOTE: The rolling average can be reset by pressing the ▼ key.

b) Preset Response Mode

1 second basic counting period, with averaging up to a pre-settable period of 1 to 25 seconds and thereafter a rolling average is maintained over this period and the display updated every second.

c) Integrate / (Sampler) Mode (By Time)

A separate integrate mode allows integration over a pre-settabe time period in the following range.

1	□□	10 s	in	1 s	steps
15	□□	30 s	in	5 s	steps
40	□□	5000 s	in	10 s	steps

(The same time intervals are used for pause times in Sampler mode).

d) Integrate / (Sampler) Mode by (Specified Precision)

Integration can be performed until the accumulated count provides 2 standard deviations (σ) to a specified precision (SP %). The range is 0.1 % to 20.0 % in 0.1 % steps to the following algorithm.

SP % = (100 x) 2 x √ N / N where N is the total accumulated count.

e) Peak Hold Mode

In this mode the display is updated as often as every second but only when the new value is greater than the previous maximum value encountered since this mode was set.

4.4.2 Alarm

Alarm level – pre-settable over defined ranges or OFF

NOTE: If DUAL probe is selected, Alarm levels are available individually for α, β, α + β key.

Ranges

a)	Count rate	cps	0.1	to	50,000	
		cpm	1	to	300,000	
b)	Contamination	Bq	0.1	to	50,000	
		Bq / cm²	0.1	to	50,000	
		Dpm	1	to	300,000	
c)	Dose rate	Sv/h	0.01 µSv/h	to	5 Sv/h	
		R/h	1 µR/h	to	500 R/h	
		Gy/h	0.01 µGy/h	to	5 Gy/h	
d)	Dose	Sv	0 µGy/h	to	5 Sv	
		R	0 µGy/h	to	500 R	
		Gy	0 µGy/h	to	5 Gy	

The full scale value may not be reached in all cases due to an Overload condition having been activated.

4.4.3 Audible Indicator

Single Channel operation: a click for each detected particle.

Dual Probe operation: clicks for each Beta, tone for each Alpha.

Alarm: Continuous tone at a frequency of 1.5 kHz.

4.4.4 Capacity

1. Sampler Mode

   1,000 integrations can be performed automatically with full integration and pause time ranges.

2. Data Logging

   500 readings may be stored.

   500 unique locations may be logged. (A location may be used for more than one logged readings).

   A location may be read from a barcode encoded with up to 16 characters.

3. Stored data:

Location, Channel 1 count rate / dose rate, Channel 2 count rate / dose rate, Units of measurement, operating mode, background subtraction status, Integrate value (time (s) / specified precision (%), time & date, probe type (intelligent probes only), suspect reading status. These readings can be extracted by the Plus Link programmed for further analysis and record keeping.

4.4.5 Display

Displayed Characters

The Liquid Crystal display provides analogue and digital indication of measurement result, unit of measurement and operational indicators.

4.4.6 Analogue

Analogue 3 decade logarithmic bar graph, with scale markers at:

1, 1.2, 1.4, 1.6, 1.8, 2, 3, 4, 5, 6, 7, 8, 9, and numerical indicators for 1, 2, 5 for each decade.

Bars are logarithmically spaced to match the scale marks and additional bars are provided for 2.25, 2.5, 3.5, and 4.5.

The bar will be black to the mark below the true value.

Resolution 20 % or better.

The display allows numerical ranges: 0.1-100, 1-1000 & 10-10,000.

The display will auto range and changes by one decade at each change, with change of units, if required.

4.4.7 Digital

4 digits with 3 decimal points show the measured rate to 3 significant digits. Actual displayed values on each of the ranges are limited by the changing and software but the display limits are 0.01 – 99.9, 0.1 – 999, 1.0 – 9990

4.4.8 Unit of Measurement

Count rate Monitoring	cps, cpm, kcps, kcpm.
Contamination Monitoring	Bq, dpm (disintegrations per minute), Bq / cm^2 with prefixes of k.
Radiation Measurement	R/h, Sv/h or Gy/h with prefixes of n, µ, m, and k.
Integrated Dose	R, Sv or Gy with prefixes of n, µ, m, and k.

The range and units displayed will be dependent on the probe used and are set by the SET UP parameters.

4.4.9 Voltage

Measurements are displayed, with the same numerical ranges as detailed above, on the digital scale in units of volts, with a step of 5 V for HV.

4.4.10 Operational Indicators

Sounder On	A sounder symbol is displayed.
Battery Low	A battery symbol is displayed when the battery voltage drops below a nominal 3.4 volts. Only 8 hours will be available once the symbol first appears.
Inhibit	An inhibit symbol is displayed if a parameter under the SET UP key is inhibited to the USER. The symbol appears in data log review (parameter r) if a reading is marked as suspect.
SET UP Parameter	A 7 segment indicator shows the SET UP parameter number, displays 'A' in alarm condition, 'o' during overload 'b' for background subtraction and 'P' for peak hold in normal operation. In GM mode, it switches between counts and Integrated Dose.
Display Illumination	A backlight is provided for the display which allows it to be read in low levels of illumination. The backlight stays on for 30 seconds after pressing the key. Three presses of the key in quick succession will enable the backlight to remain fully on indefinitely until the backlight key is pressed again.

4.4.11 Control

Operational keypad	Location	Top Panel
	Type	Pressure sensitive switches, embossed and tactile.
Key Marking	Function	
ON/OF	Toggles the Instrument On/Off.	
α, β, α + β	Selects the Alpha, Beta or Alpha+Beta particle count rate for display in the Dual mode only, (also shows individual channels in data log review (parameter r), alarm level(parameter l), response factor (parameter 9). In GM mode it switches between particle count rate and integrated dose.	
Sounder symbol	Toggles the sounder On/Off. Also selects data to be viewed	
	Location, time, date and reading number.	
Lamp symbol	Switches the Backlight On for 30 seconds or if pressed three times in quick succession will activate the backlight indefinitely until the key is pressed again.	
Rate Integ	Toggles the operational mode between Rate and Integrate.	
Set Up	Sets the instrument into the condition to view and adjust, if enabled, a number of parameters. These are shown in the table on the next page.	
Inhibit Symbol	Indicates to the USER that a parameter is inhibited under the SET UP key. Also used to log data, to mark a logged result as 'suspect in data	

	log review (parameter r) and to access serial mode when the unit is first switched on.
ENTER	Allows access and storage of the parameters under SET UP key. Allows storage and clearing of the value to be used for background subtraction.
▲	Allows the digitally controlled parameters to be incremented. Also allows scrolling up through the parameters under the SET UP key. Also allows Peak Hold mode to be set /cancelled (toggle).
▼	Allows the digitally controlled parameters to be decremented. Allows scrolling down through the parameters under the SET UP key. Causes reset of rolling average. Used (press twice) to switch between internal Geiger and external probe.

4.4.12 SET UP

Parameters that can be set, or viewed using the SET UP key are:

No.	Parameter	Digital Display	Unit
0	Battery voltage	battery volts	V
1	Alarm level (α, β, α + β)	Alarm count rate, contamination or dose rate or OFF	Cps or cpm or Bq or dpm or Bq/cm^2 or Sv/h, R/h or Gy/h
2	Stored background (α, β, α + β)	Background count rate or dose rate	Cps or cpm or Bq or dpm or Bq/cm^2 or Sv/h, R/h or Gy/h
3	High Voltage setting	HV setting	V
4	Overload current	Overload current	μA
5	Dead time	Dead time	μs
6	Upper Level	Threshold voltage	V
7	Integrate setting	Integrate time or precision	S or %
8	Units	Unit	Cps or cpm or Bq or dpm or Bq/cm^2 or Sv/h, R/h or Gy/h
9	Response factor	Use to change Units	
A	Inhibit background subtraction	On or off	
B	Integrate mode facility	Inhibit on, tome, precision	
C	Rate monitoring algorithm	PrES or Auto	
D	Preset response time	Response time	s
E	Pulse counting mode	Int or diff or dual	
F	GM or Scintillation (66	G 0r S66 or S120	

	MΩ chain or 120 MΩ chain)		
n	Auto switch – off	Off, 1-30	min
q	Sampler mode, # of samples	1 – 1000	
r	Data log review	View only	
t	Sampler pause time	Pause Time	S
u	Location by bar code	Bar code	
	Selectra Plus only:		
G	Probe type number		
H	Probe serial number		

4.5 Operation

4.5.1 Initial Instrument Setup Using the DP6BD Probe

The Electra attached to the DP6BD probe will respond to a range of -15% to +30% of the check source strength. To compensate for this, perform an initial setup using the following steps. Background subtract mode is not used in Initial Instrument Setup.

Note: This setup operation is not required for the Electra GM Plus internal Gieger Muller Detector, only the external DP6BD detector.

1. Place the DP6BD probe in an empty source jig.
2. Initiate a 60 second count. Repeat this 10 times and record each reading for alpha and beta on Attachment 3.
3. Average the 10 readings for both alpha and beta background and record.
4. Place the alpha check source in the jig and perform 10 one minute counts and record.
5. Average the 10 readings.
6. Repeat steps 4 and 5 using the beta source and record .
7. Subtract the average alpha background from the alpha source/background column and record.
8. Repeat step 7 for beta.
9. To establish the daily source response range, calculate +/- 20% of each of the values obtained in steps 7 and 8. Record these values on Attachment 3 and on Attachment 1 or 2 as applicable to the type of instrument used.

4.5.2 Initial Setup of the Electra GM Plus

1. When using the Electra GM Plus with the DP6BD probe, perform the same setup as stated in 5.5.1 using Attachment 2.
2. Turn the Electra GM Plus on and allow the instrument to perform the self check.

3. When the instrument enters the count rate mode, press the ▼ twice. After several seconds the screen will display the dose rate screen and will activate the internal GM detector.
4. To set up the GM detector, obtain the appropriate source and place the source on the + located on the top of the instrument case.
5. Initiate an integrated count for one minute. Record the dose rate on Attachment 2 under γ Instrument Response mR. Calculate and record the +/- 20% of this value and record in the appropriate boxes for gamma dose rates.

   Note: The Electra GM Plus can be operated as a dose rate only instrument without the DP6BD probe attached. Do not disconnect the DP6BD probe when the unit is on.

4.5.3 Daily QC Instrument Source Check

1. Perform preoperational inspections (physical damage, calibration.)
2. Press the ON/OFF button to start the instrument. The instrument will perform a display test with all LCD segments lit, perform a self check, then begin counting in the Alpha/Beta count rate mode.
3. Verify the battery symbol does not appear on the display. If battery symbol appears, replace with three new C cell batteries. Access to the battery compartment is through a cut out in the end cover below the handle.

   NOTE: When the battery symbol first appears by intermittent blinking, there is approximately eight hours of battery life remaining. The batteries must be changed when the battery symbol remains on.
4. Perform a QC source check by first initiating the background subtract function.
5. Place the detector probe over the appropriate radioactive source and begin a 60 second timed count using the integrate mode.
6. Verify the response is within the tolerance of +/- 20% of the expected response for each source. Record the responses on Attachment 1 for the Electra Plus or Attachment 2 for the Electra GM Plus.
7. If the instrument does not fall within the daily source response range, repeat steps 4 and 5 until two (2) consecutive QC source checks fall within the daily source response range. Up to four (4) additional QC checks may be performed for a total of five (5). If the instrument does not pass these QC source check, tag and place the instrument out of service, inform the RPO Supervisor and do not use.
8. For the Electra GM Plus, source check the GM detector as described in 5.5.2.
9. Return the scale selector switch to the OFF position when instrument is not in use.

4.5.4 Integrate Mode

1. Press the RATE/INTEG button to begin an integrated count. The instrument will beep and then begin the count for the preset time. The user can toggle between the Alpha,

Beta, and Alpha+Beta channels during and following the integrate count. When the integrate count is started, the bar graph on top of the display disappears to indicate to the user that the instrument is in the integrate mode.

2. To view and change the integrated preset time perform the following:

   a. Press the SET Up button

b. Press the ▲ button and toggle through the instrument settings until the number "7" appears in the lower left-hand corner of the display. The number shown is the integrate count time in seconds.

c. Press the ENTER button to change the integrate time; the number "7" will start blinking.

d. Press the ▲ or ▼ button to increase or decrease the integrate time (seconds) to the desired time.

e. Press the ENTER button to store the new integrate time; the number "7" will now stop blinking.

f. Press the SET UP button to return the instrument to normal operation.

4.5.5 Background Subtract

When the background subtraction option is used, values are stored for both alpha and beta channels. The stored background value is subtracted from the measurement value for each channel so that the net count is displayed on the meter for the RATE and INTEGRATE mode. For this reason, negative count values may appear on the display. The bar graph will disappear and the instrument will beep each time the value displayed is negative and beeps again when the value returns to positive.

NOTE: The background value subtracted is automatically the value detected at the time the background subtraction option is started. (e.g., if you are in a background of 5000 dpm, 5000 dpm will be subtracted as long as this option is used or until the value is changed by the user.

1. Press the enter button to store background values and start the subtraction option. This can be performed anytime in the RATE mode or following the completion of an INTERGATE count. The letter "b" will appear in the lower left corner of the display when the background subtraction option is used.

2. Press the ENTER button a second time to remove the background values and stop the background subtraction option.

4.5.6 Peak Hold

The Peak Hold option will maintain only the highest measurement on the display. The instrument beeps to alert the user each time a greater count rate is detected an automatically updates the display value.

1. Turn the instrument on an begin counting in the RATE mode.

2. Press the ▲button to begin the Peak Hold option. The letter "P" will appear in the lower left-hand corner of the display.

3. Press the ▼button to reset the Peak Hold mode. This essentially zeros the instrument and allows the user to begin a new peak search. When the background subtraction option is in use (i.e., “b” is displayed in the lower left hand corner) and the Peak Hold option is started; the “P” appears in he same location and then alternates with the “b” to indicate both options are in use. The displayed value is the highest background corrected count rate.
4. Press the ▲button to return to the RATE mode.

4.5.7 Alarm Operation

The alarm condition will be entered if the mean count rate displayed is above the preset values. The alarm condition is indicated by a continuous, high pitched, tone from the speaker and with the letter ‘A’ being displayed in the bottom left of the display. The alarm is not operative in the integrate mode.

1. The alarm level setting may be viewed or altered by the operator by selecting Parameter 1 under the SET UP key.
2. When in dual probe operation the separate alarm levels for Alpha and Beta are displayed by pressing the α, β, α + β key then using the ▲▼ keys to change the values.
3. The alarm sound can be muted by pressing the sounder key, but the displayed ‘A’ remains as an indication of the alarm condition.
4. If an alarm level is exceeded in either the α or β channel, the relevant α or β symbol will flash
5. If background subtraction is being used, the subtracted rate is compared with the alarm levels.
6. For personnel frisking, set alarms at 200 dpm alpha and 1000 dpm beta, greater than background.

Electra Plus Source Response Check Form

Project	Area	Month	Year

Instrument Type	Insrument ID #	Probe Type	Probe ID #	Cal Date	Cal Due Date
Electra Plus					

α Source Type	α Source ID #	α Source Assay Date	α Source Assay Activity	α Source Decay Date	α Source Decay Activity
Bγ Source Type	Bγ Source ID #	Bγ Source Assay Date	Bγ Source Assay Activity	Bγ Source Decay Date	Bγ Source Decay Activity

5% α Source Decayed Activity dpm	15% α Source Decayed Activity dpm	Initial α Instrument Response dpm	□20% Initial α Instrument Response dpm	+20% Initial α Instrument Response dpm
5% Bγ Source Decayed Activity dpm	15% Bγ Source Decayed Activity dpm	Initial Bγ Instrument Response dpm	□20% Initial Bγ Instrument Response dpm	+20% Initial Bγ Instrument Response dpm

Performed by:	Sign:	Date:

Date	Time	Phy ✓ Sat/Un	Bat✓ Sat/Un	HV✓ Sat/Un	α Source Response	Sat/Un	Bγ Source Response	Sat/Un	Comments	Initials

Reviewed By	Sign	Date	Page____of____

Electra GM Plus Source Response Check Form

Project	Area	Month	Year

Instrument Type	Insrument ID #	Probe Type	Probe ID #	Cal Date	Cal Due Date
Electra GM Plus					

α Source Type	α Source ID #	α Source Assay Date	α Source Assay Activity	α Source Decay Date	α Source Decay Activity
Bγ Source Type	Bγ Source ID #	Bγ Source Assay Date	Bγ Source Assay Activity	Bγ Source Decay Date	Bγ Source Decay Activity
γ Source Type	γ Source ID #	γ Source Assay Date	γ Source Assay Activity	γ Source Decay Date	γ Source Decay Activity

5% α Source Decayed Activity dpm	15% α Source Decayed Activity dpm	Initial α Instrument Response dpm	□20% Initial α Instrument Response dpm	+20% Initial α Instrument Response dpm
5% Bγ Source Decayed Activity dpm	15% Bγ Source Decayed Activity dpm	Initial Bγ Instrument Response dpm	□20% Initial Bγ Instrument Response dpm	+20% Initial Bγ Instrument Response dpm
5% γ Source Decayed Activity dpm	15% γ Source Decayed Activity dpm	Initial γ Instrument Response dpm	□20% Initial γ Instrument Response dpm	+20% Initial γ Instrument Response dpm

Performed by:	Sign:	Date:

Date	Time	Phy ✓ Sat/Un	Bat✓ Sat/Un	HV✓ Sat/Un	α Source Response	Sat/Un	Bγ Source Response	Sat/Un	γ Source Response	Sat/Un	Initials

Reviewed By	Sign	Date	Page____of____

Initial Instrument Setup for the Electra With DP6DB Probe

Instrument Type	Insrument ID #	Probe Type	Probe ID #	Cal Date	Cal Due Date

α Source Type	α Source ID #	α Source Assay Date	α Source Assay Activity	α Source Decay Date	α Source Decay Activity
Bγ Source Type	**Bγ Source ID #**	**Bγ Source Assay Date**	**Bγ Source Assay Activity**	**Bγ Source Decay Date**	**Bγ Source Decay Activity**

Initial α Background dpm	Initial Bγ Background dpm	α Source + Background dpm	Bγ Source + Background dpm

Average Initial α Background dpm	Average Initial Bγ Background dpm	Average α Source + Background dpm	Average Bγ Source + Background dpm

Average α Instrument Response dpm	□20% Initial α Instrument Response dpm	+20% Initial α Instrument Response dpm	Average Bγ Instrument Response dpm	□20% Initial Bγ Instrument Response dpm	+20% Initial Bγ Instrument Response dpm

Average α or Bγ Instrument Response dpm = (α or Bγ Source + Background dpm) - (Initial α or Bγ Background dpm)

THERMO EBERLINE HANDECOUNT SYSTEM

1.0 PURPOSE

To provide instructions for operating and performing daily quality control checks on the Thermo Eberline HandECount Dual Scintillation Counting System.

SCOPE

This procedure applies to the in field use of the HandECount in the “Simple” or “Normal” operational modes and does not apply to the use of this system in the “Administrative” operational mode.

This is a reference procedure. The user is not required to have this procedure present while performing the activity.

The following activities are described in Section 4.0 of this procedure:

4.1 System Description

4.2 System Start-Up (Connecting Power and Activating System)

4.3 Sample Counting

4.4 Background Updates

4.5 QC Source Check Verifications

4.6 Setup Menu Access

4.7 Updating QC Check Source Data

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

TtNUS Radiation Protection Plan (RPP)

TtNUS Radiation Protection Operations Procedures (RPOP)

Vendor Technical Manual, Thermo Eberline HandECount Technical Manual

3.0 GENERAL

3.1 EQUIPMENT

- HandECount instrument(s)
- Universal AC power supply
- PDA stylus
- HandECount designated QC Check Sources
- Planchets.

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Comply with applicable Radiological Work Permit (RWP).

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Delegating performance of procedures to qualified personnel. Also responsible for arranging procedure training, monitoring implementation, ensuring "in-use" procedures are current, and taking corrective action as needed.
- Responsible for reviewing background, Quality Control (QC) Source Check, and analysis data from the HandECount system.

3.3.2 RCTs are responsible for:

- Properly performing and documenting results of the radiological sample analysis in compliance with this procedure.
- Responsible for performing background updates, QC Source Checks and analysis of sample media using the proper procedures and recording data on proper documentation.
- Exercising appropriate contamination control techniques in the performance of radiological sample analysis and while handling sample media.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

None

3.5 RECORDS

Radiological records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project guidance. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

Although the HandECount is designed for portability, there are limitations that must be adhered to when using the HandECount.

- If a background update is being performed on the HandECount and the count is interrupted, either on purpose, accidentally, or due to low battery power, the HandECount can not be used to count samples. Interruption of the background update function can lead to incorrect sample results. Any interrupted background update must be started again and allowed to run until complete.
- Any time a unit is moved to a new location, a background update must be performed and verified to be within operational limits.

- The eight-hour internal battery can provide full operational power when needed, but use of available AC power should be used to preserve internal power when present.
- The HandECount is not to be used in a location where the potential for the unit getting wet is high.
- Abnormal environmental conditions can affect the operational capabilities of the HandECount.
- The PDA contained within the HandECount System is to be used for operation of the HandECount System only. Any attempt to access the PDA operational program(s) for any other purpose is prohibited.
- The HandECount PDA stores each designated function performed by the system and the results. Be aware that any qualified personnel can verify the function was performed and review these results.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite and thus no revision bars are included.

3.8 OTHER

TERMS/DEFINITIONS

Administrative Mode	The operating mode that allows full setup and calibration access to the multiple applications establishing the true operational parameters by which the system is to operate. Used during calibration and repairs.
Application Buttons	The four buttons across the bottom of the PDA that have been programmed to bring up specific screens while running the HandECount application.
Command Buttons	Commands identified on the PDA touch screen. A box with rounded corners always surrounds them. Tapping the Command Button on the touch screen with your finger or the stylus will initiate the command.
Field Input	Blank fields that are indicated by dotted horizontal lines and are used to input user defined variables.
Master Password	A password that allows a user to access all functions of the application, including calibration.
Menu	Listing of available applications that are accessible.
Normal Mode	The operating mode which allows the user full setup access to the multiple applications available with the HandECount system.
PDA	Personal Digital Assistant (handheld computer). The PDA is contained inside the HandECount and is not removable.
Setup Password	The password that allows the user access to the Setup Menu.

Simple Mode	The single screen operating mode which restricts access to critical operational settings and calibration.
Touch Screen	The screen of the PDA computer system equipped with touch control command buttons which are used to maneuver through the various screens and commands. Commands are initiated with the use of fingertips or supplied stylus (use of ink pens is prohibited).
User Selections	Popup Menus as noted by upside down triangles that present users with multiple selection criteria.

3.9 ATTACHMENTS

Attachment 1 HandECount Background/Quality Control Check Log

4.0 PROCEDURE

4.1 System Description

The Thermo Eberline Model HandECount is a sample counting system that provides simultaneous alpha and beta measurements. This system is controlled by a PDA type PC computer platform and operating system, which communicates with Thermo Eberline's standard modular detector board to perform all counting operations. The PDA computer's built-in informative color screen, intuitive controls, internal clock and powerful database capabilities provide numerous cost-effective advantages over custom built systems.

The HandECount system incorporates a 2-inch diameter dual phosphor scintillator coupled to a sliding drawer mechanism accommodating a 2-inch diameter (50.8 mm) sample. The drawer uses a height adjustable sampling area to permit use with different sample types. To successfully initiate the counting process, the sample drawer must be inserted completely back so it makes contact with the power switch. The enclosure is made from very durable plastic, which will withstand rough handling. The built-in handle in combination with the battery option facilitates portability for field use up to eight hours between battery charges.

All measurements automatically subtract the stored background value, apply crossover corrections and the appropriate efficiency before calculating the final result based upon the unit of measurement pre-selected.

All measurement results are automatically stored in a database. In addition to the measurement results database, the HandECount also supports a database comprising all the background update and QC source check results to support quality control. A radiation source library references all radiation sources employed for checking and calibrating the instrument. All source activities are automatically decay-corrected to simplify and maintain accuracy in these functions. Password controls prevent access to any editing and calibration functions. All calibration results are stored in a calibration reporting database for review on the PDA or for later retrieval by a PC.

4.2 System Start Up (Connecting Power and Activating System)

The primary means for powering the HandECount instrument is via the AC power adaptor supplied with the unit. This power supply is universal to accommodate a wide range of voltages.

1. Before plugging the adaptor into the wall, INSERT the male connection to the female receptacle on the back of the instrument as indicated by the Power label. Then PROCEED with plugging the adaptor into the power source.

   The PDA has a single USB or RS232 serial line capable of communicating to one device at any given time. As such, the PDA needs to be switched between communications to the internal detector and electronics for “Normal” counting operation or to an external “PC” whenever stored data is to be exported.

2. To ensure normal counting operations, VERIFY that the communication switch on the back of the instrument is in the “Normal” communications setting. The switch should be depressed or flat against the case under the Normal label. The HandECount instrument requires two switches to be activated to initiate proper operation of the instrument. This is due to the fact that the PDA utilizes its own power switch that acts totally independent of the instrument itself.

3. To properly turn on the HandECount:

   a. ACTIVATE the main power switch located at the top of the instrument. With the switch activated, a green LED will shine at the top right hand side of the front panel (which is also the power button).

   b. TURN on the PDA via its power button. The PDA uses a button located on the right-hand side of the front panel.

   NOTE 1: It is possible to activate the PDA only and have the appearance that the unit is fully operational. When activated in this manner, only the PDA is powered, but not the counting electronics. No counting or normal operation will exist under these conditions.

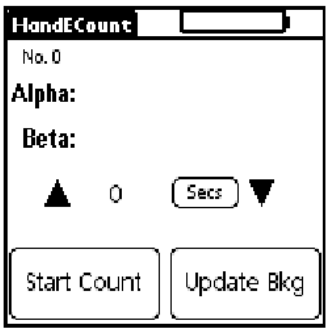
   NOTE 2: It is necessary to always turn both switches on for the HandECount instrument to function properly.

CAUTION

Never use your pencil, pen or any other hard object when making selections on the PDA screen as this will scratch the surface.

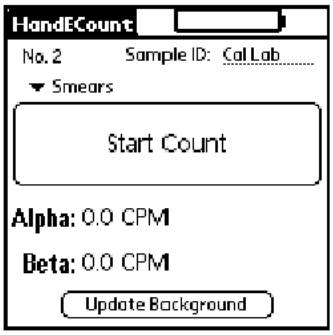
In the event the HandECount application has been exited, it may be reinitiated by using the supplied stylus. A stylus pocket is provided at the top rear area of the instrument for convenient storage anytime this tool is not in use. With the stylus in hand, TAP the HandECount application icon on the screen to launch the operating program.

The HandECount application should now be active and display the following:



"Simple Mode"

or



"Normal Mode"

NOTE: In the upper right corner of the sample counting screen is a battery icon. The interior of the icon is a bar graph that gives the status of the palm's internal battery. When the bar graph fills the interior of the icon with a blue color, then the backup battery is fully charged or external power is present. When the bar graph is green, then the percentage of power remaining in the palm unit's internal battery can be inferred from the portion of the bar graph that fills the icons interior. If the bar graph turns red, unit use should be immediately stopped and external power applied in order to charge the palm's internal battery.

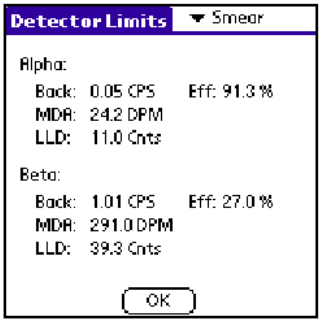
4.3 Sample Counting

4.3.1 Determine Sample Count Time

4.3.1.1 Smears

Count time needed for smear samples, as with other sample media, is based on the required Minimum Detectable Activity (MDA) necessary for the analysis of the media. The HandECount system provides the calculation of the MDA value for the system in use based on the count time selected and displayed on the "detector limits" screen. This screen is accessed through the "View" dropdown menu on the "Detector Limits" function. To verify the count time chosen will provide the required MDA values (based on present MDA values) for smears, PERFORM the following:

1. SET the count time on the "simple mode" count screen on 1 minute.
2. SELECT the "View" dropdown menu and TAP on the "Detector Limits" function.



3. If the MDA values are < 20 dpm for alpha and < 200 dpm for beta, then smears can be counted for the 1 minute count time.
4. IF the MDA level for alpha is ≥ 20 dpm and or ≥ 200 dpm for beta, THEN INCREASE the count time setting on the "simple mode" count screen (normally to 2 minutes) until MDA values shown on the "detector limits" screen are less than 20 dpm alpha and 200 dpm beta.

   NOTE: The HandECount operating system has been upgraded to provide an updated MDA value for any count time entry made during use of the "simple mode" operation.

5. IF the MDA level for alpha is ≥ 20 dpm and/or ≥ 200 dpm for beta, THEN COUNT smears for 2 minutes.

   NOTE: Changing the count time used in the “simple mode” will not change the MDA value given in the “detector limits” function. The MDA calculation is based on the count time established in the setup “smear” basic setting which is 1minute.

4.3.1.2 Q-tips, Soil, or Liquid

A count time of 10 minutes for Q-tips, soil samples, or liquid samples will have MDAs of <10 dpm alpha and < 100 dpm beta on the HandECount based on operational limits used by the system.

4.3.1.3 Air Sample Count Times for the HandECount

Air samples are typically counted for 20 minutes. Using the Air Sample Calculation spreadsheet, verify that the Minimum Detectable Concentration (MDC) for the given counting situation is capable of seeing 0.1 DAC. If 0.1 DAC can not be seen, consult RPO supervision to determine adequate count times.

4.3.2 Sample Counting in the “Simple Mode”

1. VERIFY HandECount system to be used is within required calibration cycle by locating the RME Calibration label on the instrument and observing the calibration date.

   IF the instrument is not within calibration, do not proceed, THEN

CONTACT RPO Supervision so that calibration may be completed or a replacement obtained.

2. VERIFY required Background Update and QC Source Check has been performed.

   IF Background Update has not been performed, THEN

   PROCEED to Section 4.4.

   IF QC Source Check has not been performed, THEN

   PROCEED to Section 4.5.

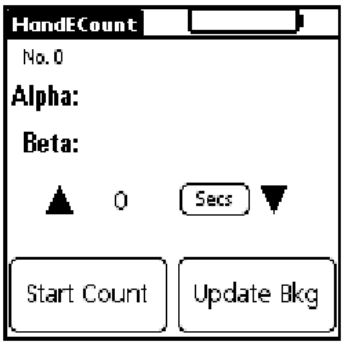
3. LOAD sample media (smears, Q-tips, air filters, etc.) into appropriate planchet.

   NOTE: Smears shall be removed from any backing material prior to placement in planchet. Verify that sample media is not elevated above the lip of planchet.

4. PULL HandECount sliding drawer open to expose sample holder.

5. PLACE loaded planchet into sample holder and PUSH sliding drawer completely in.

6. VERIFY Count screen is present on the HandECount. PERFORM as instructed in Section 4.3.1.



7. VERIFY necessary count time is identified on Count screen.

   IF count time needs to be changed, THEN

   TAP the “up arrow” to increase count time or the “down arrow” to reduce count time (one minute count minimum). Count time is set in minute units.

8. INITIATE count by tapping “Start Count” command.

   NOTE: The system is programmed to verify that the background and QC Check have been updated every 24 hours. If not, the HandECount will show a notice to complete these checks prior to completing a sample count.

9. When count is completed, PULL sliding drawer out and REMOVE planchet.

10. REMOVE sample media from planchet and PLACE in proper location.

11. RECORD sample results on proper documentation.

4.3.3 Sample Counting in the "Normal Mode"

1. VERIFY HandECount system to be used is within required calibration cycle by locating the RME Calibration label and observing the calibration date.

   IF the instrument is not within calibration, do not proceed, THEN

   CONTACT RPO supervision so that calibration may be completed or a replacement obtained.

2. VERIFY required Background Update and Daily QC Source Check have been performed.

   IF Background Update has not been performed, THEN

   PERFORM as instructed in Section 4.4.

   IF QC Source Check has not been performed, THEN

   PERFORM as instructed in Section 4.5.

3. VERIFY proper count time for sample media. PERFORM as instructed in Section 4.3.1.

   IF count time needs to be changed, THEN

   BRING UP the Setup menu, AND

   TAP the "Smear" function, AND

   SELECT the "Count Time" field, AND

   INCREASE, OR

   REDUCE count time as necessary. Count time is set in minute units.

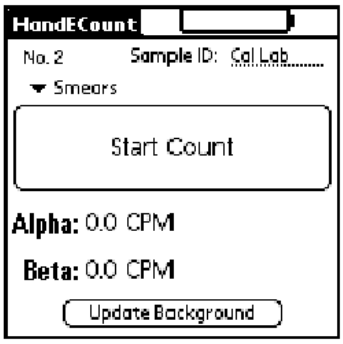
4. LOAD sample media (smears, Q-Tips, air filter, etc.) into appropriate planchet.

   NOTE: Smears shall be removed from any backing material prior to placement in planchet. Verify that sample media is not elevated above the lip of planchet.

5. PULL HandECount sliding drawer open to expose sample holder.

6. PLACE loaded planchet into the sample holder and PUSH sliding drawer completely in.

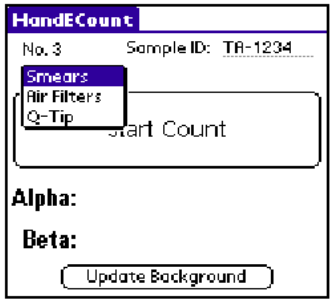
7. VERIFY Count screen is present on the HandECount.



8. VERIFY proper media type (smears, air filters, or Q-tips) is identified on Count screen.

   IF proper media type is not displayed on screen, THEN

   SELECT the proper media type from the popup, using stylus.



9. ENTER appropriate media sample ID on user selection, if needed.
10. INITIATE count by tapping “Start Count” command.
11. When count is completed, PULL sliding drawer out and REMOVE planchet.
12. REMOVE sample media from planchet and PLACE in proper location.
13. RECORD sample results on proper documentation.

4.4 Background Updates

The updating of background levels is required at least every 24 hours. The system screen will post a notification and can not count a sample until this update requirement has been performed. Background updates are also required when the location of operation or radiological conditions of the area have significantly changed.

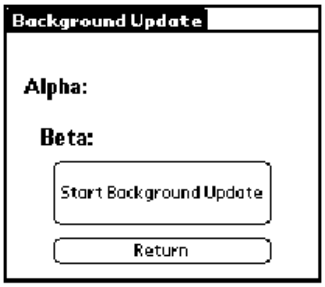
!WARNING!

A background update must be run until it is completed. Any interruption of the background update (e.g., open drawer, low battery, manually stopped) will lead to incorrect sample results. If background update is interrupted, the update must be started again and allowed to run until complete.

1. VERIFY HandECount system to be used is within required calibration cycle by locating the RME Calibration label and observing the calibration date.

   IF the instrument is not within calibration, do not proceed, THEN

   CONTACT RPO supervision so that calibration may be completed or a replacement obtained.
2. RECORD required information on ATTACHMENT 1.
3. PULL HandECount sliding drawer open to expose sample holder.
4. PLACE a clean empty planchet into the sample holder and PUSH sliding drawer completely in.
5. VERIFY Background Update screen is present on the HandECount.



6. INITIATE Background Update by tapping “Start Background Update” command button.
7. When count is completed, PULL sliding drawer out and REMOVE planchet.
8. PUSH sliding drawer back all the way and PLACE planchet in proper location.
9. VERIFY background results are within required range.

   IF not within required range, THEN

   DECONTAMINATE the sample tray, OR

   MOVE counter system to lower background area, AND

   RECOUNT background.

NOTE: Background results with the HandECount are given in “cpm” or “cps” (cps x 60 = cpm). To easier relate these units, the following equivalents are given for reference.	
Alpha	Beta
0.01 cps = 0.6 cpm	0.5 cps = 30 cpm
0.02 cps = 1.2 cpm	1.0 cps = 60 cpm
0.03 cps = 1.8 cpm	1.5 cps = 90 cpm
0.04 cps = 2.4 cpm	2.0 cps = 120 cpm
0.05 cps = 3.0 cpm – (Max Bkg)	2.5 cps = 150 cpm – (Max Bkg)

10. RECORD background results on ATTACHMENT 1.
11. TAP “Return” command button on screen or first application button at bottom of PDA to return to Sample Count screen.

4.5 QC Source Check Verification

QC Source Check verification is required at least every 24 hours. The system screen will post a notification and can not count a sample until this update requirement has been performed. Be aware that the system notification only requires a source check to be performed. The results of

the source check will not prevent the system from counting samples once a QC Source Check is completed even if the results were “Failed (F)”.

1. VERIFY HandECount system to be used is within required calibration cycle by locating the RME Calibration label on the instrument and observing the calibration date. VERIFY Background Update has been performed

   IF the instrument is not within calibration, do not proceed, THEN

   CONTACT RPO supervision so that calibration may be completed or a replacement obtained.

   IF Background Update has not been performed, THEN

   PERFORM as instructed in Section 4.4.
2. PULL HandECount sliding drawer open to expose sample holder.
3. OBTAIN appropriate alpha and beta sources.
4. PLACE source into sample holder and PUSH sliding drawer completely in.
5. VERIFY “Run Check Src” screen is present on HandECount.
6. SELECT proper QC check source ID number from pull down source library menu to match source being counted.

7. INITIATE the source check via the “Start Count” command button.
8. VERIFY the response is identified as “Passed (P)”, upon completion of count cycle. RECORD each “Passed (P)” or “Failed (F)” result on ATTACHMENT 1. The HandECount will store every QC count performed in memory. ENSURE that each QC check performed is recorded on ATTACHMENT 1.
9. IF response has been identified as “Failed (F)”, THEN

   PERFORM the following checks:

   a. VERIFY background update has been performed and background results are within required range.

      IF not, THEN

      DECONTAMINATE the sample tray, OR

MOVE counter system to lower background area.

b. REMOVE check source from sample tray and VERIFY check source ID identified on source library menu matches the check source ID on the source placed in the sample tray.

IF not, THEN

SELECT proper source ID from source library menu.

10. PLACE source back into sample holder and PUSH sliding drawer completely in.
11. RERUN the source check via the “Start Count” command button.
12. IF response is identified as “Passed (P)”, THEN

PUSH “Start Count” command button to acquire a third count.

NOTE: A “Failed (F)” result on the first attempt will result in three count entries on ATTACHMENT 1 in order to pass.

13. IF a second “Passed (P)” response is obtained, THEN

REMOVE source planchet, AND

RECORD results, AND

RETURN to Count screen.

14. IF second or third response is identified as “Failed (F)”, THEN

REMOVE source planchet, AND

RECORD results on ATTACHMENT 1, AND

TAG instrument out of service, AND

CONTACT RPO supervision for technical assistance.

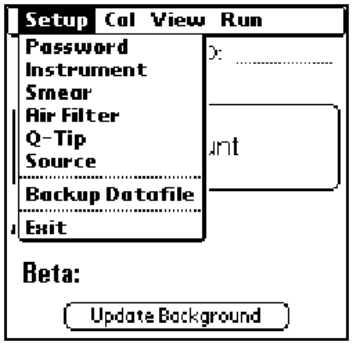
4.6 Setup Menu Access

Upon receipt, the HandECount is preset in the “Simple” operating mode. Access to the Setup menu or use of a password is not required to perform sample counting, background updates, daily source checks or to view data logs in this mode.

Access into the Setup menu is needed to access instrument settings, calibration routines, and viewing of stored calibration and QC records. The need to access the Setup menu could be to:

- Change operating mode (Simple to Normal)
- View Next Calibration Date (determined by cycle above and last calibration)
- Change audible beep setting (on, off)
- Change Display Error setting (on, off)
- Change “Normal” operation mode smear settings
- Change “Normal” operation mode air filter settings

- Change “Normal” operation mode Q-tip settings
- Access Source Library to perform an update to a Check Source measured efficiency, view or edit source data, or add a new QC Check Source to library.
- View stored data such as Calibration logs, Background logs, Check Source logs, or Detector Limits (MDAs).



In order to access the Setup menu, TAP the HandECount logo in upper left of screen to display the four menus or PRESS the “dropdown logo” button on the PDA.

Access to “Setup” applications will require use of the Setup password. Access to “Cal” applications requires use of the Master password.

The password for the Setup menu is “1”. This password can be entered in the required blank field using the PDA number entry screen or by use of the graffiti screen.

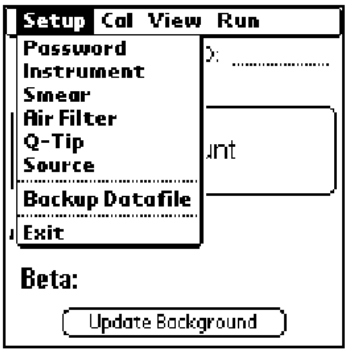
The user may logoff anytime or the password will automatically time out after 30 minutes.

4.7 Updating QC Check Source Data

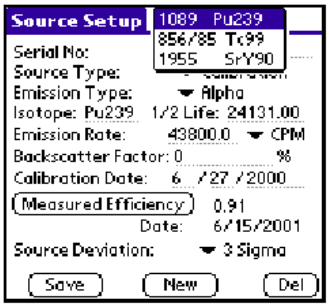
4.7.1 Performing Measured Efficiency Update of Check Source

When a HandECount is received by a facility after calibration, repair, or maintenance, QC Source efficiency must be updated for each of the HandECount check sources used in the facility and “Section A” of a new ATTACHMENT 1 completed.

1. PERFORM a background update to the system prior to performing an update of the QC Check Source efficiency.
2. ACCESS the Setup menu and OPEN the Source Library (entry will require using the Setup password).



3. VERIFY the Source Library has the appropriate QC Check Sources for the unit listed.



4. CHOOSE the appropriate check source from the pull down menu of the Source Library using the stylus.

   IF the needed check source is not listed in the pull down menu, THEN

   GO to Section 4.7.2, it must be added to the Source Library.

5. PULL HandECount sliding drawer open to expose sample holder.
6. OBTAIN appropriate alpha and beta sources.
7. PLACE source into sample holder and PUSH sliding drawer completely in.
8. VERIFY the proper check source ID number from pull down Source Library menu to match source being counted is present on HandECount.
9. TAP the “Measured Efficiency” control button to begin the update.
10. ENTER the date and initials of RCT who performed update into “Section A” of a new ATTACHMENT 1 form. Once the new efficiency and a new date appears,

    ENTER required data on ATTACHMENT 1.

11. COMPLETE Steps 6 through 12 for each appropriate QC check source.
12. RETURN to Count screen.

4.7.2 Addition of New Check Source into Library

1. PERFORM a background update to the system prior to entering a source into the QC Check Source library.
2. ACCESS the Setup menu and OPEN the Source Library (entry will require using the Setup password).
3. VERIFY the source to be added is not already listed in the Source Library.
4. TAP the “New” command button on the Source Library screen.
5. Using source data sheet supplied with the check source, ENTER the new source serial number exactly as given on the data sheet.

   NOTE: The source data sheet supplied with the check source is designed to look just like the screen you will be entering data into. All data is entered exactly as given on the data sheet.
6. USING the Source Type User Selection, SELECT the “CHECK” source identifier.
7. USING the Emission Type User Selection, SELECT the “Alpha” or “Beta” emission identifier depending on isotope.
8. Next to Isotope, ENTER the identifier given on data sheet.
9. ENTER the ½ Life (years) given on the data sheet.
10. ENTER the Emission Rate and unit value (cpm, cps, etc.) as given on the data sheet.
11. ENTER a “0” value next to the Backscatter Factor %.
12. ENTER the Calibration date as given on the data sheet.
13. With the Source Deviation user selection, SELECT the “3 sigma” identifier.
14. REVIEW all source data and VERIFY all data from the source data sheet is entered.
15. PULL HandECount sliding drawer open to expose sample holder.
16. OBTAIN the appropriate alpha and beta sources.
17. PLACE source planchet into sample holder and PUSH sliding drawer completely in.
18. VERIFY the proper check source ID number from pull down Source Library menu to match source being counted is present on HandECount.
19. TAP the “Measured Efficiency” control button to begin the update.
20. ENTER the date and initials of RCT who performed update into “Section A” of a new ATTACHMENT 1 form and RECORD all necessary data. Once the new efficiency and a new date appear, ENTER required data on ATTACHMENT 1.
21. COMPLETE Steps 1 through 21 for each QC check source to be added to library.
22. TAP the “Save” button.

    NOTE: If the measured efficiency has not been completed, the HandECount will display a notice and ask if you desire to exit without running efficiency.

HandECount Background/Quality Control Check Log

Page ____ of ____

Section A – Location, System, Background and Source Information					
Location:	ID:	Cal. Date	Cal. Due:		
α Check Source ID	Measured Efficiency Updated Date Initials:	β Check Source ID	Measured Efficiency Updated Date Initials:	α Max Bkgd ≤ 0.05 cps or 3 cpm	β Max Bkgd ≤ 2.5 cps or 150 cpm

Section B – Daily Data

Date	Time	Location	Bkgd - Limit		QC Check (P/F)		Comments	Initials
			α	β	α	β		

Reviewed By:	Date:

Radiological Sampling

1.0 PURPOSE

To provide comprehensive guidance for performing swipe sampling and sampling of various types of media including soil, sediment, solid material (such as concrete, brick, porcelain, wood), and water. This procedure also details sample packaging and transporting samples to the laboratory.

SCOPE

This procedure shall be implemented by when collecting samples on field projects related to radiological surveys.

This procedure details the methods, documentation, and requirements for surveying and sampling various media.

The following activities are described in Section 4.0 of this procedure:

4.1 Swipe Sampling

4.2 Soil Sampling

4.3 Sediment Sampling

4.4 Solid Material Sampling

4.5 Pipe and Drain Line Sampling

4.6 Ventilation Sampling

4.7 Water Sampling

4.8 Sample Packaging and Transportation

4.9 Documentation

2.0 REFERENCES

10 CFR 20, *Standards for Protection Against Radiation*

10 CFR 835, *Occupational Radiation Protection*

Tt Radiation Protection Operations Procedures (RPOP)

3.0 GENERAL

3.1 EQUIPMENT

- Portable radiological survey equipment prepared for use per RP-OP-012
- Soil sampling equipment/cleaning supplies

3.2 SAFETY CONSIDERATIONS

- Comply with applicable safety rules.
- Soil sampling may involve remote areas, climbing, or other situations that are out of the ordinary. Personnel should maintain a high level of safety awareness when obtaining soil samples.

- All personnel shall be alert for dangerous wildlife or conditions in remote or overgrown areas. Snake boots should be worn as needed in season.
- Comply with applicable Radiological Work Permit (RWP).
- Surveys shall not be performed when inclement weather conditions make the task dangerous or may interfere with obtaining accurate survey results.

3.3 RESPONSIBILITIES

3.3.1 RPO Supervision is responsible for:

- Approving any sampling generated in accordance with this procedure.
- Reviewing data related to possible contamination and determining possible radiological hazards/material that may be present.
- Ensuring that EH&S has been consulted regarding any potential industrial hygiene hazards, protective clothing, monitoring, and equipment requirements.
- Delegating performance of procedures to qualified personnel.

3.3.2 RCTs are responsible for:

- Properly surveying and documenting results of the radiological survey in compliance with this procedure.
- Exercising appropriate contamination control techniques in the performance of radiological surveys and while handling sample media.
- Complying with entry requirements for the areas to be surveyed.
- In addition, if the RCT identifies an error in the procedure or can suggest an improvement in the radiation protection method, the RCT should notify appropriate management and, with concurrence, initiate a procedure change**.**

3.4 PREREQUISITES

None

3.5 RECORDS

Radiological survey records are generated during the process of implementing this procedure. The originals are record copies for the Radiation Protection program. The record copy is maintained in accordance with project procedures. Copies of the records may be made for information purposes.

3.6 PRECAUTIONS AND LIMITATIONS

If alternative survey/sampling methods are required, note any deviations in the survey remarks.

3.7 REVISIONS

This procedure shall be reviewed every three years, or as appropriate. This revision is a complete rewrite and thus no revision bars are included.

3.8 OTHER - Terms and Definitions

Swipe Samples – Swipe samples are materials, which after being wiped over a surface, are analyzed to determine the presence of removable radioactivity on the surface area that was wiped.

Soil Samples – Soil samples are defined as soil collected for analytical purposes. Soil samples will be collected from the top 15 centimeters (cm) of the surface, unless otherwise noted in the applicable work-planning document [e.g. a Task-specific Plan (TSP), Work Instruction or Work Plan].

Sediment Samples – Sediment samples are defined as a collection of clay, silt, sand, and/or gravel deposited by water, wind, or glaciers used for analytical purposes.

Solid Material Samples – Solid material samples are defined as 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.

Liquid Samples – Liquid samples are defined as liquid collected for analytical purposes from sinks, drain piping, sewer systems, rinsate, groundwater, leachate, liquid investigation-derived waste, and low-point accumulation areas inside of buildings, sumps, and excavation pits.

3.9 ATTACHMENTS

None

4.0 PROCEDURE

Field instruments used for measurements required by this procedure shall be checked with standards and verified to have current calibration.

Anytime this procedure is in effect, the RCT (or qualified designee) should ensure, by 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 COC documentation.

4.1 Swipe Sampling

Swipe samples will be obtained in accordance with RP-OP-002, Surveys. Swipe samples will be documented in the sample logbook as applicable. Sample COC records shall be completed in accordance with the SAP.

4.2 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 here 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 TSPs as the need arises.

Samples will typically 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:

4.2.1 Loosen the soil at the selected sampling location to a depth of approximately 15 cm, using a trowel or other digging instrument.

4.2.2 Remove large rocks, vegetation and foreign objects. In some cases, however, these objects may be the source of the contamination and may be collected as separate samples for characterization.

4.2.3 Place as much soil as practical into a 250-milliliter (mL)-wide mouth plastic bottle or equivalent container.

4.2.4 If sample containers are not readily available, samples may be collected in a plastic bag for subsequent transport to the laboratory for sample preparation.

4.2.5 Tape the cap of the container in place or seal the ziplock plastic bag.

4.2.6 Label the sample container in accordance with the SAP.

4.2.7 Document all samples collected in the sample logbook as applicable. Sample COC records shall be completed in accordance with the SAP.

4.2.8 Prepare samples for shipment to offsite laboratory as soon as possible after sample collection. Sample packaging and shipment procedures are described in Section 4.8 of this procedure.

4.2.9 Clean or decontaminated tools will be used at each sampling location.

4.2.10 If soil samples are collected using alternate means (i.e., direct push technology, drill rig, etc.), follow guidance in accordance with applicable task-specific procedures.

4.3. 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:

4.3.1 A hand-auger, trowel or similar device will be used to access each sampling location. The sample collection tool will be selected based on physical limitations accessing the sample location.

4.3.2 Place as much material as practical into a 250-mL-wide mouth plastic bottle or equivalent container.

4.3.3 Follow steps 4.2.4 through 4.2.9 to complete sample collection.

4.4 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:

4.4.1 Break up the material into small enough pieces to fill a 250-mL-wide mouth plastic bottle or equivalent container.

4.4.2 Follow steps 4.2.4 through 4.2.9 to complete sample collection. Samples should be collected from areas with the highest potential for contamination.

4.5 Pipe and Drain Line Sampling

Pipe and drain line sampling is conducted to assess residual radioactivity that may be inside of drain lines or materials within sanitary sewer and storm drain systems.

4.5.1 Since the type of material found inside drain lines varies, there is no specific method identified to collect these samples. Samples may be collected using a plumber's snake, swabs, scraper, trowel, etc.

4.5.2 As much material as possible should be collected and placed into a 250-mL-wide mouth plastic bottle or equivalent container

4.5.3 Follow steps 4.2.4 through 4.2.9 to complete sample collection.

4.6 Ventilation Sampling

Ventilation sampling will be performed to identify if the system is impacted and assess the residual radioactivity that may be present.

4.6.1 If visible dust is present inside the ventilation system, use a masslin cloth to accumulate the material into a pile. (If no visible dust is present, collect a swipe sample as discussed in RP-OP-002, Surveys.)

4.6.2 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 or equivalent container.

4.6.3 Follow steps 4.2.4 through 4.2.9 to complete sample collection.

4.7 Water Sampling

Water samples will be collected as follows:

4.7.1 Collect water using any of the following sampling equipment: disposable bailer, pump, coliwassa-type tube sampler, or equivalent. Care will be taken to avoid collection of bottom sediment or vegetation.

4.7.2 Fill completely a 250-mL-wide mouth plastic bottle or equivalent container (s).

4.7.3 Follow steps 4.2.5 through 4.2.9 to complete sample collection.

4.8 Sample Packaging and Transportation

Samples designated for transport off site will be packaged in accordance with applicable Department of Transportation (DOT) and International Air Transport Association (IATA) procedures. At a minimum, sample containers will be placed in a box, cooler, or similar container for shipment and packaged with bubble wrap or other materials as necessary to prevent container breakage.

For samples shipped via a commercial carrier, the COC will include the airbill number, and the "Received By" box will be labeled with the commercial courier's name. The top two copies (white and pink) of the COC will be sealed in a resealable bag and then taped to the inside of the sample cooler lid or placed inside the box. The yellow copy of the COC will be maintained by the on-site laboratory and the manila copy will be submitted to the project Radiological Engineer (RE). A duplicate of the manila copy may also be kept in the project file on site. The box/cooler will be taped shut with strapping tape as necessary. Two custody seals will be

taped across the lid: one seal in the front and one seal in the back. The pouch for the airbill will be placed on the box/cooler and secured with clear tape. The airbill will be completed for priority overnight delivery and placed in the pouch. If multiple boxes/coolers are being shipped, then the original airbill will be placed on the box/cooler with the COC, and copies of the airbill will be placed on the other boxes/coolers. The number of packages should be included on each airbill (1 of 2, 2 of 2).

Prepared packages will also be surveyed prior to shipment.

4.9 Documentation

Sample collection records will include field logbooks and COCs. These records will be completed and maintained in accordance with the SAP.

RADIOLOGICAL PROTECTION IMPLEMENTATION PLAN

Table of Contents

RADIOLOGICAL PROTECTION IMPLEMENTATION PLAN

FOREWORD

The provisions of this Radiation Protection Implementation Plan (RPIP) apply to Tetra Tech NUS, Inc. (TtNUS) personnel and to all associated subcontractors. Regulatory requirements for occupational radiation protection are established in Title 10 of the Code of Federal Regulations, Part 835 (10 CFR 835), *Occupational Radiation Protection* and Part 20 (10 CFR 20)*, Standards for Protection Against Radiation*. This RPIP does restate, paraphrase, or cite many (but not all) of the requirements of 10 CFR 835 and related documents. Compliance with the requirements of this manual and associated project radiological control procedures will ensure that the user is in compliance with 10 CFR 835 and related documents, which will in turn be compliance with 10 CFR 20 and related documents. The user is encouraged to review any underlying regulatory and contractual requirements and the primary guidance documents in their original context to ensure compliance with the applicable requirements.

CHAPTER 1 EXCELLENCE IN RADIOLOGICAL CONTROL

TABLE OF CONTENTS

Part 1 Radiation Protection Implementation Plan

111 Radiological Health and Safety Policy

A key element of the Radiation Protection Guidance to the Federal Agencies for Occupational Exposure approved by President Reagan on January 20, 1987, and a fundamental principle underlying this manual is:

"There should not be any occupational exposure of workers to ionizing radiation without the expectation of an overall benefit from the activity causing the exposure."

Tetra Tech EC, Inc. (TtEC) is firmly committed to having a radiological control program of the highest quality.

112 Manual Applicability and Control

TtEC has established basic standards for occupational radiation protection in Federal regulation 10 CFR part 835, "Occupational Radiation Protection". 10 CFR 835 requires affected DOE activities to be conducted in compliance with a documented radiation protection program (RPP) that addresses each requirement of that regulation. This Radiation Protection Implementation Plan (RPIP) implements those Westinghouse Savannah River Corporation (WSRC) RPP requirements determined to be applicable to radiological activities performed under this contract. This RPIP is primarily directed towards radiological project management; it therefore discusses specific detailed measures that should be implemented by project management and the subcontractor radiological protection organization (SRPO) to insure protection of workers, the general public and the environment.

The radiological control program discussed in this manual goes beyond the scope of, and includes more details than, the documented RPP required by 10 CFR 835. Should any conflicts arise between this manual and the documented RPP [see WSRC-RP-94-1239], the requirements of the documented RPP should take precedence.

113 Implementation

1. The words "shall" and "should" have the meaning below when used in this Manual.
2. The word "shall" identifies those elements and requirements that are mandatory due to their derivation from related regulatory requirements found in 10 CFR 835 or other regulations or DOE Orders. These requirements are indicated by a bracketed and bolded reference following the related provision (e.g., **[see 835.XXX]**). For purposes of regulatory and contractual compliance, users should contact WSRC to determine the applicability of the requirement to the specific project operations and hazards.
3. The word "should" means TtEC has evaluated the provision and found that it is a proven practice or remedy that supports compliance with the basic requirements found in applicable regulations or DOE Orders or their underlying basis documents for occupational radiation protection. TtEC does not intend to take any exceptions to the “should” provisions identified in this manual. If at some point it is determined that an exception is warranted, TtEC will submit these exceptions with justification to WSRC for consideration. Exceptions will not be implemented without written approval from WSRC.
4. The term "Article" is used to reference portions or sections of this document. For ease of communications, portions of this document should be referred to as Articles. For example, the appropriate reference to this Article is Article 113.4.

114 Site-Specific Manual

1. TtEC has issued and endorses this radiological control manual that invokes the applicable provisions of the DOE Radiological Control Standard. The RPIP requires review and acceptance by WSRC.
2. This RPIP addresses radiological controls for activities specific to the T-Area Cap Project.
3. Subcontractors for this project shall comply with this RPIP, as specified in their contracts.
4. This RPIP should be kept current and entered into the WSRC document control system.

115 Reserved

116 Reserved

117 The "As Low As Is Reasonably Achievable" Process

10 CFR 835 requires DOE activities to develop and implement plans and measures to maintain occupational radiation exposures as low as is reasonably achievable (ALARA) **[see 835.101(c) and 835.1001(a)]**. As applied to occupational radiation exposure, the ALARA process does not require that exposures to radiological hazards be minimized without further consideration, but that such exposures be optimized, taking into account both the benefits arising out of the activity and the detriments arising from the resultant radiation exposures and the controls to be implemented.

An effective ALARA process includes effective consideration, planning, and implementation of both physical design features (including engineering controls) and administrative controls to balance the risks of occupational radiation exposure against the benefits arising out of the authorized activity. Lessons learned are documented, institutionalized, and considered in planning and executing subsequent activities to further the goals of the ALARA process and to provide optimal employee protection.

118 Integrated Safety Management

DOE requires its contractors to develop and implement an Integrated Safety Management system (ISM) that integrates safety (including radiological safety) into management and work practices at all levels (See DOE Policy 450.4 and its associated guidance documents). TtEC will operate in accordance with the WSRC ISMS Description. This manual supports the WSRC ISMS Program by providing a system of radiological controls that can be tailored to meet project- and hazard-specific needs. This manual also provides guidance for increasing worker involvement in identification and implementation of appropriate controls. Like the ALARA process, an effective integrated safety management system emphasizes the development and implementation of controls that are commensurate with the hazards associated with any specified activity. Project management should use this manual as a guide to integrating radiological control measures into work planning and execution.

119 No Deliberate Intake Policy

TtEC will not allow personnel to enter posted Airborne Radioactivity Areas (ARA) without proper respiratory protection.

Part 2 Leadership in Radiological Control

Superior, consistent performance is achieved when qualified individuals use approved procedures and management actively monitors the workplace and assesses ongoing activities. Management at all levels should emphasize the need for high standards for radiological control through direct communication, instruction, and inspection of the work space. Line management should be held accountable for implementation of the RPIP.

121 Management Commitment

1. Managers should establish high standards for radiological control performance and frequently communicate these standards and management expectations to the work force.
2. Managers should ensure that orientation, training, and indoctrination reinforce rules and guidelines for each worker to control radiation exposure and radiological conditions.
3. Management should hold workers and their managers accountable for radiological control performance.
4. Managers should solicit feedback from their radiological control professionals, line management, and workers on radiological control performance.
5. Managers should be alert to opportunities for minimizing the generation of radioactive waste and discharges to the environment, controlling contamination at its source, and reducing radiation exposure to workers and the public.

122 Reserved

123 Worker Responsibilities

Trained individuals should recognize that their actions directly affect contamination control, personnel radiation exposure, and the overall radiological environment associated with their work. Each worker should understand that proper radiological control is an integral part of his or her daily duties. The following radiological control rules are applicable to each individual in the workplace. A poster that displays basic worker responsibilities, such as those on the next page, should be produced and displayed at appropriate access points and work areas.

TO CONTROL YOUR RADIATION EXPOSURE AND RADIOACTIVE MATERIAL, OBSERVE THE FOLLOWING RULES:

OBEY

- Posted, written, and oral radiological control instructions and procedures, including instructions on radiological work permits.
- "Evacuate" and "stop work" orders from radiological control personnel promptly.

DO NOT

- Loiter in radiation areas.
- Smoke, eat, drink, or chew in contamination areas, high contamination areas, and airborne radioactivity areas.

BE SURE TO

- Wear personnel monitoring devices where required by radiological work permits, signs, procedures, or by radiological control personnel. Report immediately the loss, damage, or unexpected exposure of personnel monitoring devices or off-scale readings of self-reading dosimeters to the radiological control organization.
- Keep track of your radiation exposure status and avoid exceeding radiological administrative control levels.
- Wear personal protective equipment and clothing properly whenever required by radiological work permits or postings.
- Minimize the spread of potential radioactive spills and promptly notify the appropriate personnel of all spills.
- Avoid contact of skin, clothing, and equipment with contaminated surfaces.
- Place contaminated tools, equipment, and solid waste items on disposable surfaces, such as plastic sheets, when not in use.
- Notify radiological control personnel of alarming or faulty radiological control equipment.
- Notify radiological control personnel of off-site occupational radiation exposures so that worker dosimetry records can be updated.

PRIOR TO ENTERING AREA

- Assure that you are mentally alert and in physically sound condition.
- Limit the amount of material taken into contaminated areas to minimize radioactive waste and future decontamination.
- Have necessary materials and equipment on hand to complete your task, thereby minimizing time and exposure.
- Notify radiological control personnel of the presence of open wounds, sores or rashes before entering an area where contamination exists and exit immediately if wound occurs while in such an area.

UPON LEAVING AN AREA

- Properly remove personal protective equipment and clothing to minimize the spread of contamination.
- Frisk or be frisked for contamination when entering an uncontaminated area after exiting contamination, high contamination, or airborne radioactivity areas and associated radiological buffer areas and notify radiological control personnel when contamination is found.

124 Reserved

125 Conduct of Radiological Operations

1. Managers at all levels should be involved in the planning, scheduling, and conduct of radiological work. Assurance of adequate radiological safety should not be compromised to achieve production, remediation, or research objectives.
2. Managers should be technically knowledgeable and inquisitive and should ask questions of the work force concerning radiological work details to verify worker comprehension.
3. Managers should periodically monitor work areas to observe personnel at work and to identify good radiological work practices and radiological deficiencies and concerns. Frequent inspections and walk-throughs, including off-hours and weekends (where appropriate), are essential to reinforce management expectations to the work force.
4. Managers should encourage the work force to identify radiological control deficiencies and concerns. Prompt action should be taken to address and eliminate identified issues and prevent recurrence.
5. Subcontractors and subcontracted employees should be treated the same as project staff in the area of radiological control matters, shall have comparable radiation safety training **[see 835.901]**, and should meet the same requirements and expectations.
6. Managers and workers should be involved in the development of accurate, clear, written procedures for performing radiological work. If during the use of procedures a written requirement cannot be responsibly followed, the work should be stopped and guidance obtained.
7. Managers should encourage the work force to identify radiological control deficiencies and concerns. Prompt action should be taken to address and eliminate identified issues and prevent recurrence. Training, indoctrination, and procedure review are useful in addressing these issues.

126 Improving Worker Awareness of Radiological Conditions

In performing assigned duties within radiological areas, workers should be familiar with the area radiological conditions and be aware of the possibility that unforeseen changes may occur. Although the conduct of radiological surveys is viewed as a traditional role of radiological control technicians, experience has shown that properly trained and qualified workers are capable of performing supplemental radiological surveys in the course of work. This process results in exposure savings and improved contamination control.

Specific examples of surveys that may be effectively performed by workers and result in exposure reductions include monitoring of tools and equipment for contamination as a qualitative check during work in contamination areas. The performance of legal record surveys, such as release surveys, should remain the responsibility of the radiological control organization.

128 Facility Modifications and Radiological Design Considerations

Radiological control performance is affected by human performance and engineered design features. This RPIP primarily addresses the way individuals implement environmental remediation and construction practices. General design criteria for new facilities and major modifications to existing facilities are provided in 10 CFR 835 and DOE O 420.1, Facility Safety, but are not applicable to TtEC since our scope of work involves remediation and removal of contaminated materials. All design functions have been developed by BSRI and are contained in the Solicitation reference material.

Part 3 Improving Radiological Control Performance

131 Radiological Performance Goals

Performance indicators and analysis of operations information [see DOE O 210.1], establishes requirements for the use of goals and performance indicators. Goals are intended as a measure of and a motivation for improvement, not an end in themselves. Goals are not to be viewed narrowly as numerical values, but as tools to assist management in focusing their priorities and attention. TtEC's radiological performance is included in WSRC's established site goals.The following are examples of TtEC radiological control goals:

1. Collective Dose (person-rem): This goal should be based upon planned activities and historical performance.
2. Personnel Contamination Occurrences (number): Personnel contaminations may indicate a breakdown of controls intended to prevent the spread of contamination.
3. Unplanned Intakes of Radioactive Material (number): Management should focus attention on any failure of the controls that results in unplanned intakes.

132 Radiological Control Goals and Performance Indicators

The following goals and performance indicators have been established for the T-Area Cap Project.

Description	Goal
Collective dose in person-rem	0.5
Average worker dose in rem	0.02
Maximum worker dose in rem	0.05
Number of unplanned exposures resulting in doses greater then the ACL	0
Number of dose assessments for lost or damaged dosimeters	2
Number of skin and personal clothing contaminations	0
Number of contaminated wounds	0
Number of facial contaminations	0
Number of new confirmed depositions	0
Number of airborne events	0

133 Radiological Control Performance Reports

1. The Project Radiological Control Manager (RCM) or designee should generate appropriate performance indicator information to the Project Manager (PM) to permit management of radiological control performance. This report should include indicators of progress toward achieving the radiological control goals established in accordance with Article 132.
2. The RCM should generate appropriate performance indicator information to permit management of radiological control performance. The frequency should be consistent with the nature of the workload and the potential for exceeding the established goals. Table 1-1 identifies suggested radiological control performance indicators.

134 Assessments

Assessment, as used in this Manual, refers to the process of providing independent feedback to senior line managers to indicate the adequacy of the project radiological control program.

1. Internal audits of the radiation protection program shall be conducted such that over a 36-month period, all functional elements are assessed **[see 835.102].** The audits should address program performance, applicability, content, and implementation. The audits should be performed by the SRPO, the Quality Assurance organization, project management, and corporate Health Physics personnel.
2. Identification of the functional elements of the program depends upon project-specific factors and upon the contents of 10 CFR 835. The following elements should be considered for inclusion in the assessment program:
    a. Dosimetry (internal and external)
    b. Instrumentation
    c. Contamination control
    d. ALARA and work planning
    e. Control of radioactive material
    f. Access control
    g. Surveys, posting, and labeling
    h. Training
    i. Radiological records and reports
    j. Drills
3. The results of all assessments, both internal and external, should be tracked and where applicable, corrective action plans should be developed. Verification that corrective actions have been successfully implemented should be documented as a part of the ISMS feedback and continuous improvement process.
4. Deficiencies identified during assessments will be reported to WSRC for determination of SIRIM reportability.

135 Reserved

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137 Reserved

138 TtEC T-AREA CAP ALARA Committee

The ALARA process of managing radiation exposures is a fundamental requirement of every radiological control program. The TtEC T-Area Cap ALARA Committee provides a forum for reviewing the overall conduct of the radiological control program to ensure continuous improvement and makes recommendations to improve ALARA initiatives. The Committee will be composed of the PM, the RCM, a QA representative, and as required, members of the workforce. The Committee will review workplans prior to implementation, review work as it is being performed, and evaluate the effectiveness of ALARA program implementation at the conclusion of each major task. The Committee will meet on a regular basis, to be determined by the Committee Chairman.

PART 4 Radiological Control Organization

141 Radiological Control Organization

1. The TtEC SRPO should be independent of the line organizational element responsible for remediation activities and should have an equivalent reporting level. A single, dedicated radiological control organization for the project is sufficient, since the scope of the project is limited. The TtEC RCM responsible for radiological operations for the project should have qualified radiological control personnel assigned to the project.
2. Radiological control personnel should monitor adherence to this manual and be available to the PM for radiological support. To function effectively in this capacity, they should receive their day-to-day priorities from the PM or Site-Superintendent. To ensure independence in making correct radiological control decisions, the radiological control organization should be accountable to the RCM.
3. The RCM heads the SRPO and is responsible for interacting with WSRC to receive feedback on radiological operations.

142 Radiological Control Manager Qualifications

1. The radiological control manager should have a minimum of a bachelor's degree or the equivalent in science or engineering, including some formal training in radiological control. The radiological control manager should have at least three years of professional experience in applied radiological control work. Radiological control manager qualifications should be consistent with the guidelines provided in DOE-STD-1107-97, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.
2. If the most effective manager for this position does not satisfy the above qualifications, special arrangements should be made. In these situations, the assignment of a deputy with the requisite expertise and qualifications can satisfy the requirement. The education, training, and skills requirements of 10 CFR 835.103 would apply to both individuals to the extent that their responsibilities address programs to ensure compliance with 10 CFR 835.

143 Radiological Control Organization Functions and Staffing

1. The senior staff of the SRPO should include health physicists and other professionals with four-year degrees in science or engineering. Training and education provisions for these individuals are identified in RP-OP-011.
2. Radiological support personnel provide health physics and radiological engineering, dosimetry, bioassay, independent oversight, instrumentation, and calibration functions. Training and education provisions for these individuals are established in Article 654.

PART 5 DOE Employees

151 DOE Employees in the Workplace

DOE employees at SRS are subject to and should adhere to the provisions of this radiological control manual.

CHAPTER 2 RADIOLOGICAL STANDARDS

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PART 1 Administrative Control Levels and Dose Limits

To accomplish the project's objective of maintaining individual doses well below regulatory limits, TtEC has established administrative control levels to reduce individual and collective radiation dose. These control levels should be multi-tiered with increasing levels of authority required to approve higher administrative control levels. Unless otherwise indicated, administrative, lifetime, and special control levels and dose limits are stated in terms of the total effective dose equivalent, which is the sum of the doses received from internal and external sources.

211 Administrative Control Level

1. The DOE Administrative Control Level (ACL) is 2,000 millirem per year. Annual personnel exposures in excess of 2,000 millirem are not expected for this project. However, if necessary, approval by the appropriate DOE Secretarial Officer or designee will be required prior to allowing an individual to exceed 2,000 millirem in a year.
2. Project management should establish an annual administrative control level (ACL) based upon an evaluation of historical and projected radiation exposures, work load, and mission. TtEC has chosen a project ACL of 1,000 millirem per year to reflect the WSRC ACL.
3. No individual should be allowed to exceed the project administrative control level without the prior written approval of the RCM and WSRC management.

212 Lifetime Control Level

1. Each individual's lifetime occupational dose should be controlled below a lifetime control level of N rem where N is the age of the individual in years.
2. To ensure compliance with the lifetime control level, efforts should be made to determine the lifetime occupational dose of individuals expected to receive more than 1 rem in a year. The lifetime occupational dose is determined by summing all occupational internal and external doses received during the individual's lifetime.

213 Occupational Dose Limits

1. Occupational dose limits are provided in Table 2-1 and shall not be exceeded **[see 835.202(a)(1)-(4)]**. All occupational dose received during the current year, except the dose resulting from planned special exposures and emergency exposures, shall be included when demonstrating compliance with Table 2-1 limits [**see 835.202(b) & 702(d)]**. If formal records of an individual's prior occupational dose during the year cannot be obtained, a written estimate signed by the individual may be accepted **[see 835.702(d)]**. Written estimates should not be used as a basis for authorizing planned special exposures. Emergency exposures cannot wait for documented exposure history.
2. In an exceptional situation, a radiological worker may be authorized to receive a dose in excess of the values of the limits specified in Table 2-1.
    a. Planned special exposures may be authorized for an individual to receive doses in addition to and accounted for separately from doses received under the Table 2-1 limits **[see 835.204(a)-(f)]**.
    b. Under emergency conditions, individuals may be authorized to receive doses that exceed the limits established in Table 2-1 **[see 835.1301 & 1302]**. The provisions of this RPIP are not intended to limit actions necessary to protect health and safety under these conditions **[see 835.3(d)]**.
3. The occupational dose limits provided in Table 2-1 apply to all general employees. However, general employees who have not completed appropriate training and examinations are not permitted unescorted access to any radiological area **[see 835.901(b)]**.

214 Member of the Public Dose Limit

Members of the public permitted access to TtEC controlled areas shall be limited to an annual radiation dose of 100 millirem from the sum of doses received from internal and external radiation sources **[see 835.208]**.

215 Embryo/Fetus Dose Controls

After a female worker voluntarily notifies her employer in writing that she is pregnant, for the purposes of fetal/embryo protection, she is considered a declared pregnant worker. This declaration may be revoked, in writing, at any time by the declared pregnant worker **[see 835.2(a), Declared pregnant worker]**.

1. The employer should provide the option of a mutually agreeable assignment of work tasks, without loss of pay or promotional opportunity, such that further occupational radiation exposure during the remainder of the gestation period is unlikely.
2. For a declared pregnant worker who chooses to continue work involving occupational exposure:
    a. The dose limit for the embryo/fetus from conception to birth (entire gestation period) as a result of the occupational exposure of the declared pregnant worker is 500 millirem **[see 835.206(a)]**. The dose to the embryo/fetus is equal to the sum of doses received from external doses, sources inside the mother, and sources inside the embryo/fetus.
    b. Measures shall be taken to avoid substantial variation above the uniform exposure rate necessary to meet the 500 millirem limit for the gestation period **[see 835.206(b)]**. Efforts should be made to avoid exceeding 50 millirem per month to the declared pregnant worker.
3. If the dose to the embryo/fetus is determined to have already exceeded 500 millirem for a declared pregnant worker, the worker shall not be assigned to tasks where additional occupational radiation exposure is likely during the remainder of the gestation period **[see 835.206(c)]**.

Table 2-1 Summary of Occupational Dose Limits

Type of Exposure	Limit
General Employee*: Whole Body (internal + external) (TEDE) **[see835.202(a)(1)]**	5 rem/year
General Employee*: Lens of the Eye (external) **[see 835.202(a)(3)]**	15 rem/year
General Employee*: Skin and extremities (external shallow dose) **[see835.202(a)(4)]**	50 rem/year
General Employee*: Any organ or tissue (other than lens of eye) (internal +external) **[see 835.202(a)(2)]**	50 rem/year
Declared Pregnant Worker: Embryo/Fetus (internal + external) **[see 835.206(a)]**	0.5 rem/ gestation period
Minors: Whole Body (internal + external) (TEDE) **[see 835.207]**	0.1 rem/year
Minors: Lens of the eye, skin, and extremities **[see 835.207]**	10% of General Employee limits

* Radiological Workers are General Employees authorized unescorted access to radiological areas per Articles 332, 334, and 335.

Notes:

1. Weighting factors shall be used in converting organ dose equivalent to effective dose equivalent for the whole body dose **[see 835.203(b)]**.
2. The annual limit of dose to "any organ or tissue" is based on the committed dose equivalent to that organ or tissue resulting from internally deposited radionuclides over a 50-year period after intake plus any deep dose equivalent to that organ from external exposures during the year **[see 835.202(a)(2)]**.
3. Exposures due to background radiation, as a patient undergoing therapeutic and diagnostic medical procedures, and participation as a subject in medical research programs shall not be included in either personnel radiation dose records or assessment of dose against the limits in this Table **[see 835.202(c)]**.
4. See Appendix 2C for guidance on non-uniform exposure of the skin.
5. Whole body dose (TEDE) = effective dose equivalent from external exposures + committed effective dose equivalent from internal exposures **[see 835.2(a)]**.
6. Lens of the eye dose equivalent = dose equivalent from external exposure determined at a tissue depth of 0.3 cm **[see 835.2(a)]**.
7. Shallow dose equivalent = dose equivalent from external exposure determined at a tissue depth of 0.007 cm **[see 835.2(a)]**.

216 Special Control Levels

Certain situations may require lower individual exposure control levels. In addition to considering recommendations from SRPO support and corporate staff and medical officials, the RCM should obtain advice from professionals in other disciplines such as human resources and legal in establishing special control levels. The RCM may wish to establish these special control levels using a radiological health advisory group.

1. A special control level for annual occupational exposure should be established for each radiological worker with a lifetime occupational dose exceeding N rem, where N is the age of the individual in years. The special control level should allow the individual's lifetime occupational dose to approach and, if practicable, fall below N rem during ensuing years as additional occupational dose is received.

2. An employer should be attentive to special circumstances of employees, such as those undergoing radiation therapy, and establish special control levels as appropriate.
3. WSRC has established Special Control Levels at 1 rem/year. Exceeding this level requires the approval of the WSRC President.

PART 2 Contamination Control and Control Levels

Control of radioactive contamination is achieved by using engineering controls and worker performance to contain contamination at the source, reducing existing areas of contamination, and promptly decontaminating areas that become contaminated.

221 Personnel Contamination Control

1. Article 338 provides personnel contamination monitoring requirements and guidance. This guidance is not relevant to individuals exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment.
2. Monitoring for contamination should be performed using frisking equipment that, under laboratory conditions, can detect total contamination at or below the values specified in Table 2-2. The use of automatic monitoring units that meet the above requirements is encouraged.
3. Individuals found with detectable contamination on their skin or personal clothing, other than noble gases or natural background radioactivity, should be promptly decontaminated as described in Article 541.

222 Contamination Control Levels

1. A surface is considered contaminated if either the removable or total surface contamination is detected above the levels in Table 2-2. Controls shall be implemented for these surfaces commensurate with the nature of the contaminant and level of contamination **[see 835.1102(b)]**.
2. Surfaces exceeding the values of Table 2-2 for total contamination may be covered with a fixative coating to prevent the spread of contamination. However, reasonable efforts should be made to decontaminate an area before a coating is applied. A fixative coating should not be applied without the approval of the RCM.
3. Appropriate controls for areas of fixed contamination are provided in Article 224.
4. For areas with contaminated soil that is not releasable in accordance with DOE's environmental protection standards, a soil contamination area should be established that:
   a. Is posted as specified in Article 238.
   b. Meets the requirements of Article 231.1 through 231.8.

223 Airborne Radioactivity Control Levels

1. Use of engineering and administrative controls to reduce the potential for internal exposure should be evaluated before allowing individuals, with or without respiratory protection, to enter areas with airborne radioactivity.
2. Posting requirements for areas with airborne radioactivity are specified in Article 235. Values of Derived Air Concentrations are provided in 10 CFR 835, Appendix A **[see 835.209(a)]**.

224 Areas of Fixed Contamination

Due to reduced concerns regarding contamination spread, areas having only fixed contamination may not warrant the full range of entry controls established for areas having removable contamination levels exceeding the Table 2-2 values. Areas located outside of radiological areas having measured total contamination exceeding the total surface contamination values specified

in Table 2-2 (removable contamination levels below Table 2-2 values) are subject to the following controls:

1. Periodic surveys shall be conducted to ensure the surface contamination remains fixed to the surface and removable surface contamination levels remain below Table 2-2 values **[see 835.1102(c)(1)]**.
2. Markings indicating the status of the area shall be applied **[see 835.1102(c)(2)]**. These markings should be applied directly to the surface (or at the access points) to provide appropriate warning. These markings may also provide appropriate instructions to individuals entering the area or contacting the surface (e.g., "Fixed Contamination" or "Fixed Contamination, Notify Radiological Control Personnel Prior to Removing Paint"). Signs, stencils, or other appropriate markings may be used.
3. Markings and postings should be maintained in a legible condition.
4. Appropriate written procedures should be implemented to prevent unplanned or uncontrolled removal of the contamination. These procedures should address issues such as access controls and fixative coatings, if needed, survey techniques and frequency, area tracking and maintenance, and required markings.
5. If surveys indicate that contamination is likely to be transferred from the area, fixative coatings should be applied. When paint is used as a fixative coating, it should consist of two layers having contrasting colors, to provide indication of erosion of the top layer. Other fixative coatings, such as strippable coatings and applied plastics and foams, should be periodically evaluated for evidence of degradation. Removable contamination should be reduced to the minimum practicable level before application of fixative coatings
6. Areas meeting these requirements are exempt from the posting requirements of Articles 232 – 238 and the entry and exit requirements of Chapter 3.

Table 2-2 Summary of Surface Contamination Values 1[10 CFR 835 Appendix D]

Radionuclide (See Note 1)	**Removable (dpm/100cm^2) (See Note 2)**	**Total (Fixed + Removable) (dpm/100cm^2) (See Note 3)**
U-natural, U-235, U-238, and associated decay products	1,000 α	5,000 α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	20	500
Th-nat, Th-232, Sr-90, Ra-223, Ra-224,U-232, I-126, I-131, I-133	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. Includes mixed fission products containing Sr-90. [5]	1,000 β-γ	5,000 β-γ
Tritium and tritiated compounds [6]	10,000	N/A

Notes:

1. The values in this table, with the exception noted in footnote 5, apply to radioactive contamination deposited on, but not incorporated into the interior or matrix of, the contaminated item. Where surface contamination by both alpha-and beta-gamma-emitting nuclides exists, the limits established for alpha-and beta-gamma-emitting nuclides apply independently.
2. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
3. The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm2 is less than three times the value specified. For purposes of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) From measurements of a representative number of sections it is determined that the average contamination level exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm2 area exceeds three times the applicable value.
4. The amount of removable radioactive material per 100 cm2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium.) When removable contamination on objects of surface area less than 100 cm2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
5. This category of radionuclides includes mixed fission products, including the S-90 which is present in them. It does not apply to S-90 which has been separated from the other fission products or mixtures where the S-90 has been enriched.
6. Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value provided in this table is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a “Total” value does not apply.

PART 3 Posting

231 General Posting Provisions

1. Radiological postings are intended to alert individuals to the presence of radiation and radioactive materials and to aid them in controlling exposures and preventing the spread of contamination. TtEC requirements for posting radiological areas are contained in RP-OP-005, *Radiological Posting, Labeling, and Access Control.*
2. Signs shall contain the standard radiation symbol (radiation warning trefoil) colored magenta or black on a yellow background **[see 835.601(a)]**. Lettering should be either magenta or black. Magenta is the preferred color.
3. Signs shall be conspicuously posted at each access point, clearly worded, and, where appropriate, may include radiological control instructions **[see 835.601(b) and 603]**. Radiological postings should be displayed only to signify actual or potential radiological conditions. Signs used for training should be clearly marked, such as "For Training Purposes Only."
4. Posted areas should be as small as practicable for efficiency.
5. Postings should be maintained in a legible condition and updated based upon the most recent habitability survey or when conditions change significantly.
6. If more than one radiological condition (such as contamination and high radiation) exists in the same area, each condition shall be identified **[see 835.603]**.
7. In areas of ongoing work activities, the dose rate and contamination level or range of each should be included on or in conjunction with each posting as applicable.
8. Rope, tape, chain, and similar barriers used to designate the boundaries of posted areas should be yellow and magenta in color.
9. Physical barriers should be placed so that they are clearly visible from all directions and at various elevations. They should not be easily walked over or under, except at identified access points. These barriers shall be set up such that they do not impede the intended use of emergency exits or evacuation routes **[see 835.501(e), 502(d)]**.
10. Areas shall be clearly and conspicuously posted **[see 835.601(b)]**. Posting of doors should be such that the postings remain visible when doors are open or closed.
11. A radiological posting that signifies the presence of an intermittent radiological condition should include a statement specifying when the radiation is present, such as "CAUTION: RADIATION AREA WHEN RED LIGHT IS ON."
12. Accessible areas may be excepted from the radiological area posting requirements:
    a. During transient radiological conditions of less than 8 continuous hours duration when posting is not practical, such as radioactive material transfers. Under these conditions, the area shall be placed under the continuous observation and control of individuals who are knowledgeable of and empowered to implement required access and exposure control measures **[see 835.604(a)]**. These individuals should be stationed to provide line of sight surveillance and verbal warnings.
    b. When the area contains only packages of radioactive material received from transportation while awaiting survey in accordance with Articles 552 and 554 **[see 835.604(c)]**.

The exceptions discussed above apply only to radiological area and radioactive material area posting requirements; however required access and exposure control measures are to be implemented by the individual empowered to control access to the area.

232 Posting Controlled Areas

Controlled areas are established and posted to warn individuals that they are entering areas controlled for radiation protection purposes. All radiological areas and radioactive material areas lie within the boundaries of controlled areas. Individuals who enter only the controlled area without entering radiological areas or radioactive material areas are not expected to receive a total effective dose equivalent exceeding 100 millirem in a year.

1. Each access point to a controlled area shall be posted whenever radiological areas or radioactive material areas may be present in the area **[see 835.602(a)]**.
2. TtEC will designate the type of sign used to avoid conflict with local security requirements **[see 835.602(b)]**.

This designation should be approved by WSRC.

233 Posting Radiological Buffer Areas

Radiological buffer areas are intended to provide secondary boundaries within the controlled area to minimize the spread of contamination and to limit doses to general employees who have not been trained as radiological workers.

1. A radiological buffer area should be established for contamination control adjacent to any entrance to or exit from a contamination, high contamination, or airborne radioactivity area. The size of the radiological buffer area should be commensurate with the potential for the spread of contamination.
2. A radiological buffer area should be established for exposure control adjacent to radiation, high radiation, and very high radiation areas. The boundary for the radiological buffer area should be established to limit radiation doses to general employees to less than 100 millirem per year.
3. A radiological buffer area is not required for:
    a. High contamination or airborne radioactivity areas that are completely within contamination areas
    b. Inactive contamination, high contamination, or airborne radioactivity areas (i.e., areas to which entry has been prohibited by posting or barricades)
    c. Exposure control, if other posted boundaries or controls provide equivalent employee protection
    d. Exposure control, if general employees who are not trained as radiological workers are restricted from unescorted entry to controlled areas.
4. The need for radiological buffer areas around radioactive material areas, soil contamination areas, and underground radioactive material areas should be evaluated based upon the potential for exposure of unmonitored individuals and the spread of contamination.
5. Posting of radiological buffer areas should be in accordance with Article 231 and contain the wording "CAUTION, RADIOLOGICAL BUFFER AREA” and if necessary for exposure control, “DOSIMETRY REQUIRED AREA”.

234 Posting Radiation Areas

1. Areas shall be posted to alert individuals to the presence of external radiation in accordance with Table 2-3 **[see 835.601(a), 603]**. In addition, hot spots should be labeled as described below to provide warning of discrete radiation sources.
2. Radiation areas and high radiation areas shall be identified based on the dose rates at a distance of 30 centimeters either from the source or from any surface penetrated by the radiation **[see 835.2(a), radiation area and high radiation area]**. Very high radiation areas shall be identified based on the dose rate at a distance of 100 centimeters either from the

source or from any surface penetrated by the radiation **[see 835.2(a), very high radiation area]**.

3. Hot spots are defined as locations where contact dose rates are ≥ 100 mrem/hr and greater than 5 times the general areas dose rate. Hot spots will be labeled with contact dose rates to alert workers to their presence.
4. Dose received in an hour may be used as the criterion for posting (Column 2 of Table 2-3). At very high dose rates (such as dose rates in a very high radiation area), dose rates should be measured and recorded in units of “rads” rather than “rem” in an hour.

Table 2-3 Criteria for Posting Radiation Areas

Area	Criteria	Required Posting
Radiation Area	Radiation levels could result in an individual receiving > 0.005 rem in 1 hour at 30 cm	"CAUTION, RADIATION AREA, TLD REQUIRED FOR ENTRY" **[see 835.603(a)]**
High Radiation Area	Radiation levels could result in an individual receiving > 0.1 rem in 1 hour at 30 cm	"DANGER," "HIGH RADIATION AREA, TLD, SUPPLEMENTAL DOSIMETER AND RWP REQUIRED FOR ENTRY" **[see 835.603(b)]**
Very High Radiation Area	Radiation levels could result in an individual receiving > 500 rad in 1 hour at 100 cm	"GRAVE DANGER, VERY HIGH RADIATION AREA, SPECIAL CONTROLS REQUIRED FOR ENTRY" **[see 835.603(c)]**

235 Posting Contamination, High Contamination, and Airborne Radioactivity Areas

1. Areas shall be posted to alert individuals to the presence (or likely presence) of surface contamination and airborne radioactivity in accordance with Table 2-4 **[see 835.603]**.
2. Derived Air Concentration (DAC) values found in 10 CFR 835 shall be used in posting airborne radioactivity areas in accordance with Table 2-4 **[see 835.209(a)]**.

Table 2-4 Criteria for Posting Contamination, High Contamination, and Airborne Radioactivity Areas

Area	Criteria	Required Posting
Contamination Area	Removable contamination levels (dpm/100 cm2) > Table 2-2 values[1] but ≤ 100 x Table 2-2 values	"CAUTION, CONTAMINATION AREA" **[see 835.603(e)]**
High Contamination Area	Removable contamination levels (dpm/100 cm2) > 100 x Table 2-2 values[1]	"DANGER," "HIGH CONTAMINATION AREA, RWP REQUIRED FOR ENTRY" **[see 835.603(f)]**
Airborne Radioactivity Area	Airborne concentrations (μCi/ml) above background[1]: 1) are > the applicable DAC values[2]; or 2) could result in an individual (w/o respirator) receiving an intake > 12 DAC-hrs in a week	"CAUTION" AIRBORNE RADIOACTIVITY AREA, RWP REQUIRED FOR ENTRY" **[see 835.603(d)]**
Fixed Contamination	Removable contamination levels < Table 2-2 removable values and total contamination levels > Table 2-2 total values	"CAUTION, FIXED CONTAMINATION"
Soil Contamination	Contaminated soil not releasable in accordance with DOE 5400.5.	"CAUTION, SOIL CONTAMINATION"

1 To maintain occupational exposures ALARA areas are posted as airborne radioactivity areas if airborne concentrations routinely exceed 0.1 DAC.

2 Levels exceed or are likely to exceed the listed values

236 Posting Radioactive Material Areas

1. Accessible areas where items or containers of radioactive material in quantities exceeding the values provided in Appendix 4A are used, handled, or stored shall be posted "CAUTION, RADIOACTIVE MATERIAL" **[see 835.603(g)]**.
2. Radioactive material areas shall be located within controlled areas **[see 835.(2)(a), radioactive material area]**.
3. Radioactive material areas may be excepted from the posting requirements when:
   a. The area is posted as a contamination, high contamination or airborne radioactivity area**;** or
   b. Each item or container of radioactive material in the area is clearly labeled to warn individuals of the hazards **[see 835.604(b)(2)]**; or
   c. The radioactive material of concern consists solely of structures or installed components which have been activated (such as by exposure to neutron radiation or particles produced in an accelerator); or

d. The area contains only packages of radioactive material received from radioactive material transportation while awaiting monitoring in accordance with Articles 552 and 554 **[see 835.604(c)]**; or

e. For periods of eight continuous hours or less, the area is under the continuous observation and control of an individual knowledgeable of, and empowered to implement, required access and exposure control measures **[see 835.604(a)]**.

4. Provisions for labeling radioactive materials are specified in Chapter 4.

237 Posting Underground Radioactive Material Areas

1. Underground radioactive material areas should be established to indicate the presence of underground items that contain radioactive materials, such as pipelines, radioactive cribs, covered ponds, covered ditches, catch tanks, inactive burial grounds, and sites of known, covered, unplanned releases (spills). Underground radioactive material areas need not be posted if physical or administrative controls are implemented to ensure appropriate radiological controls are established prior to excavating, penetrating, or otherwise disturbing underground radioactive materials and when access is not likely to result in individual doses greater than 100 millirem in a year.

2. Unless physical or administrative controls are implemented per Article 237.1, underground radioactive material areas should be posted "UNDERGROUND RADIOACTIVE MATERIAL." Posting should include instructions or special warnings to workers such as "Consult With Radiological Control Organization Before Digging" or "Subsurface Contamination Exists." The posting should meet the applicable requirements of Article 231.

3. Underground radioactive material areas may be located outside controlled areas unless access is likely to result in individual doses (total effective dose equivalent) greater than 100 millirem in a year from underground radioactive material.

4. Underground radioactive material areas are exempt from the entry and exit requirements of Chapter 3 when access is not likely to result in individual doses greater than 100 millirem in a year. Article 333.1 provides entry provisions for instances in which access is likely to result in individual doses greater than 100 millirem in a year.

238 Posting Soil Contamination Areas

1. For areas with contaminated soil that is not releasable in accordance with DOE's environmental protection standards, a soil contamination area should be established that is posted in accordance with the applicable provisions of Article 231. Posting should include the words "Caution, Soil Contamination Area" and instructions or special warnings to workers, such as "Consult With Radiological Control Organization Before Digging" or "Subsurface Contamination Exists."

2. Soil contamination areas may be located outside controlled areas if exposure to the material in the area is not likely to cause any individual to receive a total effective dose equivalent in excess of 100 millirem in a year.

3. If the contamination levels in the area exceed the values provided in Table 2-2 (as evidenced by the likelihood of tracking contamination out of the area at levels exceeding these values), then the area is a contamination area or high contamination area and shall be posted in accordance with Article 235 **[see 835.2(a), contamination area and high contamination area and 835.603(e) and (f)]**.

Appendix 2A Reserved

Appendix 2B Reserved

Appendix 2C

Non-Uniform Exposure of the Skin

Non-uniform exposures of the skin from X-rays, beta radiation, and radioactive materials on the skin, including hot particles, shall be assessed and recorded as specified in the table below **[see 835.205(a)].**

AREA OF SKIN IRRADIATED	METHOD OF AVERAGING, ADDING TO OTHER DOSES RECEIVED, AND RECORDING NON-UNIFORM SKIN DOSE
$\geq$ 100 cm^2 **[see 835.205(b)(1)]**	Averaged over the 100 cm^2 of skin receiving the maximum dose Added to any uniform dose equivalent also received by the skin Recorded as the annual extremity or skin (shallow) dose equivalent (H)[1]
$\geq$ 10 cm^2 and < 100 cm^2 **[see 835.205(b)(2)]**	Averaged over the 1 cm^2 of skin receiving the maximum dose (D), reduced by the fraction (f) which is the irradiated area in cm^2 divided by 100 cm^2 (i.e. H=fD) Added to any uniform dose equivalent also received by the skin Recorded as the annual extremity or skin (shallow) dose equivalent[1]
< 10 cm^2 **[see 835.205(b)(3)]**	Averaged over the 1 cm^2 of skin receiving the maximum dose Not added to any other dose equivalent, extremity or skin (shallow) dose equivalent recorded for the annual dose equivalent Recorded in a individual's radiation dose record as a special entry[1]

[1] Recording of shallow dose equivalents resulting from non-uniform exposure of the skin is not required if the resulting dose is less than 1 rem **[see 835.702(b)]**.

CHAPTER 3 CONDUCT OF RADIOLOGICAL WORK

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Appendices

Tables

PART 1 Planning Radiological Work

311 General

1. DOE regulations for occupational radiation protection require written authorizations to control access to and work in radiological areas **[see 835.501(d)]**. Technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning, should incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. The TtEC ALARA process is discussed in RP-OP-001, *ALARA Reviews.*
2. The primary methods used to maintain exposures ALARA shall be project and equipment physical design features **[see 835.1001(a)]**. Performance of certain activities, such as maintenance and modifications, may render permanently installed physical design features inadequate. In such instances, a special subset of design features, often referred to as engineering controls (e.g., temporary shielding, containment devices, and filtered ventilation systems) should be used, as appropriate, to control individual exposures.
3. When physical design features, including engineering controls, are impractical or inadequate, they shall be augmented by administrative controls **[see 835.1001(a) & (b)]**. To accomplish this, the design and planning processes should incorporate radiological control considerations in the early planning stages (see Appendix 3A).
4. To ensure adequate protection of the work force, planning for radiological work should also include consideration of all other workplace hazards (e.g., industrial hygiene and safety, fire safety, electrical safety), consistent with the principles of Integrated Safety Management as discussed in Article 118.

312 Planning for Maintenance, Operations, and Modifications

1. Maintenance and modification plans and procedures should be reviewed to identify and incorporate radiological control requirements, such as engineering controls and dose and contamination reduction considerations. Performance of this review should be the responsibility of line management, with support and concurrence from the radiological control organization.
2. For routine tasks, such as surveillance, tours, and minor non-radiological maintenance, performance of the above review and documentation of identified radiological protection requirements may be conducted as part of the radiological work permit process (see Article 321) or comparable work authorization processes that control routine entries to radiological areas.
3. The following trigger levels require formal radiological review of non-routine or complex work activities:
    a. Estimated individual or collective dose greater than pre-established values (e.g., the estimated dose for an individual worker for the duration of the job is greater than or equal to 50% of the administrative control level or the estimated cumulative dose for the duration of the job is greater than or equal to 1.0 man-rem)
    b. Predicted airborne radioactivity concentrations in excess of pre-established values (e.g., greater than 50 times the applicable derived air concentration (DAC) value(s) provided in 10 CFR 835)
    c. Removable contamination on accessible surfaces greater than pre-established values (e.g., greater than 100 times the values in Table 2-2)
    d. Entry into areas where dose rates exceed 1 rem/hour
    e. Potential releases of radioactive material to the environment

f. Estimated skin and extremity exposure rates measured at the job site are greater than or equal to 10 rem/hour, and the skin/extremity dose is the limiting radiological concern.

4. For non-routine or complex tasks a formal hazards analysis should be conducted using a nationally recognized process as discussed in DOE G 440.1-1. This review is in addition to the formal radiological review discussed above. An integrated set of controls for all hazards (e.g., radiological, chemical, and physical) should be developed from this hazard analysis.
5. At a minimum, the formal radiological review should consider the following:
   a. Inclusion of radiological control hold points in the technical work documents (TWD)
   b. Elimination or reduction of radioactivity through line flushing and decontamination
   c. Use of work processes and special tooling to reduce time in the work area
   d. Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity
   e. Specification of special radiological training or monitoring requirements
   f. Use of mock-ups for high exposure or complex tasks
   g. Engineering, design, and use of temporary shielding to reduce radiation levels
   h. Walk-down or dry-run of the activity using applicable procedures
   i. Staging and preparation of necessary materials and special tools
   j. Maximization of prefabrication and shop work
   k. Review of abnormal and emergency procedures and plans
   l. Identification of points where signatures and second party or independent verifications are required
   m. Establishment of success or completion criteria, with contingency plans to anticipate difficulties
   n. Development of a pre-job estimate of collective dose to be incurred for the job
   o. Provisions for waste minimization and disposal.
6. Radiological control requirements identified as part of the above formal radiological review should be documented in the job plans, procedures, or work packages.
7. The approval required for radiological work that will exceed established levels depends on the level of the planned exposure. Radiological work that will exceed the project Administrative Control Level, but less than the DOE Administrative Control Level requires the approval of the Project Manager and the project RCM, the WSRC Division Vice-President for SGCP and the WSRC Section Manager responsible for Radiological Controls..
8. Optimization techniques, such as cost-benefit analyses, represent a fundamental part of radiological design analysis and work review. For review of minor activities with low associated doses, a cost-benefit evaluation is an intrinsic part of the engineering review process and a detailed evaluation is not necessary. For review and planning of major tasks involving higher collective dose expenditures (e.g., 10 man-rem), a detailed and documented evaluation should be performed.

313 Infrequent or First-Time Activities

In addition to the planning provisions of Article 312, special management attention should be directed to radiological activities that are infrequently conducted (i.e., activities for which there is insufficient project or worker planning and execution experience to provide assurance of adequate radiological controls) or represent first-time operations. Planning for such activities should include:

1. Formal radiological review in accordance with Article 312.3.
2. Senior management review directed toward anticipation of concerns and emphasis and specification of protective measures.
3. Review and approval by the project ALARA Committee.
4. Enhanced line and radiological control organization management oversight during the initiation and conduct of the work.
5. The extent of the formal radiological review should be commensurate with the expected and potential hazards and required controls.

314 Temporary Shielding

1. The installation, use, and removal of temporary shielding should be evaluated and controlled by the SRPO.
2. The effects of the additional weight of temporary shielding on systems and components should be evaluated and established to be within the design basis prior to installation.
3. Installed temporary shielding should be periodically inspected and surveyed to verify effectiveness and integrity. Installed temporary shielding should be periodically evaluated to assess the need for its removal or replacement with permanent shielding.
4. Radiation surveys should be performed during the alteration or removal of installed temporary shielding.
5. Installed temporary shielding should be visibly marked or labeled with the following or equivalent wording: "Temporary Shielding - Do Not Remove Without Permission from SRPO"

315 Technical Work Documents

1. Technical work documents, such as procedures, work packages, or job or research plans, should be used to control hands-on work with radioactive materials.
2. Technical work documents used to control radiological work activities should be reviewed and approved by the radiological control organization.
3. Radiological control action steps or hold points should be incorporated into technical work documents for steps that require action by the radiological control organization to assess existing radiological conditions or prevent significant adverse radiological consequences during subsequent steps.

316 Control of Internal Exposure

1. The primary methods used to maintain individual internal doses ALARA shall be physical design features, such as confinement, ventilation, and remote handling **[see 835.1001(a)]**. The design objective shall be, under normal conditions, to avoid releases of radioactive material to the workplace atmosphere. The primary objective, under all conditions, shall be to control inhalation of radioactive material to levels that are ALARA **[see 835.1002(c)].**

2. Administrative controls, including access restrictions and the use of specific work practices designed to control airborne radioactivity, shall be used as the secondary method to maintain internal doses ALARA **[see 835.1001(b)]**.
3. When engineering and administrative controls have been applied and a reasonable potential for airborne radioactivity still exists, respiratory protection should be used to limit internal exposures. Use of respiratory protection should be considered under the following conditions:
    a. Entry into airborne radioactivity areas
    b. During breach of contaminated systems or components
    c. During work in areas or on equipment with removable contamination levels greater than 100 times the values in Table 2-2
    d. During work on contaminated or activated surfaces with the potential to generate airborne radioactivity.
4. The selection of respiratory protection equipment should include consideration of worker safety, comfort, and efficiency.
5. When notified that an individual with an open wound wishes to enter an area where contact with radioactive contamination is possible, Project medical professionals (offsite medical provider) should examine the wound and require appropriate measures to prevent the entry of radioactive contamination. These measures range from requiring an appropriate bandage or other covering up to prohibiting access to affected areas until the wound has healed. The Project medical professional will also make the determination to remove any restriction/bandage requirements for entry into a Contamination Area.

PART 2 Work Preparation

321 Radiological Work Permits

The RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP informs workers of area radiological conditions and entry requirements and provides a mechanism to relate worker exposure to specific work activities **[see 835.501(a)]**.The TtEC radiation work permit process is discussed in RP-OP-006, *Radiological Work Permits.*

1. The RWP should include the following information:
    a. Description of work
    b. Work area radiological conditions
    c. Dosimetry requirements
    d. Pre-job briefing requirements, as applicable
    e. Training requirements for entry
    f. Protective clothing and respiratory protection requirements
    g. Radiological Control coverage requirements and stay time controls, as applicable
    h. Limiting radiological conditions that may void the RWP
    i. Special dose or contamination reduction considerations
    j. Special personnel frisking considerations
    k. Technical work document number, as applicable
    l. Unique identifying number

m. Date of issue and expiration

n. Authorizing signatures.

322 Use of Radiological Work Permits

Standing RWPs are used for entry and repetitive work in areas with known and stable low hazard radiological conditions. Job-specific RWPs are used for more complex work and for entry into higher-hazard areas.

1. RWPs should be used to control the following activities:
   a. Entry into radiological areas
   b. Handling of materials with removable contamination that exceed the values of Table 2- 2
   c. Work in localized benchtop areas, laboratory fume hoods, sample sinks, and containment devices that has the potential to generate contamination in areas that are otherwise free of contamination
   d. Work that disturbs the soil in soil contamination areas
   e. Work that involves digging in underground radioactive material areas
2. Job-specific RWPs should be used to control non-routine operations, routine work with elevated/complex radiological conditions and/or work in areas with changing radiological conditions. The job-specific RWP should remain in effect only for the duration of the job. Long duration work covered by job-specific RWPs requires periodic review to verify the adequacy of radiological controls. Long duration job-specific RWPs may be approved for periods longer than one year.
3. Standing RWPs may be used to control routine or repetitive activities, such as tours and inspections or minor work activities, in areas with well-characterized and stable radiological conditions. Standing RWPs may be approved indefinitely, but must be reviewed on an annual basis.
4. Radiological surveys should be routinely reviewed to evaluate the adequacy of RWP requirements. RWPs should be updated if radiological conditions change to the extent that protective requirements need modification.
5. RWPs should be posted at the access point to the applicable radiological work area or otherwise made available at the work location. Where contamination or inclement weather is a consideration, maintain a copy at the work area access point and maintain the original in the project SRPO office or designated RWP access point.
6. Workers should acknowledge by signature, or through electronic means where automated access systems are in place, that they have read, understand, and will comply with the RWP prior to initial entry to the area and after any revisions to the RWP.
7. Worker electronic dosimeter readings should be recorded in a format that identifies and provides linkage to the applicable RWP.
8. An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in this Article and Articles 321 and 323.

323 Radiological Work Permit Preparation

1. The responsibility for ensuring adequate planning and control of work activities resides with project management. The lead work group responsible for the planned activity or for the area should initiate the preparation of the RWP.

2. The RWP should be based on current radiological surveys and anticipated radiological conditions.
3. The RWP, including any revisions or extensions, should be approved by the manager responsible for the work or area and the RCM.

324 Pre-Job Briefings

1. At a minimum, pre-job briefings should be held prior to the conduct of work anticipated to exceed the trigger levels identified in Article 312.3.
2. At a minimum, the pre-job briefing should include:
   a. Scope of work to be performed
   b. Radiological conditions of the workplace
   c. Procedural and RWP requirements
   d. Special radiological control requirements
   e. Radiologically limiting conditions, such as contamination or radiation levels that may void the RWP
   f. Radiological control action steps or hold points
   g. Communications and coordination with other groups
   h. Provisions for housekeeping and final cleanup
   i. Emergency response provisions.
3. 10 CFR 835 requires maintenance of records of actions taken to maintain doses ALARA; therefore, if pre-job briefings are used for ALARA purposes, records of the briefings shall be maintained **[see 835.704(b)]**.

325 Use of Personal Protective Equipment and Clothing

1. Individuals shall wear protective clothing during work in contamination, high contamination areas and airborne radioactivity areas **[see 835.1102(e)]** and should wear protective clothing during the following activities:
   a. Handling of contaminated materials with removable contamination in excess of Table 2-2 levels
   b. As directed by the radiological control organization or as required by the RWP or other work authorization.
2. Protective clothing and shoes designated for radiological control should be:
   a. Marked in accordance with Article 461
   b. Used only for radiological control purposes.
3. Protective clothing dress-out areas should be established adjacent to the work area. Workers should proceed directly to the radiological work area after donning personal protective equipment and clothing.
4. General guidelines for protective clothing selection and use are provided in Appendix 3C and in Table 3-2.
5. The use of labcoats as radiological protective clothing is appropriate for limited applications where the potential for personal contamination is limited to the hands, arms, and upper front portion of the body. Labcoats may be used to perform light physical work in contamination areas.

6. Appropriate instructions for donning and removing protective clothing should be posted at the dress-out areas and step-off pad(s) for the affected work areas.
7. For radiological control purposes, modesty or company-issued clothing that is not specifically intended to protect individuals from contamination hazards should be considered the same as personal clothing.
8. The use of personal protective equipment or clothing (including respiratory protection) beyond that authorized by the radiological control organization or other cognizant safety authorities detracts from work performance and is contrary to ALARA principles and waste minimization practices. Such use should not be authorized.

PART 3 Entry and Exit Provisions

331 Controlled Areas

1. DOE regulations for occupational radiation protection require that individuals complete radiation safety training commensurate with the hazards and required controls:
    a. Prior to unescorted access to controlled areas **[see 835.901(a)]**; and
    b. Prior to receiving occupational dose during access to controlled areas (whether escorted or not) **[see 835.901(a)]**.
2. Training provisions for unescorted entry into controlled areas and radiological areas are specified in Table 3-1. Article 622 establishes training provisions that should be met prior to permitting members of the public in controlled areas.

332 Radiological Buffer Areas

1. Minimum requirements for unescorted entry into radiological buffer areas should include the following:
    a. Training in accordance with Table 3-1
    b. Primary dosimeter, if required for exposure control.
2. Contamination monitoring provisions for individuals who exit a radiological buffer area containing contamination areas, high contamination areas, or airborne radioactivity areas are specified in Article 338.
3. Protective clothing and monitoring provisions specific to benchtop work, laboratory fume hoods, sample stations and gloveboxes are identified in Article 347.

333 Radioactive Material, Soil Contamination, and Underground Radioactive Material Areas

Minimum requirements for unescorted entry into radioactive material areas, soil contamination areas, and underground radioactive material areas should include training in accordance with Table 3-1. If individual doses are likely to exceed the applicable monitoring thresholds, individual monitoring shall be conducted in accordance with Article 511 and Article 521 **[see 835.402(a) and (c)]**.

334 Radiation, High Radiation, and Very High Radiation Areas

1. Minimum requirements for unescorted entry into radiation areas shall include radiation safety training **[see 835.901(b)]** and should include the following:
    a. Training in accordance with Table 3-1
    b. Worker's signature (see Article 322.6) on the RWP,
    c. Primary dosimeter.

2. Physical controls to prevent inadvertent or unauthorized access to high and very high radiation areas are established in Appendix 3B.
3. Minimum requirements for unescorted entry into high radiation areas shall include radiation safety training **[see 835.901(b)]**, a primary dosimeter **[see 835.402(a)(5)]**, a current radiation survey, and supplemental dosimeter **[see 835.502(a)]** and should include the following:
    a. Training in accordance with Table 3-1
    b. Worker's signature (see Article 322.6) on the RWP.
4. Minimum requirements for unescorted entry into high radiation areas where dose rates exist such that an individual could exceed a whole body dose of 1 rem in one hour shall include radiation safety training **[see 835.901(b)]**, a primary dosimeter **[see 835.402(a)(5)]**, a current radiation survey, and supplemental dosimeter **[see 835.502(a)]** and should include the following:
    a. Training in accordance with Table 3-1
    b. Worker's signature (see Article 322.6) on the RWP
    c. A determination of the individual’s current dose, based on primary and supplemental dosimeter readings
    d. Pre-job briefing, as applicable
    e. Review and determination by the radiological control organization regarding the required level of radiological control technician coverage.
5. Individuals shall be prevented from unauthorized or inadvertent entry to very high radiation areas **[see 835.502(c)]**. In addition to the controls required in Articles 334.2 and 334.3, a survey should be performed prior to the first entry to the area after the source has been secured or shielded to verify the termination of the very high radiation field.
6. Operations personnel should immediately notify the radiological control organization of operational or system changes that could result in significant changes in radiological hazards. Such notifications facilitate radiological control organization actions to erect postings and implement required entry controls.
7. The number, issue, and use of keys should be strictly controlled where locked entryways are used to control access to high and very high radiation areas.
8. The radiological control organization should maintain a list of high and very high radiation areas.
9. Written procedures should be implemented to ensure the effectiveness and operability of barricades, devices, alarms, and locks. Weekly inspections of the physical access controls to high and very high radiation areas should be performed, in operational or occupied facilities, to verify controls are adequate to prevent unauthorized entry.

335 Contamination, High Contamination, and Airborne Radioactivity Areas

1. Minimum requirements for unescorted entry into contamination areas shall include radiation safety training **[see 835.901(b)]** and protective clothing **[see 835.1102(e)]** and should include the following:
    a. Training in accordance with Table 3-1
    b. Worker's signature (see Article 322.6) on the RWP
    c. Personnel dosimetry, as required.

2. Minimum requirements for unescorted entry into high contamination or airborne radioactivity areas shall include radiation safety training **[see 835.901(b)]** and protective clothing **[see 835.1102(e)]** and should include the following:
    a. Training in accordance with Table 3-1
    b. Worker's signature (see Article 322.6) on the RWP
    c. Respiratory protection when specified by the RWP
    d. Pre-job briefing for high contamination or airborne radioactivity areas, as applicable
    e. Personnel dosimetry, as required.
3. Individuals exiting contamination, high contamination, or airborne radioactivity areas should remove protective clothing (See Appendix 3C for recommended method). When entering an uncontaminated area, these individuals shall be monitored, as appropriate, for the presence of contamination on their skin and clothing **[see 835.1102(d)].** These individuals should perform whole body frisking to detect personnel contamination in accordance with Article 338.
4. Exit points from contamination, high contamination, or airborne radioactivity areas should include the following:
    a. Step-off pad located outside the exit point, contiguous with the area boundary
    b. Step-off pads maintained free of radioactive contamination
    c. Designated containers inside the area boundary for the collection of protective clothing and equipment
    d. Contamination monitoring equipment located as close to the step-off pad as background radiation levels permit.
5. Multiple step-off pads should be used at the exits from high contamination areas Use of multiple step-off pads is described in Appendix 3C.
6. Protective clothing and monitoring provisions specific to benchtop work, laboratory fume hoods, sample stations, and gloveboxes are identified in Article 347.
7. Article 421 provides requirements and guidance for removing materials and equipment from these areas.

336 Member of the Public and Untrained Workers Entry Provisions

1. Members of the public or employees that lack Radiological Worker training with a demonstrated need to enter the following areas may be allowed access if such access is controlled with a combination of orientation and the use of escorts trained for the specific area:
    a. Radiological buffer areas
    b. Radiation areas
    c. Contamination areas
    d. Radioactive material areas
    e. Soil contamination areas
    f. Underground radioactive material areas
2. Members of the public and untrained employees should be prohibited from entering very high radiation, high radiation, high contamination, and airborne radioactivity areas.
3. Orientation provisions for members of the public are identified in Article 622.

337 Controlling the Spread of Contamination

Controls shall be implemented as necessary to prevent the spread of removable contamination outside of radiological areas under normal operating conditions **[see 835.1102(a)]**. The extent of these controls is dependent upon the type and level of contamination present and the activities in and around the area (see Articles 342, 381 and 463). The following measures should be used to prevent the spread of contamination across the boundaries of contamination, high contamination, and airborne radioactivity areas:

1. Use solid barriers to enclose areas wherever practical.
2. Mark and secure items such as hoses and cords that cross the boundary to prevent safety hazards and the spread of contamination. Markings may include radiological hazard warning labels, ribbon, or tape.
3. Control and direct airflow from areas of lesser to greater removable contamination or airborne radioactivity.
4. Use engineering controls and containment devices such as glovebags, gloveboxes, and tents.

338 Monitoring for Personnel Contamination

1. Individuals shall be monitored as appropriate for the presence of surface contamination when exiting contamination, high contamination, and airborne radioactivity areas **[see 835.1102(d)]**. Individuals should perform a whole body frisk immediately upon entry into an uncontaminated area after exiting contamination, high contamination, or airborne radioactivity areas or as directed by the RWP or SRPO.
2. In addition to the above, individuals exiting a radiological buffer area containing contamination, high contamination, or airborne radioactivity areas should, at a minimum, perform a hand and foot frisk. This frisk is optional if the radiological buffer area exit is immediately adjacent to the location where the exiting individual has already performed a whole body frisk.
3. Where frisking cannot be performed at the exit from contamination, high contamination, or airborne radioactivity areas due to high background radiation levels or other extenuating circumstances (i.e., proximity of work in relation to nearest automated personnel contamination monitor) individuals should, at the direction of the radiological control organization:
    a. Remove all protective equipment and clothing at the exit
    b. Proceed directly to the nearest designated monitoring station
    c. Conduct a whole body frisk.
4. Personnel frisking should be performed after removal of protective clothing and prior to washing or showering.
5. Guidelines for personnel frisking are provided in Appendix 3D.
6. Personal items, such as notebooks, papers, and flashlights, may be frisked by the individual carrying them, provided the individual has been trained to perform this function.
7. Instructions for personnel frisking should be posted adjacent to personnel frisking instruments or monitors.
8. The personnel frisking provisions in this Article are not applicable at those facilities that contain only radionuclides, such as tritium, that cannot be detected by currently available hand-held or automated frisking instrumentation. At such facilities, additional emphasis

should be placed on bioassay programs and routine area contamination survey and air sampling programs.

Table 3-1

Radiological Control Training Guidelines

Activities	Minimum Training	Article Number(s)
Member of the public entry[1]	Orientation	622
Unescorted entry into controlled area, underground radioactive material areas and soil contamination areas for work that does not disturb the soil where an individual is not likely to receive 0.1 rem in a year	GERT	612, 613, 621
Unescorted entry into radiological buffer areas and radioactive material areas Unescorted entry into soil contamination areas for work that does not disturb the soil Unescorted entry into radiation areas	RWI	612, 613, 631, 632
Unescorted entry into contaminated areas[2] Unescorted entry into high radiation areas[3] Unescorted entry into soil contamination areas to perform work that disturbs the soil Use of containment devices with high contamination levels[4]	RWII	612, 613, 631, 633

Notes:

1. The WSRC Radiological Control Manager may authorize exceptions to the escort requirements in accordance with Article 622.

2. Includes Contamination, High Contamination, and Airborne Radioactivity Areas.

3. This requirement may be satisfied by completing both RWI training and High Radiation Area Training in lieu of RWII training.

4. Includes glove boxes and other containment devices with surface contamination levels exceeding 100 times Table 2-2 values.

PART 4 Radiological Work Controls

341 General

1. Radiological work activities shall be conducted as specified by the controlling written authorization **[see 835.501(d)]**.
2. Prerequisite conditions, such as tag-outs and system isolation, should be verified in accordance with the technical work documents before work is initiated.

342 Work Conduct and Practices

1. Contamination levels caused by ongoing work should be monitored and maintained ALARA. Work should be curtailed and decontamination performed at pre-established levels, taking into account worker exposure.
2. Tools and equipment should be inspected to verify operability before being brought into contamination, high contamination, or airborne radioactivity areas.
3. The use of radiologically clean tools or equipment in contamination, high contamination, or airborne radioactivity areas should be minimized by the implementation of a contaminated tool crib in accordance with Article 442.5. When such use is necessary, tools or equipment with complex or inaccessible areas should be wrapped or sleeved to minimize contamination.
4. Engineering controls, such as containment devices, portable or auxiliary ventilation, and temporary shielding, should be installed in accordance with the technical work documents and inspected prior to use.
5. The identity of components and systems should be verified prior to work.
6. Work activities and shift changes should be scheduled to prevent idle time in radiological areas.
7. Where practicable, parts and components should be removed to areas with lower radiological hazards to perform work.
8. Upon identification of radiological concerns, such as inappropriate work controls or procedural deficiencies, workers should immediately report the concern to line supervision or the radiological control organization. If appropriate to control individual exposure to radiological hazards, the affected individuals should exit the radiological area until these issues are resolved and appropriate controls have been instituted.
9. Requirements for area cleanup should be included in technical work documents. Work activities should not be considered complete until support material and equipment have been removed and the area has been returned to at least pre-work status.
10. To minimize intakes of radioactive material, smoking, eating, or chewing should not be permitted in contamination, high contamination, or airborne radioactivity areas. When the potential for personnel heat stress exists, drinking may be permitted within a contamination area under the following conditions and controls:
    a. The potential for heat stress cannot be reduced by the use of administrative or engineering controls
    b. All drinking is from approved containers or sources
    c. At a minimum, workers' hands and faces are monitored for contamination prior to drinking
    d. Participating workers are monitored as part of the bioassay program
    e. The applicable requirements and controls are described in approved procedures

343 Logs and Communications

1. Radiological control personnel should maintain logs to document radiological occurrences, status of work activities, and other relevant information.
2. During continuous or extended daily operations, oncoming radiological control personnel should review logs and receive a turnover briefing from the personnel they are relieving.
3. Communication systems required by the radiological work permit or technical work document should be checked for operability before being brought into the work area and periodically during work.
4. Workers and project management should keep radiological control personnel informed of the status of work activities that affect radiological conditions.

344 Review of Work in Progress

1. As part of their normal work review, both radiological control and project managers should periodically review ongoing jobs to ensure prescribed radiological controls are being implemented.
2. Radiological control personnel should conduct frequent tours of the workplace to review the adequacy of radiological work practices, posting, and area controls.
3. During the performance of jobs for which a pre-job dose estimate was made, the SRPO, in cooperation with project management, should periodically monitor collective dose accumulation and compare it with the pre-job dose estimate.
4. Differences should be reviewed to identify causes and assess the need for corrective actions.

345 Stop Radiological Work Authority

1. Radiological control technicians and their managers, line management, and any worker through their manager shall have the authority and responsibility to stop radiological work activities for any of the following reasons [see DOE Order 440.1A paragraph g]:
    a. Inadequate radiological controls
    b. Radiological controls not being implemented
    c. Radiological control hold point not being satisfied.
2. Once radiological work has been stopped, it should not be resumed until proper radiological control has been reestablished.
3. Resumption of work involving radiological hazards should require the approval of the line manager responsible for the work and the TtEC radiological control manager or designee.

346 Response to Abnormal Situations

Procedures shall establish SRPO response requirements for abnormal situations. Example situations requiring response include personnel contamination events or spills of radioactive material.

347 Controls for Benchtop Work

The following provisions are applicable to radiological work that has the potential to generate radioactive contamination in localized benchtop areas, laboratory fume hoods, or sample station areas located in areas that are otherwise contamination free.

1. Provisions for radiological work permits are provided in Article 322.

2. For a posted contamination area, protective clothing should, at a minimum, include labcoats, gloves and shoecovers.
3. For a posted RBA, protective clothing, at a minimum, should include gloves.
4. Workers should periodically monitor their hands during work.
5. Upon completion of work or prior to leaving the area, workers shall monitor those areas of their body that are potentially contaminated **[see 835.1102(d)]**. At a minimum, this includes hands, arms, and front portions of the body.
6. If there is a potential for splashing or airborne radioactivity, such as when taking pressurized samples, additional controls such as rubber aprons, face shields, full PCs, or respiratory protection should be instituted.

348 Controls for Hot Particles

Hot particles are small, discrete, highly radioactive particles capable of causing extremely high doses to a localized area in a short period of time. Hot particle contamination may be present or be generated when contaminated systems are opened or when operations such as machining, cutting, or grinding are performed on highly radioactive materials.

1. Hot particles are defined as a small, discrete, highly radioactive particle capable of producing a shallow dose equivalent greater than 100 mrem in one hour.
2. Measures for controlling hot particles, as identified in items 3 through 7 of this Article, should be implemented under the following conditions:
    a. Upon identification of hot particles
    b. During new or non-routine operations with a high potential for hot particles, based on previous history
    c. Upon direction of the radiological control organization.
3. Survey provisions for areas or operations with the potential for hot particle contamination are established in Article 554.10.
4. Contamination area postings should be annotated to specifically identify the presence of hot particles.
5. Access to hot particle areas should be controlled by a job-specific RWP. The following controls should be considered for inclusion on the RWP:
    a. Periodic personnel monitoring during the work activity, at a frequency based on the potential magnitude of personnel exposure
    b. Additional personal protective equipment and clothing
    c. Direct radiological control coverage during work and assistance during protective clothing removal
    d. Use of sticky pads or multiple step-off pads.
6. Personal protective equipment and clothing used in hot particle areas should be segregated from other radiological protective equipment and clothing during laundering and surveyed prior to reuse.
7. Response to hot particle skin or clothing contamination should include the following:
    a. Immediate removal and retention of the hot particle for subsequent analysis
    b. Analysis of the particle
    c. Assessment of worker dose

d. Evaluation of work control adequacy..

PART 5 Evaluation of Performance

During the conduct of radiological work abnormal events may occur which could indicate a breakdown in established radiological controls. Prompt, consistent gathering of facts related to such events is required to formulate corrective actions to prevent recurrence and satisfy investigation or reporting requirements. In addition, successful performance or completion of non-routine radiological activities should be evaluated to identify post-job programmatic improvements and associated lessons learned.

351 Conduct of Critiques

Critiques are meetings of individuals knowledgeable about an abnormal event whose primary objective is to document a chronological listing of the facts. All incidents identified during project activities will be documented and reported to WSRC. The initiation of a formal critique will be determined by WSRC and will be conducted according to their established procedures.

352 Post-Job Reviews

Performance should be reviewed after completion of non-routine radiological work. The following radiological circumstances require a post-job ALARA review:

1. All jobs requiring a pre-job ALARA review will also require a post-job ALARA review
2. When the estimated cumulative dose for the duration of the job was less than 1.0 man-rem and the actual cumulative dose exceeded 1.0 man-rem, and was more than 25% above the estimate
3. When the actual cumulative dose was at least 0.5 man-rem and exceeds the pre-job estimated cumulative dose by greater than 25%
4. After the completion of non-routine work

Post-job ALARA reviews may also be performed at the discretion of the RCM or at the request of cognizant individuals within the radiological control organization or the organization having the work performed..

353 Lessons Learned

Lessons learned are available from post-job reviews and reports of past radiological events on the project, SRS and at other DOE facilities. The SRPO, in conjunction with project management, should evaluate lessons learned, provide prompt distribution, and incorporate the lessons into the project radiological control program, the radiological control training program, and related operations.

PART 6 Special Applications

361 Reserved

362 Reserved

363 Reserved

364 Reserved

365 Radiation Generating Devices

TtEC will not be using radiation generating devices on this project and therefore this section is not applicable.

PART 7 Environmental Restoration Projects

Restoration projects, including decontamination and decommissioning (D&D), remedial action, or other actions involving materials which contain low levels of radioactivity and have a low radiological risk may present special problems and require project-specific or program-specific control methods. These radiological operations and work activities should be conducted in accordance with this RPIP. In light of the special nature of these low radiological risk activities, which typically involve low-levels of radioactivity and the use of heavy construction or earth-moving equipment, these projects require some radiological considerations different from other activities governed by this RPIP. The tailored radiological control program for these low radiological hazard and risk projects and facilities should be adopted in radiological control implementing procedures.

Part 8 Design and Control

TtEC will not be designing or modifying any facilities and therefore this section is not applicable.

Appendix 3A

Checklist for Reducing Occupational Radiation Exposure

Preliminary Planning and Scheduling

- Plan in advance
- Delete unnecessary work
- Determine expected radiation levels
- Estimate collective dose
- Sequence jobs
- Schedule work
- Select a trained and experienced work force
- Identify and coordinate resource requirements

Preparation of Technical Work Documents

- Include special radiological control requirements in technical work documents
- Perform ALARA pre-job review
- Select and optimize engineering and administrative controls to control doses
- Plan access to and exit from the work area
- Provide for service lines (air, welding, ventilation)
- Provide communication (sometimes includes closed-circuit television)
- Remove or shield sources of radiation
- Plan for installation of temporary shielding
- Decontaminate
- Work in lowest radiation levels
- Perform as much work as practicable outside radiation areas
- State requirements for standard tools
- Consider special tools, including robots
- State staging requirements for materials, parts and tools
- Incorporate radiological control hold points
- Analyze PPE requirements to ensure optimization of hazard control, risks, and costs
- Minimize discomfort of workers
- Revise estimates of collective dose
- Prepare radiological work permits (RWPs

Temporary Shielding

- Design shielding to include stress considerations
- Control installation and removal by written procedure
- Inspect after installation
- Conduct periodic radiation surveys

• Prevent damage caused by weight of heavy temporary shielding
• Balance radiation exposure received in installation against exposure saved by installation
• Shield travel routes
• Shield components with abnormally high radiation levels early in the maintenance period
• Shield position(s) occupied by worker
• Perform directional surveys to improve design of shielding by locating source of radiation
• Use mock-ups to plan temporary shielding design and installation
• Consider use of water-filled shielding

Rehearsing and Briefing

• Rehearse
• Use mock-ups duplicating working conditions
• Use photographs and videotapes
• Conduct briefings of workers in accordance with Article 324

Performing Work

• Comply with technical work documents and RWPs
• Post radiation levels
• Keep excess personnel out of radiation areas
• Control radiation exposure while controlling exposure to other hazards
• Managers and workers keep track of radiation exposure
• Compare actual dose against pre-job estimates
• Workers assist in radiation and radioactivity measurements
• Delegate radiological control monitoring responsibilities
• Evaluate the size of the work crew as work progresses
• Reevaluate methods used to control radiation doses
• Compare actual collective dose against pre-job estimate
• Coordinate personnel at the job site to reduce non-productive time

Appendix 3B

Physical Access Controls for High and Very High Radiation Areas

1. One or more of the following features should be used for each entrance or access point to a high radiation area and shall be used for each entrance or access point to a high radiation area where radiation levels exist such that an individual could exceed a whole body dose of 1 rem in any one hour **[see 835.502(b)]**:

    a. A control device that prevents entry to the area when high radiation levels exist or upon entry causes the radiation level to be reduced below that level defining a high radiation area

    b. A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area

    c. A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the manager of the activity are made aware of the entry

    d. Entryways that are locked, except during periods when access to the area is required, with positive control over each entry

    e. Continuous direct or electronic surveillance that is capable of preventing unauthorized entry

    f. A control device that automatically generates audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.

2. In addition to the above requirements, additional measures shall be implemented to ensure individuals are not able to gain access to very high radiation areas when dose rates are in excess of the posting requirements of Table 2-3 **[see 835.502(c)]**.

3. Physical access controls over high and very high radiation areas shall be established in a manner that does not prevent an individual from leaving the area **[see 835.502(d)]**.

Appendix 3C

Contamination Control Practices

Selection of Protective Clothing (PC)

1. Workers should inspect protective clothing prior to use for tears, holes, or split seams that would diminish protection. Any defective items should be replaced with intact protective clothing.
2. Protective clothing as prescribed by the radiological work permit should be selected based on the contamination level in the work area, the anticipated work activity, worker health considerations, area(s) of the body likely to be exposed to removable contamination, and regard for non-radiological hazards that may be present. Table 3-2 provides general guidelines for selection. As referenced in the table, a full set and double set of protective clothing typically includes:

   Full Set of PCs

   a. Coveralls

   b. Cotton glove liners

   c. Gloves

   d. Shoe covers

   e. Rubber overshoes

   f. Hood

   Double Set of PCs

   a. Two pairs of coveralls

   b. Cotton glove liners

   c. Two pairs of gloves

   d. Two pairs of shoe covers

   e. Rubber overshoes

   f. Hood
3. Cotton glove liners may be worn inside standard gloves for comfort, but should not be worn alone or considered as a layer of protection.
4. Shoecovers and gloves should be sufficiently durable for the intended use. Leather or canvas work gloves should be worn in lieu of or in addition to standard gloves for work activities requiring additional strength or abrasion resistance.
5. Use of industrial safety equipment, such as hard hats, in contamination, high contamination, and airborne radioactivity areas should be controlled by the radiological work permit.
6. Reusable industrial safety equipment designated for use in such areas should be distinctly colored or marked.
7. Shoe covers and gloves should be secured or taped at the coverall legs and sleeves when necessary to prevent worker contamination. Tape should be tabbed to permit easy removal.
8. Supplemental electronic dosimeters should be worn outside the protective clothing, in a manner accessible to the worker. Workers should protect such dosimeters from contamination by placing them in an outer coverall pocket or in plastic bags or pouches.

9. Outer personal clothing should not be worn under protective clothing for entry to high contamination areas or during work conditions requiring a double set of protective clothing.

Removal of Protective Clothing

Potentially contaminated protective clothing should be removed without spreading contamination and in particular without contaminating the skin. Workers should be instructed not to touch the skin or place anything in the mouth during protective clothing removal.

Recommended Sequence for Removing a Full Set of Protective Clothing at the Step-Off Pad

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

1. Remove exposed tape
2. Remove rubber overshoes
3. Remove gloves
4. Remove hood from front to rear
5. Remove respiratory protection, as applicable
6. Remove coveralls, inside out, touching inside only
7. Take down barrier closure, as applicable
8. Remove tape or fastener from inner shoe cover
9. Remove each shoe cover, placing shoe onto clean step-off pad
10. Remove cloth glove liners
11. Replace barrier closure, as applicable
12. Commence whole body frisking
13. Monitor badge and 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.

Recommended Sequence for Removing a Double Set of Protective Clothing Using Two Step-Off Pads

Before stepping to the inner step-off pad, the worker should:

1. Remove exposed tape
2. Remove rubber overshoes
3. Remover outer gloves
4. Remove hood from front to rear
5. Remove respiratory protection, as applicable
6. Remove outer coverall, inside out, touching inside only
7. Remove tape from inner coverall and sleeves
8. Remove each outer shoe cover, stepping on inner step-off pad as each is removed.

Before stepping to the outer step-off pad, the worker should:

1. Remove inner rubber gloves
2. Remove inner coveralls, inside out, touching inside only
3. Take down barrier closure, as applicable
4. Remove tape or fastener from inner shoe cover
5. Remove each inner shoe cover, placing shoe on clean outer step-off pad
6. Remove cotton glove liners
7. Replace barrier closure, as applicable
8. Commence whole body frisking
9. Monitor badge and 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.

Use of Multiple Step-Off Pads

1. Multiple step-off pads should be used to control exit from high contamination areas. These pads define interim control measures within the posted area to limit the spread of contamination. The following controls apply:
    a. The inner step-off pad should be located immediately outside the highly contaminated work area, but still within the posted area
    b. The worker should remove highly contaminated outer clothing prior to stepping on the inner step-off pad
    c. Additional secondary step-off pads, still within the posted area, may be utilized as necessary to restrict the spread of contamination out of the immediate area
    d. The final or outer step-off pad should be located immediately outside the contamination area.

Table 3-2 Guidelines for Selecting Protective Clothing (PC)

	Removable Contamination Levels		
	Low (1 to 10 times Table 2-2 values**)**	**Moderate** (10 to 100 times Table 2-2 values)	**High** (>100 times Table 2-2 values)
Work Activity	**Recommended Protective Clothing**		
Routine	Full set of PCs	Full set of PCs	Full set of PCs, double gloves, double shoe covers
Heavy Work	Full set of PCs, work gloves	Double set of PCs, work gloves	Double set of PCs, work gloves
Work with pressurized or large volume liquids or closed system breech	Full set of non-permeable PCs	Double set of PCs (outer set non-permeable), rubber boots	Double set of PCs and non-permeable outer clothing, rubber boots

Note:

For approved work activities as defined in Article 347 or for hands-off tours or inspections in contamination areas only, labcoats, shoecovers, and gloves may be used instead of full PCs. Under low contamination potential conditions, minimum protective clothing requirements may be modified to reduce heat stress to workers in accordance with procedural guidance and RWP.

Appendix 3D

Guidelines for Personnel Contamination Monitoring with Hand-Held Instruments

General Requirements

1. Verify that the instrument is in service, has a valid source check, is set to the proper scale, and the audio output can be heard during frisking.
2. Hold probe less than 1/2 inch from surface being surveyed for beta and gamma contamination, approximately 1/4 inch for alpha contamination.
3. Move probe slowly over surface, approximately 2 inches per second.
4. If the count rate increases during frisking, pause for 5 to 10 seconds over the area to provide adequate time for instrument response.
5. If the count rate increases to a value greater than a pre-established contamination limit or the instrument alarms, remain in the area and notify radiological control personnel.
6. The whole body frisk should take at least two to three minutes.

Performance of Monitoring:

1. Frisk the hands before picking up the probe.
2. Perform the frisk in the following order:
    a. Head (pause at mouth and nose for approximately 5 seconds)
    b. Neck and shoulders
    c. Arms (pause at each elbow for approximately 5 seconds)
    d. Chest and abdomen
    e. Back, hips and seat of pants
    f. Legs (pause at each knee for approximately 5 seconds)
    g. Shoe tops
    h. Shoe bottoms (pause at sole and heel for approximately 5 seconds)
    i. Personnel and supplemental dosimeters.
3. Return the probe to its holder and leave the area. The probe should be placed on the side or face up to allow the next individual to monitor his/her hands before handling the probe.

CHAPTER 4 RADIOACTIVE MATERIALS

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Tables

PART 1 Radioactive Material Identification, Storage, and Control

411 General

1. Materials in contamination, high contamination, or airborne radioactivity areas shall be considered contaminated until surveyed and released **[see 835.1101(a)]**. Any equipment or system component removed from a process that may have had contact with radioactive material should be considered contaminated until disassembled to the extent required to perform an adequate survey, surveyed, and shown to be free of contamination at levels exceeding the Table 2-2 values. These survey and release provisions do not apply to airborne radioactivity areas where only gaseous, short-lived (half-life of 1 hour or less) radionuclides are present. Detailed provisions for release of materials from radiological areas are provided in Articles 421 and 422.
2. Radioactive material located within contamination, high contamination, airborne radioactivity or radioactive material areas does not require specific labeling or packaging if sufficient information is provided to allow individuals to take appropriate protective actions **[see 835.606(a)]**. The information may be provided by means of postings, pre-job briefings, training, or other appropriate means.
3. Response and notification requirements associated with a loss of radioactive material, including searches, internal investigations, documentation, and reporting are addressed in WSRC Manual 9B, "Site Item Reportability and Issue Management" and RP-OP-009, *Response to Radiological Incidents*. The WSRC Radiological Protection Services Section will be notified in the event of a loss of radioactive material. A TtEC incident report will be forwarded to WSRC and WSRC will be responsible for determining reportability.
4. Sealed radioactive source labeling is described in Article 431.

412 Radioactive Material Labeling

1. 10 CFR 835 requires labeling of individual containers of radioactive material and radioactive items except under certain specified conditions in which existing postings and control measures provide adequate warning **[see 835.605 and 835.606(a)]**. TtEC requirements for labeling radioactive material are contained in RP-OP-005, *Radiological Posting, Labeling, and Access Control.*
2. Postings and access control requirements for radiological areas generally provide sufficient personnel protection to negate the need for individual container or item labeling; however, items having removable contamination in excess of the Table 2-2 values should be labeled when used, handled, or stored in areas other than contamination, high contamination, or airborne radioactivity areas.
3. Required labels shall include the standard radiological warning trefoil and the words "Caution" or "Danger" and "Radioactive Material" **[see 835.605]**. The radiation warning trefoil shall be black or magenta and imposed upon a yellow background **[see 835.601(a)]**. Magenta is the preferred color for the trefoil and the lettering.
4. Required labels shall also provide sufficient information to permit individuals handling, using, or working in the vicinity of the labeled material to take appropriate actions to control exposures **[see 835.605]**. The following information should be included on radioactive material labels, to the extent appropriate to the radiological hazard created by the material and the education, training, and skills of the individuals who may be exposed to the hazards:
    a. Radionuclides (if known)
    b. Nature of material (e.g., sealed radioactive source, contaminated component, activated target)
    c. Radiological hazard information (e.g., radiation and contamination levels)

d. Total quantity of radioactive material (in subunits or multiple units of curies) (if known)

e. Required precautions

f. Name of surveyor

g. Date of survey

5. If an item is too small to be labeled with all of the desired information, the label should be applied to the device or storage location with sufficient information available to trace the item to the appropriate label.

6. If a label is applied to packaged radioactive material, the label should be applied to the outside of the package or be visible through the package.

7. Radioactive materials and containers should be labeled in accordance with Table 4-1.

Table 4-1 Radioactive Material Labeling

ITEM/MATERIAL	REQUIRED LABELING[1]
Equipment, components, and other items that are radioactive, potentially radioactive, or have been exposed to radioactive contamination or activation sources	Standard radiation warning Trefoil, And "CAUTION" "RADIOACTIVE MATERIAL" [See 10 CFR 835.605]
Sealed and unsealed radioactive sources or associated storage containers	
Equipment, components, and other items with actual or potential internal contamination	Standard radiation warning Trefoil, and CAUTION "INTERNAL CONTAMINATION" OR "POTENTIAL INTERNAL CONTAMINATION"
Components, equipment, or other items with fixed contamination	Standard radiation warning Trefoil, and CAUTION "FIXED CONTAMINATION"

1 Labeling required on item or container meets the labeling criteria established in 10 CFR 835.605.

8. Items and containers may be excepted from labeling in accordance with Table 4-2.

Table 4-2 Exceptions from Radioactive Material Labeling Requirements

Exception Criteria	Items Typically Included*
Material is used, handled, or stored in contamination, high contamination, airborne radioactivity or radioactive material areas **[see 835.606(a)(1)]**	All radioactive material in radiological areas and radioactive material areas. This exception should not be applied to items that have removable contamination exceeding the Table 2-2 values that is stored outside of contamination, high contamination, or airborne radioactivity areas.
Radioactive sources having a total quantity of radioactive material below one tenth of the Appendix 4A values **[see 835.606(a) (2)]**	Items having extremely low levels of radioactive material content, such as low activity sealed radioactive sources.
Material that has been packaged, labeled, and marked in accordance with the applicable (e.g., DOE or Department of Transportation) radioactive material transportation requirements **[see 835.606(a)(3)]**	Radioactive material packages awaiting shipment
Material that is inaccessible, or accessible only to individuals authorized to handle or use them, or to work in the vicinity **[see 835.606(a)(4)]**	Material stored in locked areas or areas having strict physical and administrative entry controls that preclude unauthorized entry. Radioactive samples being handled or transported by authorized personnel.
Material that is installed in manufacturing, process, or other equipment **[see 835.606(a)(5)]**	Piping, tanks, valves, instrument sensors, test sources, etc., that are installed in immobile systems
Material that consists solely of nuclear weapons or their components **[see 835.606(a)(6)]**	Nuclear weapons components

* Caution must be exercised to ensure that the listed items actually meet the criteria established in the first column.

Note - Caution should also be exercised to ensure that other applicable requirements (e.g., member of the public dose limits [Table 2-1], training requirements [Table 3-1], ALARA requirements [Article 117], controlled area dose expectation [Article 232]) will be met in the absence of radioactive material labels.

413 Radioactive Material Packaging

1. Radioactive material that is outside contamination, high contamination, or airborne radioactivity areas and is confirmed or suspected of having removable radioactive contamination levels greater than Table 2-2 values should be securely wrapped in plastic or placed in a closed container.
2. Radioactive material with removable or potentially removable contamination levels in excess of 100 times Table 2-2 values should have additional packaging controls such as double-wrapping or the use of plastic bags inside containers.
3. Yellow plastic wrapping material (or plastic wrapping materials emblazoned with yellow markings) should be used for packaging radioactive material and should not be used for non-radiological purposes. To allow for the inspection of radioactive material, the use of clear plastic bags with yellow tinted stripes is acceptable for the packaging of radioactive material. Also, non-transparent bulk containers may be of a color other than yellow provided the proper radiological markings are included.
4. The amount of combustible material used in packaging should be minimized.

414 Radioactive Material Storage

1. Radioactive material in quantities exceeding the applicable Appendix 4A values shall be used, handled, and stored in a radioactive material area or other area posted in accordance with Article 234 or 235, as appropriate **[see 835.2(a), radioactive material area, and 835.603]**.
2. Each radioactive material area should be approved by the TtEC RCM or designee.
3. A custodian should be assigned responsibility for each radioactive material area and should conduct walk-throughs of radioactive material areas periodically to check integrity of containers and wrapping materials.
4. An assigned custodian should conduct annual or more frequent reviews of each radioactive material area, with emphasis on treatment, decontamination, movement of material to long-term storage locations, and disposal of unneeded material.
5. Storage of non-radioactive material in a radioactive material area is discouraged.
6. Outdoor storage of radioactive material is discouraged. In cases where outdoor storage is necessary, the integrity of containers or wrapping materials used should be ensured to prevent degradation from weathering and subsequent release of radioactive material.
7. Radioactive material should be stored in a manner that reduces combustible loading. The use of cardboard containers for storage is discouraged.
8. Flammable or combustible materials should not be stored adjacent to radioactive material areas.
9. Fire protection measures, such as smoke detectors, water sprinklers, and fire extinguishers, should be considered when establishing a radioactive material area.

PART 2 Release and Transportation of Radioactive Material

421 Release to Controlled Areas

Once materials and equipment have entered radiological areas controlled for surface contamination or airborne radioactivity, comprehensive evaluations of the potential for contamination are required prior to releasing the material or equipment to controlled areas.

1. Accessible surfaces of material or equipment that has entered contamination, high contamination, or airborne radioactivity areas shall be surveyed prior to release from these areas to controlled areas **[see 835.1101(a)]**. Guidance for conducting these surveys is provided in the footnotes to Table 2-2.
2. If an assessment of the prior use of the material or equipment indicates that inaccessible surfaces are not likely to be contaminated in excess of applicable limits, the completed survey of accessible surfaces and documentation of the assessment may be an appropriate basis to release materials to the controlled area **[see 835.1101(a)(2)]**.
3. If an assessment of the prior use of the material or equipment indicates that inaccessible surfaces are likely to be contaminated to levels in excess of the Table 2-2 values, then the material shall not be released from the radiological area, except as permitted under Article 421.5 or 421.6 **[see 835.1101(a)(2)]**. If it is necessary to release the material or equipment from the radiological area, the material or equipment should be disassembled to the extent necessary to perform adequate surveys.
4. Removable contamination levels shall be less than Table 2-2 values prior to releasing material and equipment for unrestricted use in controlled areas **[see 835.1101(a)(1) & (a)(2)]**.
5. Material and equipment with nonremovable contamination levels that exceed the total contamination values specified in Table 2-2, and removable contamination levels less than

Table 2- 2 values, may be released for restricted use in controlled areas outside of radiological areas **[see 835.1101(c) & (c)(1)]**. The material or equipment shall be routinely monitored and clearly marked or labeled to alert individuals to the contaminated status **[see 835.1101(c)(2)]**

6. Material and equipment with total or removable contamination levels exceeding Table 2-2 values may be moved from one project radiological area to another in accordance with Article 423 if appropriate monitoring is performed and appropriate controls are established and implemented **[see 835.1101(b)]**. These controls should include provisions for containment to the extent practicable, labeling in accordance with Article 412, monitoring and control of the transfer route and participating individuals, and control of spills.
7. The requirements of 10 CFR 835.1101 apply only to material and equipment that is radioactive due to the deposition of radioactive contamination. Although DOE has not established any specific controls over the release of other radioactive materials [e.g., activated materials or naturally occurring radioactive materials (NORM)] to controlled areas, the release of these materials is subject to other requirements of 10 CFR 835. The following regulatory requirements and guidance are applicable to the release of this type of material and equipment.
    a. Controls shall be adequate to ensure compliance with 10 CFR 835 radiation safety training requirements **[see 10 CFR 835.901(a)]**. Release of material and equipment to controlled areas may result in occupational or non-occupational exposure of individuals to radiation.
    b. Controls shall be adequate to ensure compliance with the 100 millirem in a year controlled area maximum total effective dose equivalent expectation **[see 10 CFR 835.602(a)]**.
    c. Controls shall be adequate to ensure the ALARA process is properly implemented **[see 10 CFR 835.101 and 1001 - 1003]**. Options that should be considered include retention in radiological areas, placement in specified areas with appropriate access restrictions and usage controls, posting, labeling or color-coding, storage for decay, removal of radioactive components, and disposal as radioactive waste.
8. When radioactive materials are moved outside of radiological areas, controls should be established to ensure no unmonitored individual is likely to exceed a dose equivalent that would require monitoring in accordance with Article 511 or 521.
9. Records for release of materials should describe the property, date of last survey, identity of the individual who performed the survey, type and identification number of the survey instruments used, and survey results. For small items and packages of similar items (such as boxes of tools or boxes of fasteners), it is not necessary to create a separate survey record for each item.

422 Release to Uncontrolled Areas

1. DOE Order 5400.5 describes radiological criteria for releasing material to uncontrolled areas.
2. DOE Order 5400.5 provides guidance on obtaining approvals on a case-by-case basis for releasing material that has been contaminated in depth or volume.
3. Material not immediately released after survey should be controlled to prevent contamination while awaiting release.

423 Transportation of Radioactive Material

Transportation routes for the transfer of radioactive material associated with this project are contained in the TtEC Traffic Safety Plan.

1. 49 CFR 170 through 180 establish requirements for inspecting and surveying packages, containers, and transport conveyances prior to transport via the public transportation system. These regulations apply to radioactive material transportation in commerce.
2. DOE Orders 460.1A, 460.2 and 461.1 provide requirements that are in conformance with 49 CFR requirements for transportation of radioactive material using any conveyance. 10 CFR 835.1(b)(4) excludes radioactive material transportation activities that are performed in accordance with the applicable transportation requirements (i.e., DOT or DOE requirements) from the requirements of 10 CFR 835. However, radioactive material transportation (as defined in 10 CFR 835) does not include preparation of materials for shipment, packaging and labeling, or performance of radiological monitoring required for occupational radiation protection. Therefore, these activities shall be conducted in accordance with 10 CFR 835 **[see 835.2(a), radioactive material transportation, and 835.1(c)]** and should be conducted in accordance with this RPIP.
3. Table 2-2 removable contamination values are more limiting than 49 CFR requirements and should be used as controlling limits for on-site and off-site transportation when using a conveyance that is owned by DOE. However, when a shipment is received from an off-site destination, by a non- DOE conveyance, the 49 CFR 173 contamination values should be applied to all subsequent onsite transfers to the ultimate on-site destination.

NOTE: Material and equipment exceeding the removable surface contamination level values specified in Appendix D of 10 CFR 835 (Table2-2) may be conditionally released for movement from one project radiological area for immediately placement in another project radiological area only if appropriate monitoring is performed and appropriate controls for the movement are established and exercised.

4. Transfers over non-public thoroughfares or between project areas should be performed in accordance with written procedures utilizing pre-approved routes. The procedures or other measures should include requirements to ensure appropriate monitoring and control of the radioactive material and should be approved by the radiological control organization.
5. Transfers over public thoroughfares by non-DOE conveyance shall be performed in accordance with Department of Transportation, state, and local shipping requirements and pre-approved agreements. Transfers over public thoroughfares by DOE conveyance shall be performed in accordance with applicable DOE Orders and should conform with state and local shipping requirements and pre-approved agreements [see DOE 460.1A].
6. Transport conveyances should be radiologically surveyed before loading, especially when using commercial carriers specializing in radioactive transport. The surveys should be adequate to identify any contamination remaining on the vehicle from previous radioactive material transport evolutions, such that DOE and its contractors would not be held liable.
7. Transport of large volumes of radioactive material by non-DOE motor vehicles should be "exclusive use" to prevent commingling of DOE and other commercial shipments.
8. The project emergency plan should describe appropriate responses for potential project radioactive material transportation accidents.
9. Drivers of DOE and non-DOE motor vehicles should have a copy of their emergency response plan, or the emergency response information required by 49 CFR 172.600, during transport.
10. Specific arrangements shall be made for receiving packages containing radioactive material, regardless of the means of conveyance, in excess of Type A quantities (as defined in 10 CFR

71.4). These arrangements shall include making arrangements to receive packages upon delivery or to receive notification of delivery which leads to expeditious receipt of the package **[see 835.405(a)]**.

11. Written procedures for safely opening packages should be developed and maintained. These procedures should include due consideration of the type of package and potential hazards present.

PART 3 Sealed Radioactive Source Controls

431 Sealed Radioactive Source Controls

The WSRC Source Control Coordinator shall be notified prior to bringing any radioactive sources on site for project use.

Sealed radioactive sources having activities equal to or exceeding the values specified in Appendix 4A **[see 835 Appendix E]** are considered accountable sealed radioactive sources.

1. Procedures should be developed and implemented to control accountable and exempt sealed radioactive sources and establish requirements for source acquisition, receipt, storage, transfer, inventory, leak testing, and usage.
2. Accountable sealed sources and all other sealed radioactive sources having activities exceeding one tenth of the Appendix 4A values, or their storage containers, shall be labeled with the radiation symbol and "CAUTION" or "DANGER" and "RADIOACTIVE MATERIAL" **[see 835.605]**. The label shall also provide sufficient information to control exposures **[see 835.605]**. Because of the wide variety of labels that are affixed to sealed radioactive sources by their manufacturers, these labels are excepted from the normal color scheme of magenta or black on yellow **[see 835.606(b)]**. If the size or configuration of the source precludes application of a suitable label, the label should be attached to the source container or mechanism.
3. Each accountable sealed radioactive source shall be inventoried at intervals not to exceed six months **[see 835.1202(a)]**. This inventory shall **[see 835.1202(a)]**:
    a. Establish the physical location of each accountable sealed radioactive source.
    b. Verify that the associated posting and labeling are adequate
    c. Establish that storage locations, containers, and devices are adequate
4. Each accountable sealed radioactive source shall be subject to a source leak test upon receipt, when damage is suspected and at intervals not to exceed six months **[see 835.1202(b)]**. Source leak tests shall be capable of detecting radioactive material leakage equal to or exceeding 0.005 μCi (as indicated by the presence of 0.005 μCi or more activity on the leak test sample) **[see 835.1202(b)]**.
5. Periodic leak tests need not be performed if the source has been documented to have been removed from service. Such sources shall be stored in a controlled location and subject to periodic inventory in accordance with Article 431.3 and subject to leak testing prior to being returned to service **[see 835.1202(c)]**.
6. If a source is located in an area that is unsafe for human entry or otherwise inaccessible, (such as due to operational or environmental constraints), then periodic inventories and leak tests need not be performed **[see 835.1202(d)]**. When the conditions that restrict access to the area have been terminated, the inventory and integrity test should be performed before allowing uncontrolled access to the area.
7. If an accountable sealed radioactive source is found to be leaking radioactive material, then controls shall be established to prevent the escape of radioactive material to the workplace

[see 835.1202(e)]. These controls should include wrapping or containing the source, applying appropriate labels, and removing the source from service.

8. Both accountable and non-accountable sealed radioactive sources shall be used, handled, and stored in a manner commensurate with the hazards associated with the operations involving the sources **[see 835.1201]**.
9. Sealed radioactive sources having activities below one tenth of the values specified in Appendix 4A should be labeled consistent with Article 412 and should be periodically inventoried to ensure their retention and proper use and storage.
10. Procurement of radioactive sources should be coordinated with the SRPO and WSRC Radiological Protection Services.
11. Receipt surveys of radioactive material shipments should be performed by the SRPO in accordance with Articles 553 and 554.
12. Sealed radioactive sources, including radiography sources, should not be brought on-site by external organizations without the prior knowledge and approval of the SRPO and the WSRC Source Custodian.
13. A custodian should be appointed to coordinate sealed radioactive source procurement, issue, inventory, leak testing, and other aspects of the sealed radioactive source control program. If justified by the scale of the program, sealed radioactive source user groups should appoint group-specific custodians to coordinate activities involving sealed radioactive sources within the group.

PART 4 Solid Radioactive Waste Management

The management of project generated radioactive waste will be in accordance with the TtEC Waste Management Plan and the Waste Minimization and Decontamination Plan.

441 Requirements

1. Radiological operations generating radioactive waste shall be designed and developed to promote minimization and permit segregation, monitoring, treatment, storage, and disposal [see DOE Order 435.1].
2. Radioactive waste minimization goals and practices shall be developed and implemented [see DOE Order 435.1].

442 Waste Minimization

A radioactive waste minimization program shall be in effect to reduce the generation of radioactive waste and spread of contamination from contamination, high contamination, or airborne radioactivity areas [see DOE Order 435.1]. The following practices should be evaluated and instituted as appropriate to support waste minimization:

1. Restrict material entering contamination, high contamination and airborne radioactivity areas and other areas surrounding radiological areas to that needed for performance of work.
2. Restrict quantities of hazardous materials, such as paints, solvents, chemicals, cleaners, and fuels, entering radiological buffer areas and other areas surrounding radiological areas and implement measures to prevent inadvertent radioactive contamination of these materials.
3. Substitute recyclable or burnable items in place of disposable ones and reuse equipment, chemicals, solvents, and cleaners when practical.
4. Select consumable materials such as protective coverings and clothing that are compatible with waste-processing systems, volume reduction, and waste form acceptance criteria.
5. Reserve an assortment of tools primarily for use in contamination, high contamination, or airborne radioactivity areas. Tools should be maintained in a designated storage or

distribution area or a contaminated tool crib. Controls should be established for tool issuance and use.

6. Survey potentially contaminated material from radiological areas to separate uncontaminated from contaminated materials.
7. Segregate known uncontaminated from potentially contaminated waste.
8. Segregate reusable items, such as protective clothing, respirators, and tools, at the step-off pad.
9. Minimize the number and size of radioactive material areas.

443 Mixed Waste

Requirements specified in the Resource Conservation and Recovery Act and Toxic Substances Control Act apply to waste that contains both radioactive and hazardous materials.

1. Technical and administrative controls should be established to minimize the volume of mixed waste generated and the amount of radioactivity in such waste. Volume reduction methods include process optimization, materials substitution, and new technology development.
2. Materials suspected of being mixed waste should be identified and segregated as soon as practical in the generating process to avoid combining mixed waste with other waste forms.

PART 5 Control of Airborne Radioactivity

451 Reserved

452 Reserved

453 Control of Airborne Radioactivity

1. The radiological control organization should be notified when engineering controls that prevent worker exposure to airborne radioactivity, such as barriers, gloveboxes, and glovebags, are compromised. An evaluation should be made of continuing operations with compromised engineering controls. The use of respiratory protection to continue activities under these conditions is discouraged. Implementation of short-term engineering modifications that provide a commensurate level of worker protection is the preferred alternative.
2. Preventive maintenance and surveillance procedures should be established to ensure equipment controls are maintained in an operable condition for containment of airborne radioactivity.

PART 6 Support Activities

461 Control and Monitoring of Personal Protective Equipment and Clothing

1. Except for disposable, single use items, protective clothing designated for radiological control use should be specifically identified by appropriate labeling.
2. Protective clothing designated for radiological control use should not be used for non-radiological work.
3. Personal protective equipment and clothing should not be stored with personal street clothing.
4. Cleaned personal protective equipment, such as face shields and respirators, that comes into contact with the wearer's face and company-issued clothing (other than protective clothing used for contamination control purposes) should be surveyed prior to use. Contamination levels should be below Table 2-2 total contamination values prior to reuse.

5. Laundered protective clothing should be surveyed and should meet the following criteria prior to reuse:
   a. Beta-gamma radioactivity less than 10,000 dpm/100 cm2
   b. Alpha radioactivity less than 1,000 dpm/100 cm2 for transuranics and other alpha emitters in the same Table 2-2 category, and less than 10,000 dpm/100 cm2 for uranium.

462 Laundry

1. Clothing and equipment should be laundered according to color, type, and level of contamination. Individual protective garments/equipment as well as bagged clothing should be less than the limits listed below upon return to the laundry facility:

   Individual Garments

   Alpha – Less than 20,000 dpm/100 cm2

   Beta-Gamma – Less than 12 mrads/hr at 5 cm

   Respirators

   Alpha – Less than 5,000 dpm/100 cm2

   Beta-Gamma – Less than 100,000 dpm/100 cm2

   Bagged Clothing/Boxed Respirators

   Beta-Gamma – Less than 2 mrads/hr at 5 cm from bag

   The external surfaces of packaging (e.g., bags, boxes, etc) will be < 20 dpm/100 cm2 α and < 200 dpm/100 cm2 β-γ.

   There are no specified limits for tritium contaminated garments, overshoes, or gloves returned to the laundry. However, any items that directly contact highly contaminated tritium surfaces shall be discarded. Under no circumstances should bagged/boxed protective clothing that could cause measurable airborne tritium contamination be sent to the laundry.
2. Laundry activities should be performed using processes that control worker dose and minimize the volume of waste generated.
3. Clothing and equipment should be screened before laundering to segregate those that are damaged, present special handling problems, or require disposal.
4. Cleaned personal protective equipment and laundered protective clothing should be periodically inspected. Clothing should be free of tears, separated seams, deterioration, and damage, or repaired in a manner that provides the original level of protection.
5. Waste streams that handle soaps, detergents, solvents, or other materials which could interfere with processing large-volume liquid waste streams should be segregated for separate processing

463 Decontamination

1. Technical work documents should include provisions to control contamination at the source to minimize the amount of decontamination needed.
2. Work preplanning should include consideration of the handling, temporary storage and decontamination of materials, tools, and equipment.
3. Project management should be responsible for directing decontamination efforts.

464 Vacuum Cleaners and Portable Air-Handling Equipment

Improper use of vacuum cleaners and portable air-handling equipment may result in the generation of airborne radioactivity, removable contamination, or high dose rates.

1. Vacuum cleaners and portable air-handling equipment used in areas established to control removable surface contamination or airborne radioactivity (except areas where only tritium is present) should be equipped with High-Efficiency Particulate Air (HEPA) filters.
2. HEPA filters used in vacuum cleaners and portable air-handling equipment should meet the applicable efficiency and construction requirements for the devices in which they are installed. The maximum flow rate of the device should not exceed the flow rate at which the HEPA filter was efficiency tested. In addition, the device should be leak tested prior to initial use, when units have undergone any type of service that may compromise the integrity of the HEPA filter or its sealing surfaces, and annually [see DOE-STD-3022-98 and 3025-99]. Maintenance and testing should be conducted in accordance with the manufacturer's instructions or project-specific procedures that meet the manufacturer's minimum requirements.
3. Vacuum cleaners used for radiological work should be:
    a. Marked and labeled in accordance with Article 412
    b. Controlled by written work authorizations
    c. Controlled to prevent unauthorized use
    d. Designed to ensure HEPA filter integrity under conditions of use
    e. Controlled to prevent unauthorized or accidental access to the inner surfaces of the vacuum.
4. Radiation and contamination surveys should be performed periodically for vacuum cleaners in use and labels on these units should be updated. The frequency of radiation surveys should depend on the specific use of the vacuum cleaner.
5. Airborne radioactivity levels should be monitored when a vacuum cleaner is used in a high contamination area.
6. A nuclear safety review should be performed and documented prior to the use of a vacuum cleaner for fissile material.

Appendix 4A

Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements

Nuclide	Activity(µCi)	Nuclide	Activity(µCi)	Nuclide	Activity(µCi)
Ac-227	1.5E+00	Cl-36	4.6E+05	Ge-68	5.7E+02
Ag-105	2.1E+06	Cm-241	6.8E+04	H-3	1.6E+08
Ag-108m	1.8E+01	Cm-242	5.8E+02	Hf-172	3.1E+04
Ag-110m	2.2E+01	Cm-243	3.3E+01	Hf-175	1.8E+06
Al-26	1.6E+01	Cm-244	4.0E+01	Hf-178m	4.1E+03
Am-241	2.3E+01	Cm-245	2.2E+01	Hf-181	3.5E+02
Am-242m	2.4E+01	Cm-246	2.2E+01	Hf-182	3.0E+03
Am-243	2.3E+01	Cm-247	2.4E+01	Hg-194	3.5E+04
As-73	5.4E+02	Cm-248	6.0E+00	Hg-203	4.9E+02
Au-195	4.8E+02	Cm-250	1.1E+00	Ho-166m	2.2E+01
Ba-133	5.2E+01	Co-56	4.0E+01	I-125	3.5E+02
Be-10	2.8E+04	Co-57	2.3E+02	I-129	1.8E+02
Be-7	3.2E+03	Co-58	1.4E+02	In-114m	7.8E+02
Bi-207	1.7E+01	Co-60	1.8E+01	Ir-192	1.4E+02
Bi-208	1.5E+01	Cs-134	2.7E+01	Ir-192m	2.6E+04
Bi-210m	1.3E+03	Cs-135	2.2E+06	Ir-194m	2.7E+01
Bk-247	1.7E+01	Cs-137	6.0E+01	K-40	2.8E+02
Bk-249	7.2E+03	Dy-159	4.1E+06	La-137	1.1E+05
C-14	4.8E+06	Es-254	6.3E+01	Lu-173	4.4E+05
Ca-41	7.4E+06	Es-255	4.6E+04	Lu-174	2.5E+05
Ca-45	1.5E+06	Eu-148	7.0E+05	Lu-174m	3.9E+05
Cd-109	1.6E+02	Eu-149	5.3E+06	Lu-177m	5.8E+01
Cd-113m	6.5E+03	Eu-152	3.1E+01	Md-258	6.0E+02
Cd-115m	1.0E+04	Eu-154	3.1E+01	Mn-53	2.0E+07
Ce-139	2.4E+02	Eu-155	3.7E+02	Mn-54	6.5E+01
Ce-141	2.4E+03	Fe-55	3.7E+06	Mo-93	7.7E+01
Ce-144	1.5E+03	Fe-59	2.0E+02	Na-22	1.9E+01
Cf-248	2.0E+02	Fe-60	1.3E+04	Nb-91	7.0E+01

Appendix 4A

Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements

Nuclide	Activity(µCi)	Nuclide	Activity(µCi)	Nuclide	Activity(µCi)
Cf-250	3.8E+01	Gd-146	2.6E+05	Nb-92	1.8E+01
Cf-251	1.7E+01	Gd-148	3.0E+01	Nb-93m	4.4E+02
Cf-252	6.4E+01	Gd-151	1.1E+06	Nb-94	2.3E+01
Cf-254	3.4E+01	Gd-153	2.1E+02	Nb-95	3.4E+02
Ni-59	7.5E+06	Re-184	2.6E+02	Tc-97m	3.6E+02
Np-235	1.2E+02	Re-184m	1.5E+02	Tc-98	2.5E+01
Np-236	2.2E+01	Re-186m	2.8E+05	Tc-99	6.8E+06
Np-237	1.9E+01	Rh-101	2.5E+05	Te-121m	1.9E+02
Os-185	1.4E+02	Rh-102	8.3E+04	Te-123m	2.8E+02
Os-194	1.5E+04	Rh-102m	2.1E+05	Te-125m	4.4E+02
Pa-231	7.8E+00	Ru-103	4.4E+02	Te-127m	8.0E+02
Pb-202	1.0E+05	Ru-106	2.1E+04	Te-129m	2.3E+03
Pb-205	9.1E+01	S-35	4.0E+06	Th-228	2.9E+01
Pb-210	9.2E+01	Sb-124	9.1E+01	Th-229	4.7E+00
Pd-107	7.8E+05	Sb-125	6.8E+01	Th-230	3.1E+01
Pm-143	1.3E+02	Sc-46	6.2E+01	Th-232	6.1E+00
Pm-144	2.9E+01	Se-75	6.4E+01	Ti-44	1.6E+02
Pm-145	2.6E+02	Se-79	1.0E+06	Tl-204	2.2E+04
Pm-146	4.5E+01	Si-32	9.9E+03	Tm-170	8.4E+03
Pm-147	2.5E+05	Sm-145	9.1E+05	Tm-171	2.8E+04
Pm-148m	1.1E+02	Sm-146	1.2E+02	U-232	1.5E+01
Po-209	6.3E+03	Sm-151	2.5E+05	U-233	7.4E+01
Po-210	1.1E+03	Sn-113	3.1E+02	U-234	7.5E+01
Pt-193	4.4E+07	Sn-119m	3.3E+02	U-235	6.7E+01
Pu-236	6.9E+01	Sn-121m	8.7E+05	U-236	8.0E+01
Pu-237	3.3E+02	Sn-123	1.3E+04	U-238	8.4E+01
Pu-238	2.5E+01	Sn-126	1.8E+02	V-49	2.9E+07

Appendix 4A

Values for Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements

Nuclide	Activity(μCi)	Nuclide	Activity(μCi)	Nuclide	Activity(μCi)
Pu-239	2.3E+01	Sr-85	1.2E+02	W-181	1.1E+03
Pu-240	2.3E+01	Sr-89	2.4E+05	W-185	3.9E+06
Pu-241	1.2E+03	Sr-90	7.7E+03	W-188	6.4E+04
Pu-242	2.4E+01	Ta-179	1.5E+06	Y-88	3.4E+01
Pu-244	2.5E+01	Ta-182	7.3E+01	Y-91	5.0E+04
Ra-226	1.2E+03	Tb-157	2.5E+03	Yb-169	5.5E+02
Ra-228	2.1E+03	Tb-158	3.9E+04	Zn-65	1.1E+02
Rb-83	9.2E+01	Tb-160	1.2E+02	Zr-88	1.2E+02
Rb-84	2.0E+02	Tc-95m	1.3E+02	Zr-93	3.1E+04
Re-183	5.4E+02	Tc-97	8.1E+01	Zr-95	2.0E+02

Notes:
1. The value for any alpha emitting nuclide not listed above and for mixtures of unknown alpha emitters is 10 μCi [**see 835, Appendix E**].
2. The value for any non-alpha emitting nuclide and for mixtures of these nuclides of unknown composition is 100 μCi [**see 835, Appendix E**].
3. When the radioactive material consists of a mixture of known quantities of listed nuclides, determine the value by summing the fractions of the quantity of each radionuclide divided by the accountability value for that nuclide. If the sum of the fractions exceeds unity (1), the value has been exceeded [**see 835, Appendix E**].

CHAPTER 5 RADIOLOGICAL HEALTH SUPPORT OPERATIONS

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PART 1 External Dosimetry

511 General Provisions

1. WSRC is responsible for providing external dosimetry for radiation workers when required.
2. TtEC personnel and their subcontractors who are issued external dosimetry will comply with all WSRC requirements related to the issuance, use, maintenance and return of external dosimetry.
3. Individuals should wear their primary dosimeters on the chest area, on or between the waist and the neck.
4. Individuals should not wear dosimeters issued by SRS while being monitored by a dosimeter at another DOE or nuclear facility. Individuals should not expose their dosimeters to security X-ray devices, excessive heat, or medical sources of radiation.
5. Dosimeters should be issued only to individuals knowledgeable of their proper use and worn only by those to whom the dosimeters were issued.
6. An individual whose dosimeter is lost, damaged, or contaminated should place work in a safe condition, immediately exit the area, and report the occurrence to the SRPO and to WSRC. The individual should be restricted from entry into radiological areas until a review has been conducted and management has approved reentry.
7. Personnel who do not adhere to WSRC dosimetry policies will be restricted from work on the project. WSRC policies will be incorporated into applicable SRPO procedures.
8. Individuals should return dosimeters for processing as scheduled or upon request, and should be restricted by project management from continued radiological work until dosimeters are returned.

512 Technical Provisions for External Dosimetry

WSRC will be responsible for properly reading and reporting results from issued dosimetry. A dose assessment should be performed for each instance of a lost, damaged, or contaminated personnel dosimeter.

513 Pocket and Electronic Dosimeters

1. WSRC will be responsible for providing pocket and/or electronic dosimeters for project operations, if determined to be necessary..
2. Supplemental dosimeters should be worn simultaneously with the primary dosimeter and located in accordance with Article 511.
3. Supplemental dosimeters should be read periodically while in use and should not be allowed to exceed 75 percent of full scale.
4. Work permitted by written authorization should be stopped when supplemental dosimeter readings indicate total dose or rate of exposure substantially greater than planned.

514 Area Monitoring Dosimeters

WSRC will establish area monitoring dosimeters and maintain their placement, movement, and results

515 Nuclear Accident Dosimeters

Nuclear accident dosimeters will not be required for this project unless required by WSRC..

PART 2 Internal Dosimetry

521 General Provisions

1. WSRC is responsible for implementing and internal dosimetry program for radiation workers when required.
2. TtEC personnel and their subcontractors who are required to participate in the WSRC internal dosimetry program shall comply with all WSRC requirements related to the implementation of this program.
3. Personnel who do not adhere to WSRC dosimetry policies will be restricted from work on the project. WSRC policies will be incorporated into applicable SRPO procedures.

522 Technical Provisions for Internal Dosimetry

WSRC is responsible for implementing and recording the results of their internal dosimetry program.

523 Technical Provisions for Dose Assessment

WSRC is responsible for the assessment of dose and bioassay results for individuals participating in the WSRC internal dosimetry program. The TtEC SRPO will assist WSRC personnel in gathering specific data when required.

PART 3 Respiratory Protection Program [See RP-OP-004]

Respiratory protection equipment includes respirators with particulate or gas-filtering cartridges, supplied air respirators, self-contained breathing apparatus, and airline supplied-air suits and hoods.

531 General Provisions

1. Use of respiratory protection shall be reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source [see 29 CFR 1910.134].
2. Respirators shall be issued only to individuals who are trained, fitted, and medically qualified to wear the specific type of respirator. Training and qualification testing shall be performed annually [see 29 CFR 1910.134 and ANSI Z88.2].
3. Positive controls should be maintained for the issue, use, and return of respiratory protection equipment to ensure that only qualified individuals wear respiratory protective devices.
4. 29 CFR 1910.134 mandates that breathing air meet the specifications of ANSI/CGA G-7.1 Grade D breathing air. Compressed air supplied to respirators shall be tested quarterly. Compressors shall be of the breathing air type and shall not allow oil or other chemicals and fumes to enter the breathing air supply. Special attention shall be focused on the location of compressor air supply intakes and on cross-connections to other compressed gas systems to prevent contamination [see 29 CFR 1910.134].

532 Medical Assessment

Each prospective respirator wearer shall have a medical assessment prior to being fit-tested. The medical assessment shall determine if an employee's medical condition precludes the use of respirators and should follow the guidance in ANSI Z88.6 on frequency and content of the examination [see 29 CFR 1910.134 and ANSI Z88.2].

533 Use of Respiratory Protection

The use of respiratory protection devices can impair worker mobility and vision and cause worker discomfort and stress. For these reasons, the issue and use of respiratory protective devices must be controlled.

1. Individuals using respiratory protection shall:
    a. Perform fit checks of close-fitting respirators to ensure a proper seal before entering areas requiring respirator use
    b. Be clean shaven in the area of fit, if applicable
    c. Use corrective lenses, if needed, that are approved for respirators
    d. Be trained to leave the work area when experiencing respirator failure
    e. Be trained to remove their respirators to avoid life-threatening situations when exiting an area after respirator failure [see 29 CFR 1910.134 and ANSI Z88.2].

534 Heat Stress

Heat stress may result from working in areas of high heat, humidity, and radiant heat; working in protective clothing; and using respirators, particularly where other protective equipment is required. Heat stress has occurred at ambient temperatures less than 70°F when multiple sets of anti-contamination clothing or plastic suits were in use or strenuous work was required.

1. The planning stages for work in hot environments should address heat stress controls.
2. Job managers should inform their personnel of heat stress precautions prior to work on job assignments in hot environments. Precautions that should be considered during work that includes a high probability of heat stress include:
    a. Engineering controls to moderate the work area environment;
    b. Appropriate work time limits;
    c. Use of protective clothing made of materials that wick perspiration away from the body;
    d. Use of body cooling devices;
    e. Provision of beverages at or near the work site, using appropriate contamination controls;
    f. Relaxation of protective clothing requirements.

PART 4 Handling Radiologically Contaminated Personnel

541 Skin Contamination

1. Skin decontamination and surveillance methods should be established for project-specific radionuclides. Skin abrasion should be avoided during the decontamination process. Intrusive decontamination methods, such as tissue removal, require medical assistance.
2. Levels of skin contamination that trigger the need for dose assessments should be established for project-specific radionuclides. These trigger levels should not exceed 100 millirem.
3. Requirements for skin exposure assessments are provided in Appendix 2C. Should a skin dose assessment be necessary, WSRC will be notified immediately and will be provided with all information necessary to perform the assessment. Promptly after completion, the results should be explained to the persons affected.

542 Contaminated Wounds

1. Emergency medical care should be administered immediately for injuries involving radioactive materials in accordance with National Council on Radiation Protection and Measurements Report Number 65. Medical treatment of injuries takes precedence over radiological control considerations.
2. The treatment of contaminated injuries should include the following:
    a. Treatment of contaminated wounds by medically qualified personnel
    b. Monitoring of wounds and associated bandages for contamination, including alpha emitters if applicable
    c. Identification of the radionuclides involved
    d. Medical determination of the need for therapeutic intervention such as blocking or chelating agents
    e. Initiation of appropriate bioassay monitoring.
    f. Determination of need for work restrictions.
3. An injured individual should be counseled promptly on the medical and radiological implications resulting from contaminated wounds.
4. BSRI and WSRC will be immediately notified in the event of a contaminated injury.

543 Handling Individuals Exposed to Airborne Radioactivity

Potential intakes of radioactive material are indicated when individuals without respiratory protection are exposed to airborne radioactivity or when respiratory protection has been compromised. If inhalation of radioactive material is indicated which could result in an individual receiving a committed effective dose equivalent greater than 100 millirem (40 DAC hrs.), the following actions should be taken:

1. Identify individuals potentially exposed to airborne radioactivity
2. Obtain nasal and saliva smears for qualitative indication of intakes when appropriate
3. Analyze air samples to determine airborne concentrations where appropriate
4. Determine duration of potential exposure to airborne radioactivity
5. Perform special bioassay appropriate for the type and quantity of radionuclides involved
6. Evaluate dose prior to permitting the worker to return to radiological work.
7. BSRI and WSRC will be immediately notified in the event of an individual exposed to airborne radioactivity which could result in an individual receiving a committed effective dose equivalent greater than 100 millirem (40 DAC-hrs).

PART 5 Radiological Monitoring

551 General Provisions

Workplace monitoring provides a basis for posting and labeling, development of RWPs and other work authorizations, implementation of ALARA measures, issuance of individual monitoring devices, and verification of the efficacy of design measures and engineering controls.

1. Radiological monitoring of radiation exposure levels, contamination, and airborne radioactivity shall be conducted to:
    a. Characterize workplace conditions and detect changes in those conditions **[see 835.401(a)(2) & (3)]**

   b. Verify the effectiveness of physical design features and engineering and process controls **[see 835.401(a)(5)]**
   c. Demonstrate regulatory compliance **[see 835.401(a)(1)]**
   d. Detect the gradual buildup of radioactive material in the workplace **[see 835.401(a)(4)]**
   e. Identify and control potential sources of personnel exposure **[see 835.401(a)(6)]**
   f. Determine exposure rates during each entry to a high or very high radiation area **[see 835.502(a)(1)].**

2. Monitoring shall be performed only by individuals who have the appropriate education, training, and skills **[see 835.103]**. The instruments used shall be **[see 835.401(b)]**:
   a. Periodically maintained and calibrated on an established frequency
   b. Appropriate for the types, levels, and energies of radiation to be detected
   c. Appropriate for existing environmental conditions
   d. Routinely tested for operability.
3. Monitoring for radiation, contamination, and airborne radioactive materials should be performed as specified in technical work documents and radiological work permits.
4. The radiological control organization should perform and document a review of the adequacy of sampling and monitoring programs as part of any project or operational changes affecting radiological control. In the absence of such changes, a review should be conducted annually
5. Vendor supplied radiation monitoring equipment will to meet the provisions of the WSRC 5Q manual pertaining to instrument selection, calibration and use.
6. Instruments used to perform radiation monitoring should be performance-checked daily or, if not checked within the past 24 hours, prior to operation. When performance checks are not within ±20 percent of the expected value, the instrument should be taken out of service. When performance checks are not feasible, such as with instruments used to measure neutrons or tritium, compensatory actions should be established to ensure proper instrument performance
7. Monitoring of radiological conditions should include a sufficient number of survey points to characterize the radiation present and to verify boundaries.
8. Monitoring should be performed before, during, and at the completion of work that has the potential for causing changes in levels of radiation and radioactivity.
9. Monitoring frequencies should be established based on potential radiological conditions, probability of change in conditions, and area occupancy factors.
10 Monitoring results should be reviewed by the SRPO supervision to ensure that all required surveys have been performed and that the documentation is accurate and complete.
11. Monitoring data in each area should be compiled and reviewed at least quarterly. Changes or trends should be noted and corrective actions assigned.

552 Radiation Exposure Monitoring

1. In addition to the requirements of Article 551, routine radiation monitoring programs should be established to ensure that surveys are performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. The following survey frequencies are suggested and should be modified as necessary to ensure area hazards are adequately characterized, based upon project-specific experience:

a. Monthly, in routinely occupied radiological buffer areas, radiation areas and other areas surrounding radiological areas where the potential exists for external radiation exposure

b. Monthly, for operating HEPA-filtered ventilation units

c. Quarterly, or upon entry, if entries are less frequent than quarterly, for radioactive material areas

2. Radiation monitoring should 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 a potential for hands-on work or other direct contact.

3. Monitoring should be conducted whenever operations are being performed that might result in individuals being exposed to small intense beams of radiation, such as those generated by shielded X-ray devices or due to removal or alteration of shielding, modification of shielding penetrations, or relocation of significant radiation sources within shielded enclosures.

4. TtEC will not receive radioactive material exceeding a Type A quantity (as defined in 10 CFR 71).

553 Area Radiation Monitors

Area radiation monitors will not be used on this project due to the fact that there is no potential for unexpected increases in dose rates above posted rates.

554 Contamination Monitoring

1. In addition to the requirements of Article 551, contamination monitoring programs should be established to ensure that surveys are performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. The following survey frequencies are suggested and should be modified as necessary to ensure area hazards are adequately characterized, based upon project-specific experience:

    a. Prior to transfer of equipment and material from contamination areas to radiological buffer areas

    b. Daily, at contamination area step-off pads when in use, or per shift in high use situations

    c. Weekly, in lunch rooms or eating areas near radiological buffer areas

    d. Weekly, in accessible areas where operations are under way that are likely to produce hot particles [see Article 338]

    e. Monthly, in routinely occupied radiological buffer areas

    f. Monthly; or upon entry if entries are less frequent, in contamination areas or where contamination area boundaries or postings are located

    g. Monthly, in radioactive material areas (frequency may be extended to quarterly for radioactive material areas exclusively used to store sealed sources)

    h. Annually, in and around areas of fixed contamination.

    i. During initial entry into a known or suspected contamination area, periodically during work, at completion of job, or as specified in a radiological work permit

    j. After a leak or spill of radioactive materials.

2. Articles 421 and 422 provide requirements and guidance for material release surveys.

3. TtEC will not receive radioactive material requiring receipt surveys for this project.

4. Contamination surveys should incorporate techniques to detect both removable and fixed contamination, as applicable (see Table 2-2, Note 2).

5. Swipe surveys for removable contamination should be recorded in units of disintegrations per minute per 100 cm2 (dpm/100 cm2). For swipe surveys of small items covering less than 100 cm2, the results should be recorded in units of dpm per area swiped. If contamination levels exceed the range of the available contamination survey meters, the swipes should be analyzed by holding an appropriate exposure rate meter within one half inch and the results should be recorded in units of millirad or rad per hour.
6. Large area wipes should be used to supplement standard swipe techniques in areas generally assumed not to be contaminated, such as entrances to radiological areas. If an evaluation indicates that an area wiped is contaminated, a thorough contamination swipe survey should be performed.
7. Areas identified as either contaminated with, or having the potential for being contaminated with, highly radioactive particles ("hot particles") should be surveyed using special swipe techniques to collect hot particles, such as tape and large area wipes (see Article 348).

555 Airborne Radioactivity Monitoring

1. In addition to the requirements of Article 551, air monitoring programs should be established to ensure that airborne radioactivity monitoring is performed at a frequency that is consistent with the existing and potential hazards and activities planned in the area. Air monitoring equipment includes portable and fixed air sampling equipment and continuous air monitors.
2. Air sampling equipment shall be used where an individual is likely to receive an exposure of 40 or more Derived Air Concentration (DAC) hours in a year **[see 835.403(a)(1)]**. This intake generally represents a committed effective dose equivalent to an individual of approximately 100 millirem. Samples shall also be taken as necessary to characterize the hazard in areas where respiratory protection devices or engineered controls have been prescribed for protection against airborne radionuclides **[see 835.403(a)(2)]**. Air samples should be adequate to evaluate the concentrations of airborne radioactive materials at the individual's work locations.
3. Real-time (or continuous) air monitors will not be used for this project.
4. Air sampling equipment should be positioned to measure air concentrations to which individuals are exposed.
5. Air monitoring equipment shall be routinely calibrated and maintained on an established frequency **[see 835.401(b)]**.
6. A technical basis document should be developed for the airborne radioactivity monitoring program. The technical basis document should provide the basis for air monitor selection, placement, and operation.
7. Preliminary assessments of air samples utilizing field survey techniques should be performed promptly upon removal. In situations where background levels of radon (Rn-222) and thoron (Rn-220) daughters interfere with evaluation of alpha air samples, prompt field assessments may not be possible.

PART 6 Instrumentation and Calibration

561 Standardization

TtEC will use commercially available standard instrumentation.

562 Inspection, Calibration, and Performance Tests

1. TtEC will not prepare calibration procedures since it does not provide instrumentation calibration. Instruments will be calibrated offsite by a qualified vendor on the suggested frequency.
2. Instruments will only be used to detect radiation for which they are calibrated.
3. Procedures should be developed for each instrument type and should include frequency of calibration, periodic performance tests requirements, and maintenance requirements.
4. Daily checks will be performed on instrumentation to demonstrate operability.
5. Instrumentation that is determined to be faulty or does not meet daily operability or response checks will be taken out of service. SRPO should review surveys performed with identified defective instruments and consider the need for additional surveys.

563 Maintenance

1. A program for preventive and corrective maintenance of radiological instrumentation should be established and documented.
2. Preventive and corrective maintenance should be performed using components and procedural recommendations at least as stringent as those specified by the manufacturer of the instrument.
3. Radiological instruments should undergo calibration prior to use following any preventive or corrective maintenance or any adjustment that voids the previous calibration. A battery change is not normally considered maintenance.

564 Calibration Facilities

This requirement is not applicable to TtEC since all instrument calibrations will be performed off-site by a qualified vendor in accordance with the recommendations of ANSI N323A.

CHAPTER 6 TRAINING AND QUALIFICATION

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PART 1 Radiological Control Training and Qualification

611 Purpose

The provisions of this chapter ensure that individuals are trained to work safely in and around radiological hazards and to maintain radiation exposures ALARA. Training provisions in this chapter apply to individuals entering project controlled areas and other individuals who are responsible for developing and implementing radiological control measures.

612 Regulatory Basis

1. 10 CFR 835.901 establishes requirements for radiation safety training programs for two classes of individuals: 1) individuals who are permitted unescorted access to controlled areas or occupationally exposed to radiation; and 2) individuals who are permitted unescorted access to radiological areas or perform unescorted assignments as a radiological worker. Within this RPIP, these training programs are referred to as General Employee Radiological Training and Radiological Worker Training (I and II), respectively. In addition, 10 CFR 835.103 establishes requirements for the education, training, and skills of individuals who are responsible for developing and implementing measures necessary for ensuring compliance with 10 CFR 835.
2. Documentation of successful completion of a core radiological training course (i.e., Radiological Worker Training) at a DOE site within the past two years will be provided to WSRC to determine if training requirements may be waived However, any additional radiological control training necessary for the individuals to perform radiological work or to enter specific areas, including project-specific aspects of the radiation safety training, shall be completed **[see 835.901(c)]**.

613 General Provisions

1. Personnel radiological training (i.e., GERT, RWT I, RWT II) will be provided by WSRC.
2. Prior to permitting an individual to enter a radiological area unescorted or perform unescorted radiological work, personnel must successfully complete the required training identified for this project
3. Personnel will complete requalification training on the required frequencies
4. Measures should be implemented to ensure that each individual's current training status can be assessed as necessary to ensure appropriate job assignments and to permit effective entry control.
5. Project-specific training should include changes in requirements and applicable updates of lessons learned from operations and maintenance experience and occurrence reporting, for the project, SRS and across the DOE complex.
6. Requirements and guidance for training records and course documentation are provided in Article 725.

614 Instructor Training and Qualifications

1. WSRC is responsible for the verification of their instructors' qualifications.
2. TtEC is responsible for the verification of their instructors' qualifications.

PART 2 General Employee Radiological Training

Table 3-1 summarizes the requirements for those individuals who should receive General Employee Radiological Training.

621 General Employees

1. WSRC will be responsible for the content and delivery of GERT
2. TtEC personnel will successfully complete GERT.

622 Radiological Safety Training and Orientation for Members of the Public

WSRC will be responsible for training members of the public who need unescorted access to SRS. TtEC will be responsible for approving and briefing visitors to their project areas and will be responsible for escorting all visitors.

PART 3 Radiological Worker Training

Table 3-1 summarizes the requirements for those individuals who should receive Radiological Worker Training.

631 General Provisions

1. Each individual shall demonstrate knowledge of the radiation safety training topics established in Article 613.1, commensurate with the hazards in the area and required controls, by successful completion of an examination and appropriate performance demonstrations prior to being permitted unescorted access to radiological areas and prior to performing unescorted assignments as a radiological worker **[see 835.901(b)]**.
2. TtEC personnel will obtain the training required by the project Training Matrix.

632 Radiological Worker I

1. Radiological Worker I Training, including High/Very High Radiation Area Training (Article 632.2), should encompass at a minimum the following practical factors:
    a. Entering and exiting simulated radiological buffer areas and radiation areas (and high radiation areas when such training is included)
    b. Performance of frisking for personnel contamination, as applicable
    c. Verification of instrument response and source check
    d. Proper response to alarm situations.
2. Unescorted worker access to high and very high radiation areas may be permitted upon successful completion of Radiological Worker I Training and High/Very High Radiation Area Training. Individuals who complete this training should not be allowed to enter contamination, high contamination, or airborne radioactivity areas unescorted, nor should they be allowed to enter soil contamination areas during activities that will disturb the soil.

WSRC will provide RWI training.

633 Radiological Worker II

Radiological Worker II Training should encompass at a minimum the following practical factors:

a. Donning of protective clothing, if applicable
b. Entering a simulated radiological buffer area, contamination area, and radiation area to perform a task, if applicable
c. Proper response to simulated abnormal situations
d. Proper response to simulated alarms or faulty radiological control equipment

e. Removing protective clothing and equipment and subsequently exiting the simulated area, if applicable

f. Performance of frisking for personnel contamination, if applicable

g. Verification of instrument response and source check.

WSRC will provide RWII training.

634 Specialized Radiological Worker Training

No specialized radiological training is required for this project.

PART 4 Radiological Control Technician and RCO Manager Qualification

641 General Provisions

Training and qualification of Radiological Control Technicians (RCTs) and their immediate supervisors should address routine operations and also focus on recognizing and handling situations in both normal and changing radiological conditions.

642 Radiological Control Technician

1. Because of the nature of their duties (e.g., monitoring the workplace, implementing administrative controls and entry controls), RCTs would generally be expected to have responsibility for implementing measures necessary for ensuring compliance with 10 CFR 835. Therefore, RCTs will generally be subject to the education, training, and skills requirements of 10 CFR 835.103. RCT training should include the standardized core course training materials, as applicable, which should be expanded to include project-specific information.
2. RCT candidates who have prerequisite knowledge, such as college credit, operational experience, or related qualifications, may satisfy individual sections of the RCT core course training requirements by passing comprehensive challenge examinations.
3. Entry-level prerequisites should be established to ensure that RCTs meet the standards for physical condition and education. At a minimum, these standards should include the following:
    a. High school education or equivalency
    b. Fundamentals of mathematics, physics, chemistry, and science
    c. Reading and comprehension level sufficient to follow procedures, write permits, prepare survey maps, write reports, and prepare shipping and transfer permits
    d. Ability to work in a support role, including communicating verbal instructions to others
    e. Physical requirements to handle personal protective equipment and other equipment and assist others in work locations, commensurate with assignment.
4. RCTs are encouraged to pursue registration by the National Registry of Radiation Protection Technologists (NRRPT). RCTs achieving NRRPT registration are exempted from their next comprehensive written exam.

643 Qualification Standards for Radiological Control Technicians

1. TtEC will only use qualified RCTs who have been approved by WSRC.
2. RCTs will be provided with project-specific training, including project procedures, policies, EHS, and radiological instrumentation.
3. Project-specific training requirements will be identified and documented on the RCT Training Qualification Card.

4. Qualification Standards for the radiological control technician position should include on-the-job training to provide hands-on experience directly applicable to the job.
5. Qualification Standards define the requirements for demonstrating completion of training. Signatures on the forms in Qualification Standards provide documentation of satisfactory proficiency.

644 Oral Examination Boards

The oral examination board provides an opportunity to identify areas of strength and weakness related to performance of radiological control technician duties and manager functions. The oral examination board also provides the opportunity to identify additional training needs to enhance radiological control technician and supervisor training programs.

1. An oral examination board should determine the initial qualification and requalification of candidates for RCT and SRPO Supervisors.
2. The RCM should designate the board members and appoint a chairperson.
3. The board constituted to evaluate RCT qualification should be composed of at least three persons to include an SRPO Supervisor, radiological control staff, and project management, as applicable.
4. The board should assess the candidate's response to normal and emergency situations. Questions should be of the type that are not normally covered in a written examination.

645 Continuing Training

TfFW RCTs will maintain training current in accordance with WSRC Manual 5Q, Article 645.

646 SRPO Supervisors

1. Because of the nature of their duties, SRPO Supervisors would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103. Training and education standards for SRPO supervisors should be consistent with DOE-STD-1107-97, Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities.
2. SRPO Supervisors should have supervisory and leadership capabilities to direct the work of technicians; effectively interact with crafts, line managers, professional staff, and other managers; and be able to respond and direct others in emergency and abnormal situations.
3. SRPO Supervisors will be provided with project-specific training, including project procedures, policies, EHS, and radiological instrumentation.
4. Project-specific training requirements will be identified and documented on the SRPO Supervisor Training Qualification Card.

647 Subcontracted Radiological Control Technicians

Sub-contract RCTs shall meet the requirements of Articles 642, 643, 644, and 645.

PART 5 Other Radiological Training

651 Management Training

TtEC Management will meet the qualifications stated in Attachment D “Field Condition Specification for Radiological Work at Savannah River Site” under RC/HP Personnel Qualification Requirements provisions 3 and 4.

652 Technical Support Personnel

Appropriate technical support personnel (engineers, schedulers, procedure writers) may be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103 and should be trained in the ALARA fundamentals and dose reduction techniques. Technical support personnel should receive training consistent with DOE-HDBK-1110-97, ALARA Training for Technical Support Personnel.

653 Planners

Planners who develop detailed work plans involving or associated with radioactivity or radioactive materials should have Radiological Worker Training to the level required by the workers using the work plans. Planners would generally be considered to be subject to the education, training, and skill requirements of 10 CFR 835.103. Planners should receive training consistent with DOE-HDBK- 1110-97, ALARA Training for Technical Support Personnel.

654 Radiological Control Personnel

SRPO senior staff will meet the requirements identified in Attachment D “Field Condition Specification for Radiological Work at Savannah River Site” under RC/HP Personnel Qualification Requirements.

655 Radiographers and Radiation Generating Device Operators

TtEC will not be performing radiography during the course of this project and will bring no radiation generating devices to project areas.

656 Emergency Response Personnel

Provisions should be in place to accommodate rapid project area and radiological area access by on-site and off-site emergency workers such as firefighters, medical personnel, and security personnel.

1. Emergency response personnel should receive special radiological worker training commensurate with the situations they are likely to encounter. Any individual assigned to perform emergency actions that may result in a dose exceeding the occupational dose limits shall receive Radiological Worker or equivalent training [see 835.1302(d)]. They shall be briefed beforehand on the known or anticipated hazards to which they will be subjected [see 835.1302(d)].
2. Such training should be based on DOE’s Radiological Worker core course and project-specific training materials.
3. If such workers are not trained, trained escorts should be assigned.
4. Training should make it clear that lifesaving has priority over radiological controls.
5. Records of this training should be maintained.

PART 6 Reserved

CHAPTER 7 RADIOLOGICAL CONTROL RECORDS

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PART 7 Records Management

PART 8 Radiological Reporting

PART 1 General Provisions

711 Purpose

This chapter prescribes practices for preparing and retaining radiological control records. The work force and management are required to use records to document radiological safety afforded to individuals for project activities. Records of radiological control programs may be required to support worker health studies and future disputes or claims. Therefore, these records should be high quality, readily retrievable, and managed for the prescribed retention period. Records should be handled such that personal privacy is protected.

712 Records Management Program

1. The radiological records management program should ensure that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable), and disposition. The records management program shall be sufficient to ensure that records are maintained as necessary to document compliance with 10 CFR 835 **[see 835.701(a)]** and should include records of the following:

    a. Radiological Control Policy Statements

    b. Radiological Control Procedures

    c. Individual Radiological Doses

    d. Internal and External Dosimetry Policies and Procedures (including Technical Bases Documents)

    e. Personnel Training (course records and individual records)

    f. ALARA Program Implementation

    g. Radiological Instrumentation Test, Maintenance, and Calibration

    h. Radiological Surveys

    i. Area Monitoring Dosimetry Results

    j. Radiological Work Permits

    k. Radiological Performance Indicators and Assessments

    l. Radiological Safety Analysis and Evaluation Reports

    m. Quality assurance measures

    n. Radiological Incident and Occurrence Reports (and Critique Reports, if applicable)

    o. Sealed radioactive source accountability and control

    p. Release of material to controlled areas

    q. Reports of loss of radioactive material.

2. Where radiological services (for example, dosimetry and laboratory analyses) are purchased, there should be a clear agreement regarding records responsibility during performance of the service. Records of results should reside in the custody of the originating contract organization.

3. Detailed information concerning an individual's exposure shall be made available to that individual, upon request, consistent with the Privacy Act of 1974 (5 U.S.C. 522a), which contains requirements to protect the privacy of individual records **[see 835.702(f) and 801(d)]**.

713 Recordkeeping Standards

1. Radiological control records should be accurate and legible. The records should include the following:
    a. Identification of the project, specific location, function, and process
    b. Signature or other identifying code of the preparer and date
    c. Legible entries in black or blue-black ink
    d. Corrections identified by a single lineout, initialed and dated
    e. Management signature to ensure review and proper completion of forms.
2. Radiological control records should not include:
    a. Opaque substances for corrections
    b. Shorthand or other non-standardized terms.
3. Similar procedural standards should be established for computerized records.
4. Unless otherwise specified, radiological control records shall use the special units of curie, roentgen, rad, and rem, including multiples and subdivisions of these units **[see 835.4]**. Use of the international system of units (becquerel, gray, and sievert) should be limited to calculational, scientific, or reference purposes.

PART 2 Employee Records

721 Employment History

1. For each radiological worker whose occupational exposure is monitored in accordance with Article 511.1 or 521.1, efforts shall be made to obtain records of prior years' occupational doses **[see 835.702(e)]**. If formal records of previous occupational doses cannot be obtained, a written estimate signed by the individual may be accepted. Where practical, the association between the radiation dose and job function should be preserved for trending purposes and future worker health studies. The following information should be maintained:
    a. Previous work history detailing radiological work assignments, to the extent practical, and yearly occupational doses at other DOE and non-DOE facilities.
    b. Nuclear Regulatory Commission Form 4 or equivalent that documents previous occupational radiation doses.
    c. Ongoing work history documenting work assignments and radiation doses; the facility and occupational codes defined in DOE Order 231.1 should be used for this process.
    d. DOE standardized forms to document previous and ongoing radiation doses.
2. These records will be maintained in the TtEC Corporate Office and will be available to WSRC upon request.

722 Personnel Radiological Records

1. Records of TtEC personnel previous exposure will be maintained in the Corporate Office and will be available to WSRC upon request.
2. All records required for badging by the WSRC Dosimetry Program will be provided.
3. All records related to internal and external doses received while working on this project will be maintained by WSRC.

723 Other Personnel Radiological Records

TtEC will maintain the following record, as required, provided this does not represent a duplication of records also being maintained by WSRC:

1. The complete records of radiological incidents and occurrences involving personnel dose should be retained in, or cross-referenced to, the individual's dose records. Records related to doses exceeding the Table 2-1 limits including authorized emergency doses and planned special exposures and other, non-authorized doses exceeding the limits, shall be maintained **[see 835.1301(b)]**.
2. Records of employee radiological safety concerns that have been formally investigated and documented should be maintained.
3. Records of the formal written declaration of pregnancy, including the estimated conception date, and revocations of declarations of pregnancy shall be maintained **[see 835.704(d)]**. Records indicating that the pregnancy has concluded (therefore, the conditions of Article 215 do not apply) should also be maintained.

724 Medical Records

Complete personnel medical records will be maintained in accordance with the DOE Standard in the TtEC Corporate Office and will be available to WSRC upon request.

725 Radiological Training and Qualification Records

1. Records of training and qualification in radiological control are maintained to demonstrate that an individual received appropriate information to perform the work assignment in a safe manner. Qualification standard records are retained for on-the-job and practical factor training as well as for formal classroom training.
2. Formal records or summary reports of training and qualification should be readily available to management of involved personnel to aid in making work assignments.
3. Personnel training records shall be controlled and retained **[see 835.704(a)]**. At a minimum, these records should include the following:
    a. Course title
    b. Attendance sheets with instructor's name
    c. Employee's name, identification number and signature
    d. Date of training
    e. Identification of the examination or evaluation form, including sufficient data to identify which test each individual completed
    f. Verification document or record confirming satisfaction of the training requirement
    g. Documentation related to exceptions for training requirements and extensions of qualification
    h. Quizzes, tests, responses and acknowledgments of training, with the date and signature of the individual trained
    i. Special instructions to females, their supervisors, and coworkers concerning prenatal radiation dose, acknowledged by the worker's signature.
4. Records shall be retained for the following types of radiation safety training **[see 835.704(a)]**:
    a. General employee radiological training
    b. Radiological worker training

c. Periodic training

d. Members of the public training for unescorted access.

Records should be retained for the following types of radiation safety training:

a. Instructor training

b. Training of other radiological control personnel

c. Respiratory protection training

d. Qualifications for special tests or operations

e. Orientation of members of the public

f. Training of emergency response personnel.

5. Records shall be maintained as necessary to demonstrate that individuals who are responsible for the development and implementation of measures necessary to ensure compliance with 10 CFR 835 have the appropriate education, training, and skills to execute these responsibilities **[see 835.103 and 835.701(a)]**. These records should include records of the training provided in accordance with Parts 4 and 5 of Chapter 6 of this Manual.

6. The following instructional materials should be maintained:

   a. Course name, with revision and approval date.

   b. Instructor's manuals, course content, or lesson plans containing topical outlines.

   c. Video and audio instructional materials, including the dates and lessons for which they were used.

   d. Handouts or other materials retained with the master copy of the course.

   e. Job-specific training documents, such as instrument use, radiological procedures, radiological work permit special training requirements, pre-job briefings, post-job evaluations, and mockup training.

7. Records for training provided by WSRC will be maintained by WSRC.

PART 3 [Reserved]

PART 4 Radiological Control Procedures

741 Policies, Procedures, and Radiological Work Permits

Records of the radiological control program should consist of policy statements, procedures, work authorizations, and supporting data. The records should be maintained in a chronological sequence that will allow correlation with the corresponding support information. For example, procedures for performing radiation surveys should be identifiable with the survey results. Completed radiological work permits should be maintained.

742 ALARA Program Records

Records of actions taken to maintain occupational exposures ALARA shall be maintained **[see 835.701(a)]**. These records shall include project design and control measures **[see 835.704(b)]** and should include:

a. ALARA plans and goals

b. The minutes of ALARA committees and other committees where radiological safety issues are formally discussed

743 Quality Assurance Records

Records of quality assurance reviews and audits developed for radiological control functions shall be retained to ensure that sufficient records are specified, prepared, reviewed, approved, and maintained to accurately reflect completed work **[see 835.704(c)]**. DOE Order 414.1A and 10 CFR 830.120 provide additional information regarding quality assurance records.

PART 5 Radiological Monitoring

751 Area Monitoring Records

1. Radiological control programs require the performance of radiation, airborne radioactivity, and contamination monitoring to determine existing conditions in a given location. Maps with sufficient detail to permit identification of original survey and sampling locations should be maintained. Radiological monitoring results should be recorded on appropriate standard forms and include the following common elements:
    a. Date, time, and purpose of the survey
    b. General and specific location of the survey
    c. Name and signature of the surveyor and analyst
    d. Pertinent information needed to interpret the survey results
    e. Reference to a specific radiological work permit if the survey is performed to support the permit.
2. Records shall be maintained to document:
    a. Results of monitoring and surveys for radiation and radioactive materials **[see 835.703(a)]**
    b. Results of monitoring and calculations used to determine individual occupational doses **[see 835.703(b)]**
    c. Results of surveys for release of materials from radiological areas **[see 835.703(c)]**
    d. Results of sealed radioactive source leak tests and inventories **[see 835.704(f)]**
    e. Results of surveys of radioactive material packages received from transportation **[see 835.405(c)]**
    f. Changes in monitoring equipment, techniques, and procedures **[see 835.704(e)]**.

752 Radiation Monitoring

1. In addition to the elements provided in Article 751, records of radiation monitoring should include at a minimum, the following information:
    a. Instrument model and serial number
    b. Results of the measurements of area dose rates
    c. Locations of hot spots and other radiological hazards
    d. Project conditions existing during the survey that may have affected radiological conditions.

753 Airborne Radioactivity Monitoring

1. In addition to the elements provided in Article 751, records of airborne radioactivity monitoring should include, at a minimum, the following information:

a. Model and serial numbers of the sampler and laboratory counting instrument when available or unique identifier of each sampler and instrument and appropriate supporting parameters including counting efficiency, counting time, and correction factors

b. Locations of fixed air samplers

c. Locations of portable air samplers used for a survey

d. Air concentrations in general airborne areas and breathing zones

e. Supporting parameters, including collection efficiency, flow rate, duration of sampling, correction factors, and filter medium

f. Identification (e.g., names and/or employee numbers) of individuals in the area for whom DAC-hour exposure should be calculated.

754 Contamination Monitoring

1. In addition to the elements provided in Article 751, records of contamination monitoring should include, at a minimum, the following information:

   a. Model and serial number of counting equipment

   b. Contamination levels (using appropriate units) and appropriate supporting parameters including counting efficiency, counting time, correction factors, type of radiation, and whether the contamination was fixed or removable

   c. Location of areas found to contain hot particles or high concentrations of localized contamination

   d. Follow-up survey results for decontamination processes cross-referenced to the original survey.

755 Sealed Radioactive Source Leak Tests and Inventories

1. TtEC will not maintain accountable sources requiring leak testing.
2. TtEC will maintain an inventory of exempt quantity check sources.

PART 6 Instrumentation and Calibration Records

761 Calibration and Operational Checks

1. TtEC will not perform instrument calibrations. All instruments will be calibrated off-site by a qualified vendor. Copies of vendor provided calibration records will be maintained in project files and will include calibration records for fixed, portable, and laboratory radiation measuring instruments and equipment and individual monitoring devices shall be maintained **[see 835.703]**. These records should include frequencies, method, dates, personnel, training, and traceability of calibration sources to National Institute of Standards and Technology or other acceptable standards.
2. Calibration and maintenance records shall be maintained for instruments and equipment used for monitoring [see 835.703]. Calibration and maintenance records should be maintained for the following equipment:

   a. Portable survey instruments

   c. Laboratory, counting room, and fixed radiation measuring equipment

   h. Air sampling equipment

3. Documentation of instrument operational checks shall be maintained **[see 835.701(a) & 835.401(b)]**. Such records should be maintained for a period not less than the calibration period of the instrument.

4. Maintenance results for each instrument and device shall be created and retained [see 835.703]. Maintenance histories for each instrument and device should be created and include the nature of any defects and corrective actions taken.

762 Special Calibration Records

Records of additional tests and checks of instrumentation used in conjunction with a suspected overexposure, questionable indication, or unusual occurrence should be retained. In addition, records of special instrument calibrations and modifications made in accordance with Article 562.6 shall be retained **[see 835.703]**.

PART 7 Records Management

771 Media

A combination of media may be used for a comprehensive records system. All records should be stored in a manner that ensures their integrity, retrievability, and security and, unless otherwise specified, shall be retained until final disposition is authorized by DOE **[see 835.701(b)]**.

772 Microfilm

TtEC will not use microfilm as a storage media.

773 Computerization of Records

1. Records may be transferred to magnetic storage media provided certain precautions are taken to ensure that the information is maintained in a retrievable configuration.
2. Controls for the use and handling of magnetic storage media should include the following:
    a. A master index of documents on the magnetic storage medium
    b. A program to ensure back-up and retrievability of information
    c. Quality control during data entry and analysis
    d. An index identifying software applications used in conjunction with the data
    e. Software validation and verification
    f. Periodic quality audits of software
    g. Prevention of unauthorized manipulation of data
    h. Assurance that previously stored information is retrievable and useable after system modifications.
3. Optical disks may be used to archive records if the optical disks satisfy the following:
    a. A reliable system to prevent overwriting or erasure of records
    b. Software and user controls consistent with Article 773.2
    c. Manufacturer recommendations relating to software control, disk life expectancy, environmental storage conditions, and maintenance incorporated into policies and procedures
    d. Quality controls on the copying and imaging processes consistent with Article 772.

774 Retention

1. 10 CFR 835 establishes requirements for retaining records. Upon cessation of activities that could result in the occupational exposure of individuals, all required records related to individual exposure monitoring shall be transferred to DOE **[see 835.702(h)]**.

2. Once a record has been created, reviewed, and signed by appropriate supervision, the record is considered complete and should not be modified. Subsequent errors identified in a completed record may be corrected by creating a supplemental record that includes traceability for the correction.

775 Physical Protection of Records

1. Methods for protecting documents should include vaults, file rooms with fixed fire suppression, fire rated cabinets, duplicate storage, or combinations of these.
2. Storage arrangements should address physical damage that could be caused by temperature extremes, moisture, infestation, electromagnetic fields, excessive light, stacking, theft, and vandalism.
3. Records should, as a minimum, be protected from:
    a. Exposure to fire, equivalent to an Underwriters Laboratories, Inc., 1.5-hour, or greater, fire resistance rating
    b. Exposure to water damage caused by a 100-year flood
    c. Exposure to windstorm velocities of 100-year recurrence.

PART 8 Radiological Reporting

781 Reports to Individuals

WSRC will be responsible for providing personnel dose reports required by 10 CFR 835. These reports should include the following:

1. Individuals who are monitored in accordance with Article 511.1 or 521.1 shall be provided an annual report of their dose **[see 835.801(c)]**. Upon request, an individual shall be provided detailed information concerning his or her exposure, consistent with the Privacy Act **[see 835.801(d)]**.
2. Upon request, terminating employees shall be provided a report, as soon as data are available but not later than 90 days following the last day of employment. A written estimate, based upon available information, shall be provided upon termination, if requested **[see 835.801(b)]**.
3. Reports of individual doses shall include the site or facility name, the individual's name and social security number, employee number, or other unique identification number, and all dose information required by WSRC 5Q Articles 722.4 - 722.9 **[see 835.801(a)]**. Reporting of lifetime occupational dose is suggested.
4. Reports of individual exposure to radiation or radioactive material required under DOE Order 232.1A or as a result of a planned special exposure, emergency exposure, or accident should be submitted to DOE in accordance with applicable occurrence reporting requirements. Copies of the individual dose information contained in these reports shall be provided to the affected individual at a time not later than transmittal of the report to the Department **[see 835.801(e)]**.

782 Annual Radiation Report

DOE O 231.1, Environment, Safety and Health Reporting, provides reporting requirements for the Annual Radiation Dose Summary. This report includes internal and external radiation dose results for monitored DOE and DOE contractor employees, and for monitored members of the public. WSRC will be responsible for the generation of this report.

REFERENCES

10 CFR 34, "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations." [365.5, 655.1]
10 CFR 71, "Packaging and Transportation of Radioactive Material." [423.10, 552.4]
10 CFR 830.120, "Quality Assurance Requirements." [743]
10 CFR 835, "Occupational Radiation Protection." [multiple citations]
29 CFR 1910.134, "Respiratory Protection." [531, 533]
49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements." [423]
49 CFR 173, "Shippers - General Requirements for Shipments and Packaging." [423]
Atomic Energy Act of 1954, as amended. Public Law 83-703. [Glossary]
ANSI N2.1, (1989) "Radiation Symbol." [Glossary]
ANSI N43.2, (1989) "Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment." [365.2]
ANSI N43.3, (1993) "General Radiation Safety - Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV." [365.1]
ANSI N323A, (1997) "Radiation Protection Instrumentation Test and Calibrations, Portable Survey Instruments." [562.1, 564]
ANSI Z88.2, (1992) "Practices for Respiratory Protection." [531.2, 532, 533]
ANSI Z88.6, (1984) "Physical Qualifications for Respirator Use." [532]
DOE O 210.1, (5/1/96) "Performance Indicators and Analysis of Operations Information" [131]
DOE O 231.1, (11/7/96) "Environment, Safety, and Health Reporting." [721, 782]
DOE O 232.1A, (7/21/97) "Occurrence Reporting and Processing of Operations Information." [781.4]
DOE O 414.1A, (7/12/01) "Quality Assurance." [743]
DOE O 420.1A, (5/20/02) "Facility Safety." [381]
DOE O 435.1 (8/28/01) "Radioactive Waste Management." [441, 442]
DOE O 440.1A, (3/27/98) "Worker Protection Management for DOE Federal and Contractor Employees." [345.1]
DOE O 460.1A, (10/2/96) "Packaging and Transportation Safety." [423.2, 423.5]
DOE O 460.2, (10/26/95) "Departmental Materials Transportation and Packaging Management." [423.2]
DOE O 461.1 (9/29/00) "Packaging and Transfer or Transportation Materials of National Security Interest." [423.2]
DOE O 5400.5, (1/7/93) "Radiation Protection of the Public and the Environment." [422, Glossary]
DOE O 5480.4, (1/7/93) "Environmental Protection, Safety, and Health Protection Standards." [365.2]
DOE G 440.1-1, (7/10/97) "Worker Protection Management for DOE Federal and Contractor Employees Guide [312.4]
DOE G 441.1-1, (3/17/99) "Management and Administration of Radiation Protection Programs Guide [134.2]
DOE HDBK-1110-97, (1997) "ALARA Training for Technical Support Personnel." [652, 653]
DOE P 441.1, (4/26/96) "Department of Energy Radiological Health and Safety Policy."
DOE P 450.4, (10/15/96) "Safety Management System Policy." [118]
DOE-STD-3022-98, (5/98) "DOE HEPA Filter Test Program." [464.2]]
DOE-STD-3025-99, (2/99) "Quality Assurance Inspection and Testing of HEPA Filters." [464.2]
DOE-STD-1095-95, (1995) "Department of Energy Laboratory Accreditation Program for Personnel Dosimetry Systems." [512.1]
DOE-STD-1098-99, (1999) "Radiological Control." [645]
DOE-STD-1112-98, (1998) "Laboratory Accreditation Program for Bioassay." [522.1]
DOE-STD-1107-97, (1997) "Knowledge, Skills, and Abilities for Key Radiation Protection Positions at DOE Facilities." [142.1, 646.1, 651.1, 654.4]

EPA Federal Guidance Report No. 11, (1988) “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.” [Glossary]
ICRP Publication 23, (1975) “Reference Man Anatomical Physiological and Metabolic Characteristics.” [Glossary]
NCRP Report No. 65, Management of Persons Accidentally Contaminated with Radionuclides [542.1]
National Conference of Standards Laboratories Recommended Practices RP-1, “Establishment and Adjustment of Calibration Intervals.” [562.3]
Privacy Act of 1974, as amended. [712.3, 781.1]
Resource Conservation and Recovery Act of 1976, as amended. Public Law 94-580. [443]
WSRC-RP-94-1239, Radiation Protection Program for 10 CFR 835 Occupational Radiation Protection. [112]
WSRC-RP-94-1268, “Standards/Requiremetns Identification Document - Integrated Safety Management System Description” [118, 311.4]
WSRC Manual 9B, “Site Item Reportability and Issue Management” [127, 134.4, 351, 411.3]
WSRC Manual 5Q, “Radiological Control” [551.5, 781.3]

GLOSSARY

abnormal situation: Unplanned event or condition that adversely affects, potentially affects, or indicates degradation in the safety, security, environmental, or health protection performance or operation of a facility.

accountable sealed radioactive source: A sealed radioactive source having a half-life equal to or greater than 30 days and an isotopic activity equal to or greater than the corresponding value provided in Appendix 4A of this manual **[see 835.2(a)]**.

activation: Process of producing a radioactive material by bombardment with neutrons, protons, or other nuclear particles.

administrative control level: A numerical occupational dose constraint established at a level below the occupational dose limits provided in Chapter 2 to administratively control and help reduce individual and collective dose.

airborne radioactivity: Radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases **[see 835.2(a)]**.

airborne radioactivity area: Any area, accessible to individuals, where: 1. the concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the derived air concentration (DAC) values listed in appendix A or Appendix C of 10 CFR 835; or an individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week **[see 835.2(a)]**.

annual limit on intake (ALI): The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose equivalent of 5 rems (0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue **[see 835.2(a)]**.

As Low As is Reasonably Achievable (ALARA): The approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this manual, ALARA is not a dose limit but a process that has the objective of attaining doses as far below the applicable controlling limits as is reasonably achievable **[see 835.2(a)]**.

ALARA Committee: Multi-disciplined forum that reviews and advises management on improving progress toward controlling radiation exposure and radiological releases.

assessment: Evaluation or appraisal of a process, program, or activity to estimate its acceptability.

background radiation: Radiation from:

(1) Naturally occurring radioactive materials which have not been technologically enhanced;

(2) Cosmic sources;

(3) Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices);

(4) Radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and

(5) Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation **[see 835.2(a)]**.

becquerel (Bq): The International System (SI) unit for activity of radioactive material. One Becquerel is that quantity of radioactive material in which one atom is transformed per second or undergoes one disintegration per second.

bioassay: The determination of the kinds, quantities, or concentrations, and, in some cases, locations of radioactive material in the human body, whether by direct measurement or by analysis and evaluation of radioactive materials excreted or removed from the human body **[see 835.2(a)]**.

calibration: The process of adjusting or determining either:

(1) The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values; or

(2) The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value **[see 835.2(a)]**.

company-issued clothing: Clothing provided by the company for non-radiological purposes, such as work coveralls and shoes.

containment device: Barrier, such as a glove bag, glovebox, or tent, for inhibiting the release of radioactive material from a specific location.

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 Chapter 2, Table 2-2, but do not exceed 100 times those values **[see 835.2(a)]**.

continuing training: Training scheduled over a specified time, such as over a two-year period, for the purpose of maintaining and improving technical knowledge and skills.

continuous air monitor (CAM): Instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels. Also referred to as a real-time air monitor.

contractor: Any entity under contract with the Department of Energy with the responsibility to perform activities at a DOE site or facility **[see 835.2(a)]**.

controlled area: Any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material **[see 835.2(a)]**.

counseling: Advice, information exchange, and guidance provided to employees on radiologically related topics, such as dose perspectives; potential health effects from radiation exposure; skin contaminations; contaminated wounds; internally deposited radioactivity; pregnancy; and radiation exposure. This advice and guidance are normally provided by knowledgeable, senior professionals from the radiological control organization and other organizations, such as Medical, as appropriate.

critical mass: The smallest mass of fissionable material that will support a self-sustaining chain reaction under specified conditions.

critique: Meetings of personnel involved in or knowledgeable about an event (either a success or an abnormal event) to document a chronological listing of the facts.

declared pregnant worker: A woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational exposure limits to the embryo/fetus as provided in Article 215. This declaration may be revoked, in writing, at any time by the declared pregnant worker **[see 835.2(a)]**.

decontamination: Process of removing radioactive contamination from personnel, equipment, or areas.

derived air concentration (DAC): For the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m3). For radionuclides listed in Appendix C of 10 CFR 835, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud. The values are based upon the derived airborne concentration found in Table 1 of the U. S. Environmental Protection Agency's Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988 **[see 835.2(a)]**.

derived air concentration-hour (DAC-hour): The product of the concentration of radioactive material in air (expressed as a fraction or multiple of the DAC for each radionuclide) and the time of exposure to that radionuclide, in hours **[see 835.2(a)]**.

disintegration per minute (dpm): The rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

DOE activity: An activity taken for or by the DOE in a DOE operation of facility that has the potential to result in the occupational exposure of an individual to radiation or radioactive material. The activity may be, but is not limited to, design, construction, operation, decontamination or decommissioning. To the extent appropriate, the activity may involve a single DOE facility or operation or a combination of facilities and operations, possibly including an entire site or multiple DOE sites **[see 835.2(a)]**.

DOELAP: Department of Energy Laboratory Accreditation Program for personnel dosimetry and bioassay programs.

dose: A general term for absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent **[see 835.2(b)]**. Various technical terms, such as dose equivalent, effective dose equivalent, and collective dose, are used to describe the amount of radiation an exposed individual receives. These terms are used to describe the differing interactions of radiation with tissue as well as to assist in the management of personnel exposure to radiation. Some types of radiation, such as neutron and alpha, deposit their energy more densely in affected tissue than gamma radiation, thereby causing more damage to tissue. The term **dose equivalent**, measured in units of rem, is used to take into account this difference in tissue damage. Therefore 1 rem from gamma radiation causes damage **equivalent** to 1 rem from alpha radiation. However, it takes one-twentieth as much energy from alpha radiation, as compared with gamma radiation, to produce this 1 rem

dose equivalent. Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following:

absorbed dose (D): Energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (orgray) (1 rad = 0.01 gray) **[see 835.2(b)]**.

collective dose: The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert).

committed dose equivalent (HT,50): The dose equivalent calculated to be received by a tissue ororgan over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert) **[see 835.2(b)]**.

committed effective dose equivalent (HE,50): The sum of the committed dose equivalents to various tissues in the body (HT,50), each multiplied by the appropriate weighting factor (wT) - that is HE,50=□wTHT,50. Committed effective dose equivalent is expressed in units of rem (or sievert) **[see 835.2(b)]**.

cumulative total effective dose equivalent: The sum of all total effective dose equivalent values recorded for an individual, where available, for each year occupational exposure was received, beginning January 1, 1989 [see 835.2(b)]. The January 1, 1989 date is not appliable to dose records at SRS. When requested, all occupational dose received at SRS is reported.

deep dose equivalent: The dose equivalent derived from external radiation at a depth of 1 cm in tissue **[see 835.2(b)]**.

dose equivalent (H): The product of the absorbed dose (D) (in rad or gray) in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert) **[see 835.2(b)]**.

effective dose equivalent (HE): The summation of the products of the dose equivalent received by specified tissues of the body (HT) and the appropriate weighting factors (WT) - that is (HE = □WTHT). It includes the dose from radiation sources internal and/or external to the body. For purposes of demonstrating compliance with the regulatory dose limits, deep dose equivalent to the

whole body may be used as effective dose equivalent for external exposures. The effective dose equivalent is expressed in units of rem (or sievert) **[see 835.2(b)]**.

external dose or exposure: That portion of the dose equivalent received from radiation sources outside the body (e.g., "external sources") **[see 835.2(b)]**.

extremity: Hands and arms below the elbow or feet and legs below the knee **[see 835.2(b)]**.

internal dose or exposure: That portion of the dose equivalent received from radioactive material taken into the body (e.g., "internal sources") **[see 835.2(b)]**.

lens of the eye dose equivalent: The external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm **[see 835.2(b)]**.

quality factor: The modifying factor used to calculate the dose equivalent from the absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate quality factor (Q) **[see 835.2(b)]**. Quality factors are provided in 10 CFR 835.

shallow dose equivalent: The dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue **[see 835.2(b)]**.

total effective dose equivalent (TEDE): The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures**) [see 835.2(b)]**.

weighting factor (wT): The fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The dose equivalent to the affected tissue (HT) is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue **[see 835.2(b)]**.

whole body: For the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee **[see 835.2(b)]**.

dose assessment: Process of determining radiation dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information, and pathway analysis.

embryo/fetus: Developing human organism from conception until birth. Same as unborn child.

engineering controls: A special form of physical design feature in which components and systems, such as piping, containments, ventilation, filtration, or shielding, are used to reduce airborne radioactivity, radiation levels, and the spread of contamination.

entrance or access point: Any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use **[see 835.2(a)]**.

facility: For the purpose of this manual, a facility includes systems, buildings, utilities, and related activities whose use is directed to a common purpose at a single location. Examples include: accelerators, storage areas, test loops, nuclear reactors, radioactive waste disposal systems and burial grounds, testing laboratories, research laboratories, and accommodations for analytical examinations of components. Also includes: pipelines, ponds, impoundments, landfills and the like, and motor vehicles, rolling stock, and aircraft.

filter integrity test: Test performed on High-Efficiency Particulate Air (HEPA) filters to identify any damage to the filter or leakage around the filter.

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 activation processes.

frisk or frisking: Process of surveying personnel for contamination. Frisking can be performed with hand-held survey instruments or automated monitoring devices.

general employee: An individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or a visitor who performs work for or in conjunction with DOE or utilizes DOE facilities **[see 835.2(a)]**.

gestation period: The time from conception to birth, approximately 9 months.

gray (Gy): SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rads).

high-efficiency particulate air (HEPA) filter: Throwaway extended pleated medium dry-type filter with 1) a rigid casing enclosing the full depth of the pleats, 2) a minimum particle removal efficiency of 99.97 percent for thermally generated monodisperse di-octyl phthalate smoke particles with a diameter of 0.3 micrometer, and 3) a maximum pressure drop of 1.0 inch w.g. when clean and operated at its rated airflow capacity.

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 Chapter 2, Table 2-2 **[see 835.2(a)]**.

high radiation area: 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 Sv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates **[see 835.2(a)]**.

hot particle: Fuel, activated corrosion product, or other particles of small size that have a high specific activity as a result of nuclear fission or neutron activation. When in direct contact with the skin, hot particles are capable of producing a shallow dose equivalent of 100 millirem or more in one hour to a localized area.

hot spot: Localized source of radiation or radioactive material normally within facility piping or equipment. The radiation levels of hot spots exceed the general area radiation level by more than a factor of 5 and are greater than 100 millirem (1 mSv) per hour on contact.

individual: Any human being **[see 835.2(a)]**.

infrequent or first-time activities: Radiological work activities or operations that require special management attention and consideration of new or novel radiological controls. The designation of infrequent or first-time activities is specifically applicable to facilities that conduct routine and recurring process operations, and is not applicable to facilities that routinely conduct first-time activities, such as experimental or research facilities.

irradiator: Sealed radioactive material used to irradiate other materials that have the potential to create a radiation level exceeding 500 rad (5 grays) in 1 hour at 1 meter. Although not addressed in this manual, acceptable radiological controls for irradiator use are specified in Title 10, Code of Federal Regulations, Part 20.1603.

lifetime dose: Total occupational dose over a worker's lifetime, including external and internal dose.

low-level waste: Waste that contains radioactive material and is not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in Section 11e(2) of the Atomic Energy Act, as amended. Test specimens of fissionable material irradiated only for research and development and not for production of power or plutonium may be classified as low-level waste provided the concentration of transuranic activity is less than 100 nCi/g.

member of the public: An individual who is not a general employee. An individual is not a "member of the public" during any period in which the individual receives an occupational dose **[see 835.2(a)]**.

minor: An individual less than 18 years of age **[see 835.2(a)]**.

mixed waste: Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively.

monitoring: The measurement of radiation levels, airborne radioactivity concentrations, radioactive contamination levels, quantities of radioactive material, or individual doses and the use of the results of

these measurements to evaluate radiological hazards or potential and actual doses resulting from exposures to ionizing radiation **[see 835.2(a)]**.

occupational dose: An individual's ionizing radiation dose (external and internal) as a result of that individual's work assignment. Occupational dose does not include doses received as a medical patient or doses resulting from background radiation or participation as a patient in medical research programs **[see 835.2(a)]**.

personal protective equipment: Equipment such as respirators, face shields, and safety glasses used to protect workers from excessive exposure to radioactive or hazardous materials.

personnel dosimeters: Devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

personnel monitoring: Systematic and periodic estimate of radiation dose received by individuals during working hours. Also, the monitoring of individuals, their excretions, skin, or any part of their clothing to determine the amount of radioactivity present.

planned special exposure: Preplanned, infrequent exposure to radiation, separate from and in addition to the annual dose limits.

prenatal radiation exposure: The exposure of an embryo/fetus to radiation.

primary dosimeter: A dosimeter worn on the body used to obtain the formal record of whole body radiation dose.

protective clothing: Clothing provided to personnel to minimize the potential for skin and personal and company- issued clothing contamination. Also referred to as "anti-contamination clothing," "anti- Cs," and "PCs."

qualification standard: The explicit performance requirements for minimum proficiency in technical, academic, and site-specific knowledge and practical skills used in determining satisfactory completion of training programs. The qualification standard is used to qualify radiological control technicians at DOE facilities.

rad: Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joules per kilogram (0.01 gray).

radiation or ionizing radiation: Alpha particles, beta particles, gamma rays, X-rays, neutrons, highspeed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as used in this manual, does not include non-ionizing radiation, such as radio- or micro-waves, or visible, infrared, or ultraviolet light **[see 835.2(a)]**.

radiation area: 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 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates **[see 835.2(a)]**.

radioactive material: Any material that spontaneously emits ionizing radiation (e.g., X- or gamma rays, alpha or beta particles, neutrons). The term “radioactive material” also includes materials onto which radioactive material is deposited or into which it is incorporated. For purposes of practicality, both 10 CFR 835 and this manual establish certain threshold levels below which specified actions, such as posting, labeling, or individual monitoring, are not required. These threshold levels are usually expressed in terms of total activity or concentration, contamination levels, individual doses, or exposure rates.

radioactive material area: Any area within a controlled area, accessible to individuals, in which items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values provided in appendix 4A of this manual **[see 835.2(a)]**.

radioactive waste: Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, and is of negligible economic value considering the cost of recovery.

radioactivity: A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy and/or particles from their nuclei and, thus change (or decay) to atoms of a different element or to a lower energy state of the same element.

radiography: Examination of the structure of materials by non-destructive methods, using a radioactive source or a radiation generating device.

radiological area: Any area(s) within a controlled area (but not including the controlled area) defined as a "radiation area," "high radiation area," "very high radiation area," "contamination area," "high contamination area," or "airborne radioactivity area" **[see 835.2(a)]**.

radiological buffer area (RBA): An intermediate area established to prevent the spread of radioactive contamination and to protect personnel from radiation exposure.

radiological control hold point: Cautionary step in a technical work document requiring the radiological control organization to perform some action or verification. The radiological control hold point requirements should be satisfactorily completed before the work is continued.

radiological control technician: A radiological worker whose primary job assignment involves assessment of workplace radiological conditions, specification of protective measures, and provision of assistance and guidance to other individuals in implementation of radiological controls.

radiological label: Label on an item which indicates the presence of radiation or radioactive materials.

radiological posting: Sign, marking, or label that indicates the presence or potential presence of radiation or radioactive materials.

radiological work: Any work that requires handling of radioactive material or access to radiological areas.

radiological work permit (RWP): Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The radiological work permit serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions.

radiological worker A general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose equivalent **[see 835.2(a)]**.

real-time air monitoring: Measurement of the concentrations or quantities of airborne radioactive materials on a continuous basis **[see 835.2(a)]**. Also see "continuous air monitor."

refresher training: Training scheduled in the alternate year when full training is not completed for Radiological Worker I and Radiological Worker II personnel.

release to uncontrolled areas: Release of material from administrative control after confirming that the residual radioactive material meets the guidelines in DOE 5400.5.

rem: Unit of dose equivalent. Dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution factor and any other necessary modifying factor (1 rem = 0.01 sievert).

removable contamination: Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing.

respiratory protective device: An apparatus, such as a respirator, worn by an individual for the purpose of reducing the individual's intake of airborne radioactive materials **[see 835.2(a)]**.

sealed radioactive source: A radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of nonradioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means intended to prevent

leakage or escape of the radioactive material. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, and radioisotope thermoelectric generators **[see 835.2(a)]**.

sievert (Sv): SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

site: An area managed by DOE where access can be limited for any reason. The site boundary encompasses controlled areas.

soil contamination area: An area in which soil contamination is present at levels that are not releasable in accordance with DOE's environmental protection standards.

source leak test: A test to determine if a sealed radioactive source is leaking radioactive material **[see 835.2(a)]**.

standard radiological warning trefoil: Symbol designed and proportioned as illustrated in ANSI N2.1.

step-off pad: Transition area between contaminated and non-contaminated areas that is used to allow exit of personnel and removal of equipment.

sticky pad: Step-off pad provided with a tacky surface to reduce the potential for inadvertently tracking contamination out of a contaminated area.

survey: An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present].

technical work document: A term used to generically identify formally approved documents that direct work, such as procedures, work packages, or job or research plans.

thermoluminescent dosimeter (TLD): Radiation monitoring device used to record the exposure of personnel or areas to certain types of radiation.

transuranic waste: Without regard to source or form, waste that is contaminated with alpha-emitting transuranic radionuclides having half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay.

unusual occurrence: Non-emergency occurrence that has significant impact or potential for impact on safety, environment, health, security, or operations. Examples of the types of occurrences that are to be categorized as unusual occurrences are contained in DOE Order 232.1A, *Occurrence Reporting and Processing of Operations Information*.

very high radiation area: Any area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates **[see 835.2(a)]**.

week: A period of seven consecutive days **[see 835.2(a)]**.

whole body dose: The sum of the effective dose equivalent for external exposures and the committed effective dose equivalent for internal exposures. Also referred to as total effective dose equivalent.

year: The period of time beginning on or near January 1 and ending on or near December 31 of that same year used to determine compliance with the provisions of 10 CFR 835. The starting date of the year used to determine compliance may be changed provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years **[see 835.2(a)]**.

APPENDIX D – BENCH-SCALE SEDIMENT TREATABILITY STUDY WORK PLAN (TO BE PROVIDED AT A LATER DATE)

APPENDIX E — WORK PLAN FOR PASSIVE PORE WATER SAMPLING AND ANALYSES

Appendix E

Work Plan for Passive Pore Water Sampling and Analysis Middle River Complex 2323 Eastern Boulevard Middle River, Maryland

Prepared for:

Lockheed Martin Corporation

Prepared by:

Tetra Tech, Inc.

June 12, 2013

Michael Martin, P.G.
Regional Manager

Eric M. Samuels
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ACRONYMS AND ABBREVIATIONS

GC	gas chromatography
GPS	global positioning system
K_{ow}	octanol-water partitioning coefficient
L/kg	liters per kilogram
Lockheed Martin	Lockheed Martin Corporation
LRMS	low resolution mass spectrometry
µg/g	micrograms per gram
µg/L	micrograms per liter
MRC	Middle River Complex
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PPW	passive pore water
PE	polyethylene
POM	polyoxymethylene
PRC(s)	performance reference compound(s)
SPME	solid phase micro-extraction
Tetra Tech	Tetra Tech, Inc.
USEPA	United States Environmental Protection Agency

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Section 1
Introduction

On behalf of Lockheed Martin Corporation (Lockheed Martin), Tetra Tech, Inc. (Tetra Tech) has prepared this work plan to collect pore water samples using passive sampling methods from the sediments of waterways adjacent to the Middle River Complex (MRC) at 2323 Eastern Boulevard in Middle River, Maryland. The objective of this proposed sampling program is to provide baseline pore water data for sediments adjacent to the Middle River Complex site, and to evaluate bioavailability reduction of polychlorinated biphenyls (PCBs) via *in situ* treatment using an adsorptive media such as activated carbon).

Work performed under this investigation will provide a baseline set of sediment pore water data for Dark Head Cove. This information will be used in conjunction with the results from the bench-scale sediment treatability study to evaluate the use of *in situ* remediation of site sediments. This work plan is organized as follows:

Section 2 – Passive Sampling Technology Background and Approach: Briefly describes the basis of the passive sampling technology being used and the application for measuring sediment pore water concentrations.

Section 3 – Investigation Approach and Methodology: Presents the technical approach to the investigation and describes the field methodology for sampling and chemical analyses

Section 4 – Data Review, Evaluation, and Reporting: Describes the reporting that will summarize the findings of the investigation program

Section 5 – References: Cites references used in compiling this planning document

Section 2
Passive Sampling Technology Background and Approach

Uptake of sediment contaminants by benthic organisms is a function of the freely dissolved concentration of the contaminant in sediment pore water. The freely dissolved concentration in pore water is dependent on a variety of factors including the chemical and physical characteristics of the contaminant, its bulk sediment concentration, sediment characteristics, the presence of organic carbon, the form of organic carbon, and the presence and concentrations of other compounds. The bioavailability of contaminants in sediment pore water has been estimated using a variety of methods and means, including calculations from bulk sediment concentration using equilibrium partitioning, to extraction of pore water for analysis by physical methods (e.g., filtration, centrifugation). Research has shown that these estimation methods can be unreliable, resulting in a significant over or underestimation of the freely dissolved concentrations in sediment pore water. Recent research by several university groups (United States Environmental Protection Agency [USEPA], 2012) has led to the development of several *in situ* passive sampling techniques that measure the concentrations of freely dissolved organic contaminants, including the use of polyethylene (PE) and polyoxymethylene (POM) sampling media and solid phase micro-extraction (SPME) analysis.

2.1 PASSIVE SAMPLING TECHNOLOGY

Passive sampling for contaminants such as polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) in sediment pore water is based on the hydrophobic nature of these compounds; this causes these organic compounds to favorably partition to organic media rather than dissolve in water. This partitioning allows the organic media (i.e., passive sampling device) to concentrate the organic compounds present in the system. With a long enough exposure period, the passive sampling media reaches an equilibrium condition, where the concentration of

contaminant per unit of sampling media is orders of magnitude higher than the concentration per unit of water.

Contaminants on the passive sampling media can be extracted in the laboratory with solvent and concentrated for analysis. The analysis can be done using standard analytical procedures, such as USEPA SW846 methods. The analytical results can be reported as contaminant mass per sampling media mass. The concentrations in the sediment pore water can be calculated from the reported analytical results using estimated or measured partitioning coefficients for the target compounds.

2.2 SAMPLING CONSIDERATIONS

The use of passive sampling media to collect useable data requires special considerations: the sampling media must be clean, and equilibrium conditions must be assessed. Sampling media can be cleaned by a thorough rinsing with multiple rounds of a strong solvent (methylene chloride), mild solvent (methanol), and deionized water before use in the field. To monitor equilibrium conditions, performance reference compounds (PRCs) are used. PRCs are used to spike the passive sampling media at the laboratory prior to deployment. Upon exposure to pore water, these spiked compounds will desorb from the sampling media to the water at a rate similar to the rate that target contaminants are taken up by the sampling media. This process provides a mechanism to determine the degree to which equilibrium has been reached.

Passive sampling media will need to be mounted on a frame to assist in handling, and to ensure full exposure to the target sediment pore water. These frames need to be designed and constructed to allow for maximum exposure to the pore water, and will need to protect the media from deformation or tearing during deployment and retrieval. Cleaning the media prior to deployment must be conducted with care to avoid contamination or damage, due to the sensitivity of the sampling and analytical methods being used. Assembly of the sampling frames should be done using clean handling techniques (e.g., nitrile gloves, covering surfaces with clean aluminum foil or other clean material) and with minimal handling of the passive sampling material.

Section 3
Investigation Approach and Methodology

Sediment pore water samples will be collected from five selected locations in Dark Head Cove where *in situ* remediation is proposed to determine a baseline concentration for polychlorinated biphenyls (PCBs) in pore water. The activities for this investigation include:

- mobilization/demobilization sampling staff and equipment, including preparation of the passive sampling media
- installation of passive sediment pore water samplers in areas of Dark Head Cove
- retrieval of passive sediment pore water samplers; submittal for chemical analysis
- laboratory chemical analyses and chemical data validation on sediment pore water samples
- evaluation of passive sampler data
- reporting of results

3.1 PREPARATION OF PASSIVE SAMPLING MEDIA

Following approval of this work plan, Tetra Tech will procure the required subcontract laboratory for the passive sampling work. Initial laboratory work will include the preparation of the selected passive sampling media for deployment in the field. Tetra Tech will coordinate with the laboratory to implement procedures to clean the sample media using a strong solvent (e.g. methylene chloride), mild solvent, and deionized water (Fernandez et al, 2009). The cleaned sampling media will be prepared and spiked with three performance reference compounds (PRCs), one light weight, one medium weight, and one heavy-weight labeled or rarely-detected PCB congeners not found in Aroclors/Clophans (Gschwend, 2012). The selected PRC will not be a compound used as a surrogate or internal standard used by the laboratory, and will not be interfered with by other congeners potentially present. The sampling media will be spiked by exposing it to the prepared

solution of performance reference compounds in a methanol/water mixture for a minimum of one week (Booij, 2002).

A minimum of one sample of prepared and spiked media will be analyzed for each batch of passive sampling media prepared, to ensure the media is clean following preparation. Four samples will be extracted and analyzed following the PRC spiking. The relative standard deviation for the PRC concentration on the sampling media must be within 10% for the media to be usable in the field (Gschwend et al., 2012). Once the sampling media meet this criterion, the individual sheets of media will be packaged in a clean sample container with approximately one milliliter of deionized water to keep the media moist. The sample media will be kept at 4 degrees Centigrade (4°C) and shipped in a sealed container to the site.

3.2 SEDIMENT PORE WATER SAMPLING

Sediment pore water samples will be collected to provide baseline PCB data to evaluate future potential remedial alternatives at the Middle River Complex (MRC). This task is described in more detail in the following sections.

3.2.1 Sediment Pore Water Sampling Locations

Passive samplers will be deployed at five locations across Dark Head Cove (Figure E-1). Five replicate samples will be placed in the top six inches of sediment at each location. Two sampling locations will be near the same location as the laboratory treatability study bulk sediment samples (i.e., locations SD-152 and SD-153). The remaining three locations will be placed across the area proposed for *in situ* remediation (see Figure E-1 and Table E-1). Each passive sampler will be comprised of a clean and inoculated sheet of polyethylene. Passive samplers will be allowed to equilibrate with pore water for two months before retrieval. Samplers will be placed in the sediment and submerged with no visible location markers at the water surface so as not to attract curious observers. Global positioning system (GPS) coordinates will be recorded at each sample location. Each sampling apparatus will be tethered to the MRC shoreline via weighted lines devised to remain along the bottom (thereby preventing a hazard to navigation) that can be readily retrieved at the end of the sampling period.

3.2.2 Sediment Pore Water Sampling Deployment

Sediment pore water samples will be collected using 6-inch x 6-inch sheets of 2 mil (51 micron) polyethylene (PE). The PE sheet will be attached to a clean metal frame so that it will not fold when inserted into the sediment. At each sampling location, five replicate samplers will be deployed in the top six inches of sediment. The samplers will be attached to a wire frame basket that will be weighted down; the PE sheets will be held vertically in the surface sediment.

Each location will be surveyed using a GPS device with sub-meter accuracy such as a portable Trimble Pro XRS GPS unit or equivalent. The GPS unit will use the Maryland State plane-coordinate Universal Transverse Mercator Zone 18. Tide stage at the time of the survey will be recorded, and the depth to the top of the surface-water/sediment interface will be measured using a weighted tape. In addition to deploying passive samplers in sediment, the media for one passive sampler will be retained in its container as a sample blank to monitor PRC stability and cross contamination. This blank passive sampling media and container will be held at 4°C in a cooler or refrigerator for the 2 month deployment time. When the deployed sediment pore water passive samplers are retrieved and prepared for shipment, the blank sample will be included in the sample shipment to the laboratory for analyzed with site samples.

3.2.3 Sediment Pore Water Sampling Retrieval

After a two month exposure period in sediment, the samplers will be retrieved. Sample locations will be confirmed using a portable GPS unit as described in section 3.2.2. Upon retrieval, the integrity of the sampler will be thoroughly inspected. If a sampling cage appears to have been moved during the deployment such that exposure to the sediment is questionable, the affected samplers will not be submitted for analysis. The sampling basket and samplers will be carefully removed from the sediment by gently pulling upward (vertically). The individual samplers will then be removed from the cage, inspected, and photographed. Any adhering sediment and debris will be brushed off of the sampling device with a clean cloth. The passive sampling sheet will be carefully removed from the frame and rinsed with deionized water to remove any remaining sediment and debris. PE sampling sheets will be placed into clean individual sample containers with approximately one milliliter deionized water for transport to the laboratory. Samples will be shipped to the laboratory overnight in a cooler with ice.

3.4.3 Sample Nomenclature

Passive pore water samples submitted to the laboratory will be labeled with a "PPW" prefix, identifying the sampled medium as sediment passive pore water, followed by a two-digit sample location, followed by a letter suffix (i.e., A, B, C, D, and E) that indicates one of five individual passive samplers at each location.. For example, PPW-01-C, refers to a passive pore water sample collected at location 01 from the third ["C"] passive sampling device. Unused passive sample media (blanks) accompanying the field samples will be identified as PPW-999-A.

3.4.4 Sample Analysis

The passive pore water media will be analyzed for PCB congeners using gas chromatography low resolution mass spectrometry (GC/LRMS). The PE sheets from the field will be extracted using methylene chloride solvent in clean jars or flasks for 24 hours on a shaker table or with a similar gentle agitation mechanism. Surrogate compounds will be added to the extraction vessels prior to the addition of solvent. A laboratory blank sample, along with a laboratory control spike sample and laboratory control spike duplicate sample, will be analyzed with each batch of PE sheets. Laboratory control spikes will be clean PE sheets with a known amount of PCB congeners added prior to extraction.

Sample analysis will follow the laboratory's standard procedure for PCB congener analysis by GC/LRMS. After extraction, the laboratory will dry and weigh the PE sheets. Results will be reported as micrograms PCB congener per gram of PE (µg/g). The concentration in pore water will be assessed using these data as described in the next section.

3.4.5 Quality Control/Quality Assurance

Data obtained from passive pore water data must meet project data-quality objectives to be used as baseline to evaluate future bioavailability reduction through *in situ* treatment. Data quality objectives are measured using precision, accuracy, representativeness, comparability and completeness, determined for this study as follows;

Precision –Five replicate passive pore water samples will be collected at each location to determine the precision of results.

Accuracy – Results from the laboratory control sample and laboratory control sample duplicate will be used to assess the accuracy. In addition, the evaluation of equilibrium using the loss of the PRCs from the passive samplers will be used to assess the accuracy of results. The field blank sample will be evaluated for cross contamination and stability of the PRCs.

Representativeness – The results for the five replicate samples collected from each location will be evaluated to determine the representativeness of the results and the variability in the reported concentrations.

Comparability – The data collected will serve as baseline for future monitoring. Passive pore water sampler results will also be compared to the results from the bench scale study for locations where samples for both tasks are collected.

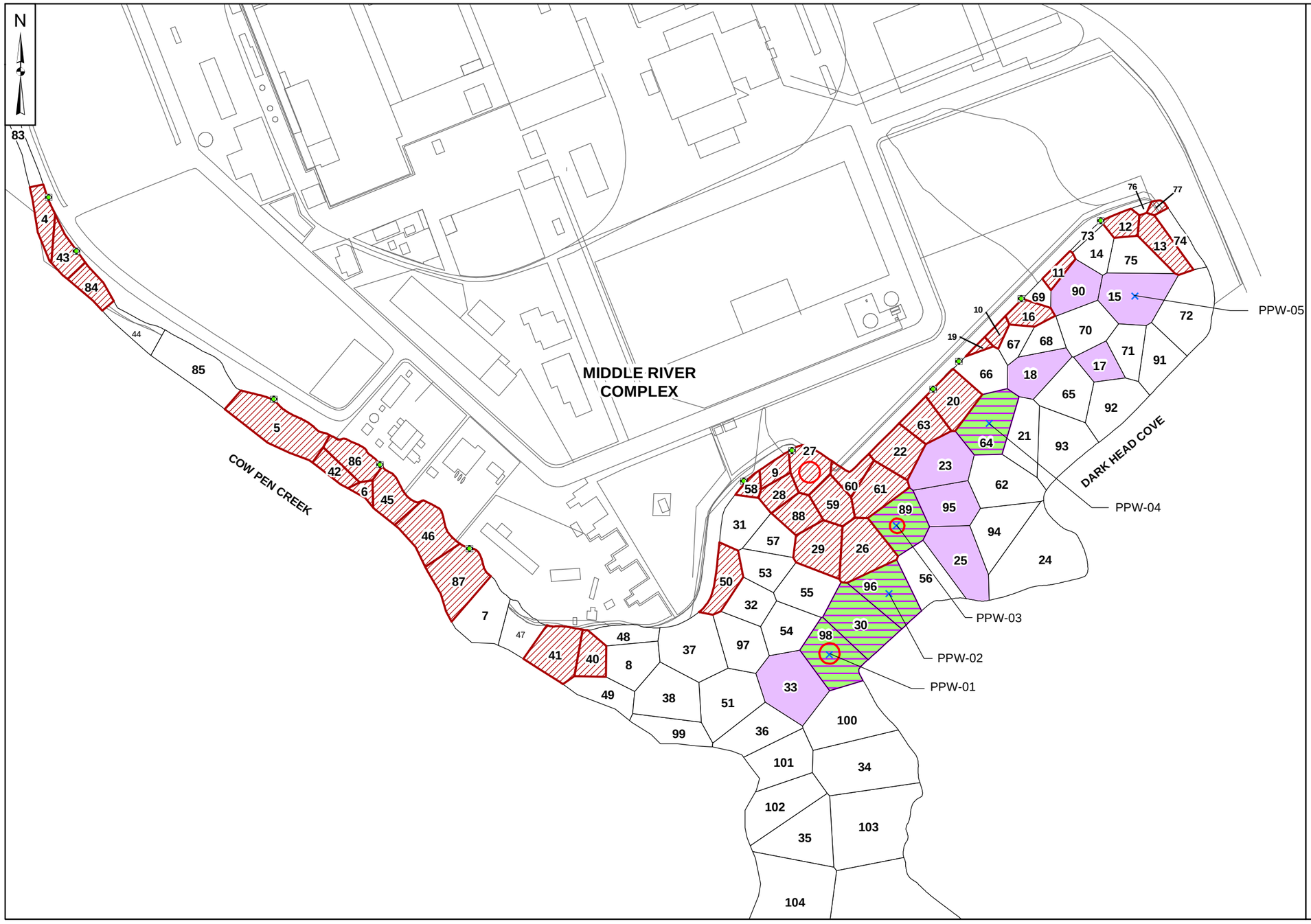
Completeness – The goal set for baseline data is that useable data is obtained from 4 of 5 samplers collected from each location.

Table E-1

Summary of Pore-Water Sampling and Chemical Analyses- Dark Head Cove, 2013
Lockheed Martin Middle River Complex, Middle River, Maryland

Sample number	Location	Sample depth	Sample analyses and methods	Rationale/purpose
PPW-01 (SD-152) PPW-03 (SD-153)	*In situ* treatment treatability sample areas	Passive samplers will be inserted to approximately 6 inches below the mudline	Laboratory analyses: PCB congeners by GC/LRMS (USEPA SW846 method 8270 modified)	Area(s) where bulk sediment samples for bench scale treatability study are collected.
PPW-02 PPW-04 PPW-05	*In situ* treatment area	Passive samplers will be inserted to approximately 6 inches below the mudline	Laboratory analyses: PCB congeners by GC/LRMS (USEPA SW846 method 8270 modified)	Area(s)s proposed for *in situ* treatment

GC = gas chromatography
LRMS = low resolution mass spectrometry
PCB = polychlorinated biphenyl
PPW = passive pore water
SD = sediment
USEPA = United States Environmental Protection Agency



TETRA TECH

Figure E-1
Proposed Dark Head Cove
Passive Pore Water Sample Locations
Lockheed Martin Middle River Complex
Middle River, Maryland

Legend

- Passive Pore Water Sample Location - 2013
- Stormwater Outfall Locations
- No Action (Polygon < PRG/RAL)
- In Situ Treatment
- In Situ Treatment + MNR
- Removal
- Treatability Testing Sample Location-2013
- Buildings/Roads
- 101 Thiessen Polygons and Sample Location Number

PRG = Preliminary Remediation Goal
RAL = Remedial Action Level
MNR = Monitored Natural Recovery

350 175 0 350
Feet

Drawn By: J. NOVAK 5/24/2013
Checked By: S. OZKAN 05/30/13
Approved By:

Contract Number: 112IC02903

PGH:P:\GIS\MIDDLE_RIVER\MAPDOCS\MXD\AUG2010_THIESSEN\COMBINEDCOC_THIESSEN_AUG2010_SS_ALT4_CDPRG_ALT4G_REVISED_350SCALE.MXD 5/30/2013 JN

Section 4
Data Review, Evaluation and Reporting

Tetra Tech, Inc. (Tetra Tech) will compile field investigation records (analytical results, field notes, photographs etc.) into a document summarizing the passive sampling field activities and analytical results. This report will be incorporated into or attached as an appendix to the main document summarizing the 2013 field program.

Passive sampling data will be reviewed to determine the degree to which the passive samplers reach equilibrium with sediment pore water by comparing the concentrations of the performance reference compounds (PRCs) detected post deployment to the initial spiked concentrations. The equilibrium condition can be determined using the pre- and post-PRC concentration data and, if necessary, adjustments to pore water calculations can be performed for non-equilibrium conditions. It is anticipated that equilibrium conditions will be achieved for all compounds except perhaps the most highly chlorinated polychlorinated biphenyls (PCBs). If equilibrium is not achieved the results for the PRC compounds can be used as discussed below to adjust the measured porewater concentration.

The fraction of PRCs left on the passive sampling media is dependent upon the compounds partitioning. Lighter weight compounds with a lower octanol-water partitioning coefficient (K_{ow}) will have higher losses than heavier, higher K_{ow}, compounds. Equilibrium is assumed to have been reached when measured PRC concentrations, compared to the initial spiked concentration, results in a value greater than 0.9 using the following equation:

$$Eq = 1 - \frac{C_{PEt}}{C_{PE0}}$$

Where:

Eq = the equilibrium level reached

C_{PE0} = the initial (spiked) concentration in the polyethylene (PE) sheet

C_{PEt} = the concentration at time *t*

This calculation is based on the performance reference compound being transferred from the passive sampling media to an infinite reservoir, assuming that at an infinite time the concentration on the sampling medium would become 0.

Sediment pore water concentrations will be calculated from the contaminant concentrations measured in the passive sampling media, according to the equation below;

$$C_d = \frac{C_{ps}}{K_{ps-D}}$$

Where;

C_d = dissolved concentration in the pore water (micrograms per liter [µg/L])

C_{ps} = concentration in the passive sampling media (micrograms per gram [µg/g])

$K_{ps\text{-}D}$ = passive sampling media/water partition coefficient for the compound (expressed as liters per kilogram [L/kg])

Attachment A includes partition coefficients for PCB congeners, estimated from the log of the individual PCB congener's K_{ow} that have been published by the United States Environmental Protection Agency (USEPA, 2003). Other estimates for PCB congener K_{ow} and $K_{PS\text{-}D}$ will be reviewed during data evaluation. If the heavier performance reference compounds are not found to be at equilibrium in the passive sampling medium, then PCB congeners of similar K_{ow} can be corrected using the equilibrium calculation equation above and applying it to the calculation for the dissolved concentration.

Tetra Tech, Inc. (Tetra Tech) will compile obtained information into a report summarizing the 2013 passive sediment sampling investigation. The report will include statistical results from each of the five sampling stations to determine the average and variance for reported dissolved pore water concentrations. Passive sediment pore water results will be presented in tabular form. The report will also include a summary describing passive sampling media preparation, and quality control results demonstrating media cleanliness and performance reference compound spiking.

Sampling techniques and procedures used will also be documented, along with a summary of the analytical procedures.

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Section 5
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Attachment A

Polychlorinated Biphenyl polyethylene – water partition coefficients

PCB #	Congener	CAS	Log K_{ow}	Log K_{PE-D}*
1	2-Chlorobiphenyl	2051-60-7	4.46	4.093
2	3-Chlorobiphenyl	2051-61-8	4.69	4.3345
3	4-Chlorobiphenyl	2051-62-9	4.69	4.3345
4	**2,2'-Dichlorobiphenyl**	**13029-08-8**	**4.65**	**4.2925**
5	2,3-Dichlorobiphenyl	16605-91-7	4.97	4.6285
6	**2,3'-Dichlorobiphenyl**	**25569-80-6**	**5.06**	**4.723**
7	2,4-Dichlorobiphenyl	33284-50-3	5.07	4.7335
8	**2,4'-Dichlorobiphenyl**	**34883-43-7**	**5.07**	**4.7335**
9	2,5-Dichlorobiphenyl	34883-39-1	5.06	4.723
10	2,6-Dichlorobiphenyl	33146-45-1	4.84	4.492
11	3,3'-Dichlorobiphenyl	2050-67-1	5.28	4.954
12	3,4-Dichlorobiphenyl	2974-92-7	5.22	4.891
13	3,4'-Dichlorobiphenyl	2974-90-5	5.29	4.9645
14	3,5-Dichlorobiphenyl	34883-41-5	5.28	4.954
15	**4,4'-Dichlorobiphenyl**	**2050-68-2**	**5.30**	**4.975**
16	**2,2',3-Trichlorobiphenyl**	**38444-78-9**	**5.16**	**4.828**
17	**2,2',4-Trichlorobiphenyl**	**37680-66-3**	**5.25**	**4.9225**
18	**2,2',5-Trichlorobiphenyl**	**37680-65-2**	**5.24**	**4.912**
19	2,2',6-Trichlorobiphenyl	38444-73-4	5.02	4.681
20	2,3,3'-Trichlorobiphenyl	38444-84-7	5.57	5.2585
21	2,3,4-Trichlorobiphenyl	55702-46-0	5.51	5.1955
22	**2,3,4'-Trichlorobiphenyl**	**38444-85-8**	**5.58**	**5.269**
23	2,3,5-Trichlorobiphenyl	55720-44-0	5.57	5.2585
24	2,3,6-Trichlorobiphenyl	55702-45-9	5.35	5.0275
25	2,3',4-Trichlorobiphenyl	55712-37-3	5.67	5.3635
26	**2,3',5-Trichlorobiphenyl**	**38444-81-4**	**5.66**	**5.353**
27	2,3',6-Trichlorobiphenyl	38444-76-7	5.44	5.122
28	**2,4,4'-Trichlorobiphenyl**	**7012-37-5**	**5.67**	**5.3635**
29	2,4,5-Trichlorobiphenyl	15862-07-4	5.60	5.29
30	2,4,6-Trichlorobiphenyl	35693-92-6	5.44	5.122
31	**2,4',5,-Trichlorobiphenyl**	**16606-02-3**	**5.67**	**5.3635**
32	**2,4',6-Trichlorobiphenyl**	**38444-77-8**	**5.44**	**5.122**
33	**2,3',4'-Trichlorobiphenyl**	**38444-86-9**	**5.60**	**5.29**
34	2,3',5'-Trichlorobiphenyl	37680-68-5	5.66	5.353
35	3,3',4-Trichlorobiphenyl	37680-69-6	5.82	5.521
36	3,3',5-Trichlorobiphenyl	38444-87-0	5.88	5.584
37	**3,4,4'-Trichlorobiphenyl**	**38444-90-5**	**5.83**	**5.5315**

PCB #	Congener	CAS	Log K_{ow}	Log K_{PE-D}*
38	3,4,5-Trichlorobiphenyl	53555-66-1	5.76	5.458
39	3,4',5-Trichlorobiphenyl	38444-88-1	5.89	5.5945
40	2,2',3,3'-Tetrachlorobiphenyl	38444-93-8	5.66	5.353
41	2,2',3,4-Tetrachlorobiphenyl	52663-59-9	5.69	5.3845
42	**2,2',3,4'-Tetrachlorobiphenyl**	**36559-22-5**	**5.76**	**5.458**
43	2,2',3,5-Tetrachlorobiphenyl	70362-46-8	5.75	5.4475
44	**2,2',3,5'-Tetrachlorobiphenyl**	**41464-39-5**	**5.75**	**5.4475**
45	**2,2',3,6-Tetrachlorobiphenyl**	**70362-45-7**	**5.53**	**5.2165**
46	2,2',3,6'-Tetrachlorobiphenyl	41464-47-5	5.53	5.2165
47	**2,2',4,4'-Tetrachlorobiphenyl**	**2437-79-8**	**5.85**	**5.5525**
48	**2,2',4,5-Tetrachlorobiphenyl**	**70362-47-9**	**5.78**	**5.479**
49	**2,2',4,5'-Tetrachlorobiphenyl**	**41464-40-8**	**5.85**	**5.5525**
50	2,2',4,6-Tetrachlorobiphenyl	62796-65-0	5.63	5.3215
51	2,2',4,6'-Tetrachlorobiphenyl	68194-04-7	5.63	5.3215
52	**2,2',5,5'-Tetrachlorobiphenyl**	**35693-99-3**	**5.84**	**5.542**
53	2,2',5,6'-Tetrachlorobiphenyl	41464-41-9	5.62	5.311
54	2,2',6,6'-Tetrachlorobiphenyl	15968-05-5	5.21	4.8805
55	2,3,3',4-Tetrachlorobiphenyl	74338-24-2	6.11	5.8255
56	**2,3,3',4'-Tetrachlorobiphenyl**	**41464-43-1**	**6.11**	**5.8255**
57	2,3,3',5-Tetrachlorobiphenyl	70424-67-8	6.17	5.8885
58	2,3,3',5'-Tetrachlorobiphenyl	41464-49-7	6.17	5.8885
59	2,3,3',6-Tetrachlorobiphenyl	74472-33-6	5.95	5.6575
60	**2,3,4,4'-Tetrachlorobiphenyl**	**33025-41-1**	**6.11**	**5.8255**
61	2,3,4,5-Tetrachlorobiphenyl	33284-53-6	6.04	5.752
62	2,3,4,6-Tetrachlorobiphenyl	54230-22-7	5.89	5.5945
63	2,3,4',5-Tetrachlorobiphenyl	74472-34-7	6.17	5.8885
64	**2,3,4',6-Tetrachlorobiphenyl**	**52663-58-8**	**5.95**	**5.6575**
65	2,3,5,6-Tetrachlorobiphenyl	33284-54-7	5.86	5.563
66	**2,3',4,4'-Tetrachlorobiphenyl**	**32598-10-0**	**6.20**	**5.92**
67	2,3',4,5-Tetrachlorobiphenyl	73575-53-8	6.20	5.92
68	2,3',4,5'-Tetrachlorobiphenyl	73575-52-7	6.26	5.983
69	2,3',4,6-Tetrachlorobiphenyl	60233-24-1	6.04	5.752
70	**2,3',4',5-Tetrachlorobiphenyl**	**32598-11-1**	**6.20**	**5.92**
71	**2,3',4',6-Tetrachlorobiphenyl**	**41464-46-4**	**5.98**	**5.689**
72	2,3',5,5'-Tetrachlorobiphenyl	41464-42-0	6.26	5.983
73	2,3',5',6-Tetrachlorobiphenyl	74338-23-1	6.04	5.752
74	**2,4,4',5-Tetrachlorobiphenyl**	**32690-93-0**	**6.20**	**5.92**
75	2,4,4',6-Tetrachlorobiphenyl	32598-12-2	6.05	5.7625
76	2,3',4',5'-Tetrachlorobiphenyl	70362-48-0	6.13	5.8465
77	3,3',4,4'-Tetrachlorobiphenyl	32598-13-3	6.36	6.088
78	3,3',4,5-Tetrachlorobiphenyl	70362-49-1	6.35	6.0775
79	3,3',4,5'-Tetrachlorobiphenyl	41464-48-6	6.42	6.151

PCB #	Congener	CAS	Log K_{ow}	Log K_{PE-D}*
80	3,3',5,5'-Tetrachlorobiphenyl	33284-52-5	6.48	6.214
81	3,4,4',5-Tetrachlorobiphenyl	70362-50-4	6.36	6.088
82	**2,2',3,3',4-Pentachlorobiphenyl**	**52663-62-4**	**6.20**	**5.92**
83	2,2',3,3',5-Pentachlorobiphenyl	60145-20-2	6.26	5.983
84	**2,2',3,3',6-Pentachlorobiphenyl**	**52663-60-2**	**6.04**	**5.752**
85	**2,2',3,4,4'-Pentachlorobiphenyl**	**65510-45-4**	**6.30**	**6.025**
86	2,2',3,4,5-Pentachlorobiphenyl	55312-69-1	6.23	5.9515
87	**2,2',3,4,5'-Pentachlorobiphenyl**	**38380–02-**	**6.29**	**6.0145**
88	2,2',3,4,6-Pentachlorobiphenyl	55215-17-3	6.07	5.7835
89	2,2',3,4,6'-Pentachlorobiphenyl	73575-57-2	6.07	5.7835
90	2,2',3,4',5-Pentachlorobiphenyl	68194-07-0	6.36	6.088
91	2,2',3,4',6-Pentachlorobiphenyl	68194-05-8	6.13	5.8465
92	**2,2',3,5,5'-Pentachlorobiphenyl**	**52663-61-3**	**6.35**	**6.0775**
93	2,2',3,5,6-Pentachlorobiphenyl	73575-56-1	6.04	5.752
94	2,2',3,5,6'-Pentachlorobiphenyl	73575-55-0	6.13	5.8465
95	**2,2',3,5',6-Pentachlorobiphenyl**	**38379-99-6**	**6.13**	**5.8465**
96	2,2',3,6,6'-Pentachlorobiphenyl	73575-54-9	5.71	5.4055
97	**2,2',3,4',5'-Pentachlorobiphenyl**	**41464-51-1**	**6.29**	**6.0145**
98	2,2',3,4',6'-Pentachlorobiphenyl	60233-25-2	6.13	5.8465
99	**2,2',4,4',5-Pentachlorobiphenyl**	**38380-01-7**	**6.39**	**6.1195**
100	2,2',4,4',6-Pentachlorobiphenyl	39485-83-1	6.23	5.9515
101	**2,2',4,5,5'-Pentachlorobiphenyl**	**37680-73-2**	**6.38**	**6.109**
102	2,2',4,5,6'-Pentachlorobiphenyl	68194-06-9	6.16	5.878
103	2,2',4,5',6-Pentachlorobiphenyl	60145-21-3	6.22	5.941
104	2,2',4,6,6'-Pentachlorobiphenyl	56558-16-8	5.81	5.5105
105	**2,3,3',4,4'-Pentachlorobiphenyl**	**32598-14-4**	**6.65**	**6.3925**
106	2,3,3',4,5-Pentachlorobiphenyl	70424-69-0	6.64	6.382
107	2,3,3',4',5-Pentachlorobiphenyl	70424-68-9	6.71	6.4555
108	2,3,3',4,5'-Pentachlorobiphenyl	70362-41-3	6.71	6.4555
109	2,3,3',4,6-Pentachlorobiphenyl	74472-35-8	6.48	6.214
110	**2,3,3',4',6-Pentachlorobiphenyl**	**38380-03-9**	**6.48**	**6.214**
111	2,3,3',5,5'-Pentachlorobiphenyl	39635-32-0	6.76	6.508
112	2,3,3',5,6-Pentachlorobiphenyl	74472-36-9	6.45	6.1825
113	2,3,3',5',6-Pentachlorobiphenyl	68194-10-5	6.54	6.277
114	2,3,4,4',5-Pentachlorobiphenyl	74472-37-0	6.65	6.3925
115	2,3,4,4',6-Pentachlorobiphenyl	74472-38-1	6.49	6.2245
116	2,3,4,5,6-Pentachlorobiphenyl	18259-05-7	6.33	6.0565
117	2,3,4',5,6-Pentachlorobiphenyl	68194-11-6	6.46	6.193
118	**2,3',4,4',5-Pentachlorobiphenyl**	**31508-00-6**	**6.74**	**6.487**
119	2,3',4,4',6-Pentachlorobiphenyl	56558-17-9	6.58	6.319
120	2,3',4,5,5'-Pentachlorobiphenyl	68194-12-7	6.79	6.5395
121	2,3',4,5',6-Pentachlorobiphenyl	56558-18-0	6.64	6.382

PCB #	Congener	CAS	Log K_{ow}	Log K_{PE-D}*
122	2,3,3',4',5'-Pentachlorobiphenyl	76842-07-4	6.64	6.382
123	2,3',4,4',5'-Pentachlorobiphenyl	65510-44-3	6.74	6.487
124	2,3',4',5,5'-Pentachlorobiphenyl	70424-70-3	6.73	6.4765
125	2,3',4',5',6-Pentachlorobiphenyl	74472-39-2	6.51	6.2455
126	3,3',4,4',5-Pentachlorobiphenyl	57465-28-8	6.89	6.6445
127	3,3',4,5,5'-Pentachlorobiphenyl	39635-33-1	6.95	6.7075
128	**2,2',3,3',4,4'-Hexachlorobiphenyl**	**38380-07-3**	**6.74**	**6.487**
129	2,2',3,3',4,5-Hexachlorobiphenyl	55215-18-4	6.73	6.4765
130	2,2',3,3',4,5'-Hexachlorobiphenyl	52663-66-8	6.80	6.55
131	2,2',3,3',4,6-Hexachlorobiphenyl	61798-70-7	6.58	6.319
132	**2,2',3,3',4,6'-Hexachlorobiphenyl**	**38380-05-1**	**6.58**	**6.319**
133	2,2',3,3',5,5'-Hexachlorobiphenyl	35694-04-3	6.86	6.613
134	2,2',3,3',5,6-Hexachlorobiphenyl	52704-70-8	6.55	6.2875
135	**2,2',3,3',5,6'-Hexachlorobiphenyl**	**52744-13-5**	**6.64**	**6.382**
136	**2,2',3,3',6,6'-Hexachlorobiphenyl**	**38411-22-2**	**6.22**	**5.941**
137	2,2',3,4,4',5-Hexachlorobiphenyl	35694-06-5	6.83	6.5815
138	**2,2',3,4,4',5'-Hexachlorobiphenyl**	**35065-28-2**	**6.83**	**6.5815**
139	2,2',3,4,4',6-Hexachlorobiphenyl	56030-56-9	6.67	6.4135
140	2,2',3,4,4',6'-Hexachlorobiphenyl	59291-64-4	6.67	6.4135
141	**2,2',3,4,5,5'-Hexachlorobiphenyl**	**52712-04-6**	**6.82**	**6.571**
142	2,2',3,4,5,6-Hexachlorobiphenyl	41411-61-4	6.51	6.2455
143	2,2',3,4,5,6'-Hexachlorobiphenyl	68194-15-0	6.60	6.34
144	2,2',3,4,5',6-Hexachlorobiphenyl	68194-14-9	6.67	6.4135
145	2,2',3,4,6,6'-Hexachlorobiphenyl	74472-40-5	6.25	5.9725
146	**2,2',3,4',5,5'-Hexachlorobiphenyl**	**51908-16-8**	**6.89**	**6.6445**
147	2,2',3,4',5,6-Hexachlorobiphenyl	68194-13-8	6.64	6.382
148	2,2',3,4',5,6'-Hexachlorobiphenyl	74472-41-6	6.73	6.4765
149	**2,2',3,4',5',6-Hexachlorobiphenyl**	**38380-04-0**	**6.67**	**6.4135**
150	2,2',3,4',6,6'-Hexachlorobiphenyl	68194-08-1	6.32	6.046
151	**2,2',3,5,5',6-Hexachlorobiphenyl**	**52663-63-5**	**6.64**	**6.382**
152	2,2',3,5,6,6'-Hexachlorobiphenyl	68194-09-2	6.22	5.941
153	**2,2',4,4',5,5'-Hexachlorobiphenyl**	**35065-27-1**	**6.92**	**6.676**
154	2,2',4,4',5,6'-Hexachlorobiphenyl	60145-22-4	6.76	6.508
155	2,2',4,4',6,6'-Hexachlorobiphenyl	33979-03-2	6.41	6.1405
156	**2,3,3',4,4',5-Hexachlorobiphenyl**	**38380-08-4**	**7.18**	**6.949**
157	2,3,3',4,4',5'-Hexachlorobiphenyl	68782-90-7	7.18	6.949
158	2,3,3',4,4',6-Hexachlorobiphenyl	74472-42-7	7.02	6.781
159	2,3,3',4,5,5'-Hexachlorobiphenyl	39635-35-3	7.24	7.012
160	2,3,3',4,5,6-Hexachlorobiphenyl	41411-62-5	6.93	6.6865
161	2,3,3',4,5',6-Hexachlorobiphenyl	74472-43-8	7.08	6.844
162	2,3,3',4',5,5'-Hexachlorobiphenyl	39635-34-2	7.24	7.012
163	**2,3,3',4',5,6-Hexachlorobiphenyl**	**74472-44-9**	**6.99**	**6.7495**

PCB #	Congener	CAS	Log K_{ow}	Log K_{PE-D}*
164	2,3,3',4',5',6-Hexachlorobiphenyl	74472-45-0	7.02	6.781
165	2,3,3',5,5',6-Hexachlorobiphenyl	74472-46-1	7.05	6.8125
166	2,3,4,4',5,6-Hexachlorobiphenyl	41411-63-6	6.93	6.6865
167	2,3',4,4',5,5'-Hexachlorobiphenyl	52663-72-6	7.27	7.0435
168	2,3',4,4',5',6-Hexachlorobiphenyl	59291-65-5	7.11	6.8755
169	3,3',4,4',5,5'-Hexachlorobiphenyl	32774-16-6	7.42	7.201
170	**2,2',3,3',4,4',5-Heptachlorobiphenyl**	**35065-30-6**	**7.27**	**7.0435**
171	**2,2',3,3',4,4',6-Heptachlorobiphenyl**	**52663-71-5**	**7.11**	**6.8755**
172	2,2',3,3',4,5,5'-Heptachlorobiphenyl	52663-74-8	7.33	7.1065
173	2,2',3,3',4,5,6-Heptachlorobiphenyl	68194-16-1	7.02	6.781
174	**2,2',3,3',4,5,6'-Heptachlorobiphenyl**	**38411-25-5**	**7.11**	**6.8755**
175	2,2',3,3',4,5',6-Heptachlorobiphenyl	40186-70-7	7.17	6.9385
176	2,2',3,3',4,6,6'-Heptachlorobiphenyl	52663-65-7	6.76	6.508
177	**2,2',3,3',4,5',6'-Heptachlorobiphenyl**	**52663-70-4**	**7.08**	**6.844**
178	2,2',3,3',5,5',6-Heptachlorobiphenyl	52663-67-9	7.14	6.907
179	**2,2',3,3',5,6,6'-Heptachlorobiphenyl**	**52663-64-6**	**6.73**	**6.4765**
180	**2,2',3,4,4',5,5'-Heptachlorobiphenyl**	**35065-29-3**	**7.36**	**7.138**
181	2,2',3,4,4',5,6-Heptachlorobiphenyl	74472-47-2	7.11	6.8755
182	2,2',3,4,4',5,6'-Heptachlorobiphenyl	60145-23-5	7.20	6.97
183	**2,2',3,4,4',5',6-Heptachlorobiphenyl**	**52663-69-1**	**7.20**	**6.97**
184	2,2',3,4,4',6,6'-Heptachlorobiphenyl	74472-48-3	6.85	6.6025
185	2,2',3,4,5,5',6-Heptachlorobiphenyl	52712-05-7	7.11	6.8755
186	2,2',3,4,5,6,6'-Heptachlorobiphenyl	74472-49-4	6.69	6.4345
187	**2,2',3,4',5,5',6-Heptachlorobiphenyl**	**52663-68-0**	**7.17**	**6.9385**
188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	74487-85-7	6.82	6.571
189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	7.71	7.5055
190	2,3,3',4,4',5,6-Heptachlorobiphenyl	41411-64-7	7.46	7.243
191	2,3,3',4,4',5',6-Heptachlorobiphenyl	74472-50-7	7.55	7.3375
192	2,3,3',4,5,5',6-Heptachlorobiphenyl	74472-51-8	7.52	7.306
193	2,3,3',4',5,5',6-Heptachlorobiphenyl	69782-91-8	7.52	7.306
194	**2,2',3,3',4,4',5,5'-Octachlorobiphenyl**	**35694-08-7**	**7.80**	**7.6**
195	2,2',3,3',4,4',5,6-Octachlorobiphenyl	52663-78-2	7.56	7.348
196	**2,2',3,3',4,4',5,6'-Octachlorobiphenyl**	**42740-50-1**	**7.65**	**7.4425**
197	2,2',3,3',4,4',6,6'-Octachlorobiphenyl	33091-17-7	7.30	7.075
198	2,2',3,3',4,5,5',6-Octachlorobiphenyl	68194-17-2	7.62	7.411
199	**2,2',3,3',4,5,5',6'-Octachlorobiphenyl**	**52663-75-9**	**7.62**	**7.411**
200	2,2',3,3',4,5,6,6'-Octachlorobiphenyl	52663-73-7	7.20	6.97
201	2,2',3,3',4,5',6,6'-Octachlorobiphenyl	40186-71-8	7.27	7.0435
202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	2136-99-4	7.24	7.012
203	**2,2',3,4,4',5,5',6-Octachlorobiphenyl**	**52663-76-0**	**7.65**	**7.4425**
204	2,2',3,4,4',5,6,6'-Octachlorobiphenyl	74472-52-9	7.30	7.075
205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	74472-53-0	8.00	7.81

PCB #	Congener	CAS	Log K_{ow}	Log K_{PE-D}*
206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	40186-72-9	8.09	7.9045
207	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	52663-79-3	7.74	7.537
208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	52663-77-1	7.71	7.5055
209	2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl	2051-24-3	8.18	7.999

USEPA, Non-Dioxin-like PCBs: Effects and Considerations in Ecological Risk Assessment, NCEA-C-1340, ERASC-003, June 2003 (Hawker and Connell, 1988)

* K_{PE-D} = -0.59+1.05*Log Kow

Bold > 1 % in at least one Aroclor based on data from Frame, Cochran and Boewadt, 1996.