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Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials

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Sample Collection Procedures for Radiochemical Analytes in Outdoor Building and Infrastructure Materials

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U.S. Environmental Protection Agency
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Acronyms, Abbreviations, Units and Symbols

NOTE: Units of measurement are provided throughout this document, in both Metric and U.S. Standard formats, as appropriate for use. In addition to the definitions provided below, units are defined with first use in each module.

AC	Alternating Current
Am	Americium
ANSI	American National Standards Institute
ASTM	ASTM International (formerly American Society for Testing and Materials)
BKG	Background
BLK	Field Blank
Bq	Becquerel
CFR	Code of Federal Regulations
cm	Centimeters
COC	Chain of Custody
DAS	Delivery of Analytical Services
DCGL	Derived Concentration Guidance Level
DOT	Department of Transportation
dpm	Disintegration per Minute
DUP	Duplicate
EPA	Environmental Protection Agency
FRMAC	Federal Radiological Monitoring and Assessment Center
ft	Feet
g	Gram
gal	Gallon
GPS	Global Positioning System
HASP	Health and Safety Plan
HCl	Hydrochloric acid
HDPE	High density polyethylene
HEPA	High-efficiency Particulate Air
HNO_3	Nitric acid
hr	Hour
IATA	International Air Transport Association
in.	Inches
kg	Kilogram
L	Liter
lbs	Pounds
LSA	Low Specific Activity
m	Meter
MDC	Minimum Detectable Concentration
min	Minute
mL	Milliliter

mm	Millimeter
MQO	Measurement Quality Objective
mR	Milliroentgens
mrem	Millirem
mSv	Millisieverts
NIST	National Institute of Standards & Technology
No.	Number
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
oz	Ounces
PPE	Personal Protective Equipment
ppm	Parts per Million
Pu	Plutonium
QC	Quality Control
Ra	Radium
REG	Regular
RIN	Sample Rinsate
RPG	Radiation Protection Group
rpm	Revolutions per minute
RSP	Radiation Safety Plan
RWP	Radiation Work Permit
SAM	*Selected Analytical Methods for Environmental Remediation and Recovery*
SCO	Surface Contaminated Object
SCP	Sample Collection Plan
SDG	Sample Delivery Group
SHO	Safety and Health Officer
SIC	Sample Identification Code
SNM	Special Nuclear Material
SOP	Standard Operating Procedure
Sr	Strontium
Sv	Seivert
TI	Transport Index
U	Uranium
WMP	Waste Management Plan

Radiometric and General Unit Conversions

To Convert	To	Multiply by	To Convert	To	Multiply by
becquerel (Bq)	picocuries (pCi)	27.0	pCi	Bq	0.037
Bq/square centimeters (cm^2)	(dpm/cm^2)	60	(dpm/cm^2)	(Bq/cm^2)	0.0167
Bq/cubic meters (m^3)	pCi/L	0.027	pCi/L	Bq/m^3	37.0
Bq/kilogram (kg)	pCi/gram (g)	0.027	pCi/g	Bq/kg	37.0
Bq/cubic meter (m^3)	Bq/L	0.001	Bq/L	Bq/m^3	103
cubic feet (ft^3)	m^3	0.0283	m^3	ft^3	35.3
disintegrations per minute (dpm)	µCi pCi	4.5×10^{-7} 0.45	pCi	dpm	2.22
disintegrations per second (dps)	Bq	1	Bq	dps	1
gallons (gal)	liters (L)	3.78	L	gal	0.264
inches (in)	centimeter (cm) millimeter (mm)	2.54 25.4	cm mm	in	0.394 0.0394
kilogram (kg)	pound (lb)	0.456	lb	kg	2.20
microcuries per milliliter (µCi/mL)	pCi/L	10^9	pCi/L	µCi/mL	10^{-9}
millirem (mrem)	millisievert (mSv)	0.01	mSv	mrem	1000
roentgen equivalent: man (rem)	sievert (Sv)	0.01	Sv	rem	1000
square centimeter (cm^2)	square inch (in^2)	0.155	in^2	cm^2	6.45
To Convert	**To**	**Use**	**To Convert**	**To**	**Use**
degree Fahrenheit (°F)	degree Celsius (°C)	(°F-32)/1.8	°C	°F	(°C×1.8)+32

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MODULE I – GENERAL INFORMATION

1.0 Introduction

1.1. Scope and Application

The procedures described in this document are intended to provide instructions regarding the collection of samples from outdoor building and infrastructure materials to be analyzed for radiological contaminants following an intentional or unintentional contamination incident or emergency. This document focuses on the Site Characterization, Remediation, and Final Status Survey (site release) phases (as described in Section 1.4) and ***is not*** intended to address sample collection needs during Initial Response. The procedures are intended for collection of samples in support of the U.S. Environmental Protection Agency (EPA) following a contamination incident.

NOTE: The procedures in this document were developed to address collection of outdoor building and infrastructure material samples specifically intended for analysis by methods that are included in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery* (SAM) (U.S. EPA, 2012a). At this time, SAM methods that are available for analysis of building materials address the following radioisotopes: americium (Am)-241, plutonium (Pu)-238, radium (Ra)-226, strontium (Sr)-90 and uranium (U). As additional methods become available for other radionuclides, this document will be updated as needed.

The procedures describe sample collection only and are intended for use by personnel who have been sufficiently trained in radiological sampling techniques and corresponding radiation safety. It is also assumed that an initial site assessment has been performed prior to implementation of these procedures. Specifically, the document provides information and instructions regarding procedures for sample collection during Site Characterization, Remediation, and Final Status Survey (site release) phases with respect to the following:

- General sampling equipment and materials
- Description of quality control (QC) samples
- Sampling documentation
- Decontamination of sample containers and equipment
- Packaging of samples for transport
- Waste management and waste minimization considerations

The procedures do not include information that is typically included in a site-specific Sample Collection Plan (SCP) (e.g., sample locations, expected contaminants and concentration levels or methods for determination of the number and type of samples required). This document also does not include tasks or activities that will be performed by site management, radiation protection personnel, safety and hygiene individuals, and transportation certification personnel. Specifically, this document does not provide information and instructions that would be included in the following documents, which are developed to address an actual event:

- Sample Collection Plan
- Radiological Protection Guidance Plan and associated procedures
- Health and Safety Plan (HASP) and associated procedures
- National Analytical Radiation Environmental Laboratory Standard Operating Procedures (SOPs)
- Waste Management Plan and associated procedures

1.2. Supplemental Plans and Procedures

1.2.1 Sample Collection Plan (SCP)

An SCP that is specific for the site being evaluated and outlines the site sampling strategy should be in place prior to initiating the sampling procedures described in this document. Guidance for development of SCPs is provided in EPA's *Guide for Development of Sample Collection Plans for Radiochemical Analytes in Environmental Matrices Following Homeland Security Events* (U.S. EPA, 2009). The SCP should be based on available historical data and recent site assessment information. The SCP will specify: derived concentration guidance levels (DCGLs)[1]; measurement quality objectives (MQOs)[2]; matrices, volumes, and number of samples to be collected; sample locations; sample container types and sizes; quality control requirements; specific sample collection equipment to be used; and requirements for field sample collection and preservation. The information included in the SCP provides detailed site-specific instructions and requirements that are to be used in conjunction with the sample collection procedures that are described in this document.

1.2.2 General Safety Plans

Safety is a primary consideration in any sampling event. Safety plans will be specific to a site and incident. Personnel safety requirements and considerations for a particular site may extend beyond radiological concerns, and may include physical hazards and chemicals that are toxic, corrosive, emit harmful or explosive vapors, or are incompatible when mixed. Safety plans should address all radiation and industrial safety requirements and procedures associated with a site.

[1] Derived concentration guidance levels (DCGLs) are derived, radionuclide-specific activity concentrations within a survey unit corresponding to the release criterion. (U.S. EPA, MARSSIM, December 1997)

[2] Measurement quality objectives (MQOs) are characteristics of a measurement method required to meet the objectives of the survey including required measurement method uncertainty, detection capability, quantification capability, expected concentration range for a radionuclide of concern, specificity, and ruggedness. (U.S. EPA, MARSAME, January 2009)

1.2.3 Laboratory Standard Operating Procedures

Laboratory SOPs are a series of documents which describe the likely analytical decision paths that would be required by personnel at a radioanalytical laboratory following a radiological or nuclear incident, such as that caused by a terrorist attack. EPA's responsibilities, as outlined in the National Response Plan, Nuclear/Radiological Incident Annex (U.S. Department of Homeland Security, 2004), include response and recovery actions to detect and identify radioactive substances and to coordinate federal radiological monitoring and assessment activities. Laboratory SOPs are developed to provide guidance to those radioanalytical laboratories that will support EPA's response and recovery actions following a radiological or nuclear incident.

1.2.4 Waste Management Plan

A Waste Management Plan (WMP) that outlines waste management requirements, procedures, strategies, and processes from the point of generation to final deposition should be in place prior to an incident. Ideally, a general WMP will be in place that can be used to prepare an incident-specific WMP. This incident-specific plan should address federal, state and local waste management requirements for the different waste streams, waste characterization and waste acceptance sampling and analysis, identification of WM facilities, on-site waste management and minimization strategies and tactics, off-site waste management, waste transportation, health and safety, as well as tracking and reporting of waste sampling results. Additional details regarding the elements of a WMP are provided in Appendix D).

1.3. Preparation

1.3.1 Laboratories should be identified and contacted, and expected requirements corresponding to the sampling event reviewed and discussed. To ensure appropriate sample preservation, sample sizes and other analytical issues are considered, laboratory specialists should be involved in the development of the SCP and the laboratory performing the analyses should review and be aware of the quality control requirements that are included in the SCP. The SCP and the sample collection procedures should also be reviewed by the laboratory for additional insight into the analysis needed.

1.3.2 Prior to sample collection, sample collectors should review the SCP. The sample collectors’ understanding of the requirements will greatly increase the success of the sampling event.

1.3.3 Off-site evaluation of any historical data and site assessment prior to entering the contamination area should be performed, and information regarding pertinent issues should be provided to the field sampling team.

1.3.4 The sample collection team should also evaluate and prepare sampling equipment and personal protective equipment (PPE) needs prior to entry. A site map should be prepared with details regarding the sample locations (if known) and other geological or topographical information to assist in locating the sample points.

1.3.5 Prior to the initiation of sample collection activities and laboratory procurement, the decision maker and the sample collection planning team should identify and discuss the data needs and purpose for the sample collection being performed, including:

- Types of samples to be collected or measurements to be performed
- Radionuclide(s) of interest
- Potential interfering radionuclides and chemical contaminants
- DCGL for each radionuclide of interest
- MQOs for each radionuclide (e.g., required method uncertainty, required minimum detectable concentration [MDC], etc.)
- Analytical or screening methods that will be used in the field and laboratory to assay samples
- Analytical bias and precision (e.g., quantitative or qualitative)
- Number of samples to be collected
- Type and frequency of field quality control (QC) samples to be collected
- Amount of material to be collected for each sample
- Sample collection locations and frequencies
- Sample tracking requirements
- Sample preservation (decontamination rinsate samples only, see Module I, Section 5.4)
- Sample shipping requirements
- Additional standard operating procedures (SOPs) to be followed or developed
- Cost of the methods being used (cost per analysis as well as total cost)
- Specific background for the radionuclide(s) of interest, if applicable (e.g., background levels in clean, non-contaminated material)
- Turnaround time required for sample results
- Analytical measurement documentation requirements
- Anticipated exposure rates, if known

1.4. Sampling Phases

> WARNING: Samples containing special nuclear material (Pu-239, Pu-241, U-233, uranium enriched in the isotope U-233 or U-235) require special consideration. Improper handling or collection may result in criticality (sustained nuclear reaction). Consult the site-specific sample collection plan and radiation safety plan for further guidance.

There are three phases in the life span of a contamination incident that require sampling: Site Characterization, Remediation, and Final Status Survey (site release). Waste characterization is an overarching process that also requires sampling, but is not addressed in this document.

- Site Characterization Phase sampling takes place after the incident occurrence and prior to initiation of site remediation activities. During this phase, the levels of exposure may be the highest encountered at any time during the process of sampling a site. Personnel should be constantly aware of existing conditions and radiation levels to ensure personnel are not unnecessarily exposed. This phase will be used to determine the extent and magnitude of the problem (i.e., extent of contamination). The samples taken will be used to determine the scope and range of activities needed to remediate the site.

- Remediation Phase sampling takes place during site remediation. During this phase, sample collection can occur with deliberate planning and preparation. However, conditions are still considered to be hazardous.

- Final Status Survey Phase sampling takes place after remediation of the affected site. This phase has specific requirements to ensure that the sampling procedures support the expected low concentration levels. Conditions are expected to be non-hazardous and clear of the presence of contamination levels that are in excess of DCGLs.

> NOTE: Waste will be generated during all three phases of sampling and the waste generated will need to be sampled for characterization in support of disposition decisions. This waste includes sampling equipment and sampling personnel decontamination rinse water and is separate from decontamination waste. Procedures for collection of sampling waste should be addressed in the incident WMP; the procedures are not included in this document.

1.5. Sampling Locations

Sampling locations may be located by the use of an alpha/numeric grid, global positioning system (GPS) coordinates, or distances from landmarks, with ±1 meter (m) (3.3 feet [ft]) accuracy. Sample collection during the Characterization Phase often uses landmarks, with the actual sample point "fine-tuned" using portable survey instrumentation. The survey team then flags or places another marker (e.g., fluorescent paint) at the sample location. Sample collection points are surveyed, and GPS coordinates recorded, at the time of collection. Maps developed for the site are dependent on the requirements of the SCP. Subsequent sample locations will be identified by the Field Team Leader per the requirements of the SCP.

1.6 Safety Consideration for Sampling and Waste Handling Personnel

1.6.1 Safety is a prime consideration in any sampling event. Personnel safety requirements and considerations for a particular site may extend beyond radiological concerns. Additional concerns include physical hazards and chemicals that are toxic, corrosive, emit harmful or explosive vapors, or are incompatible when mixed.

1.6.2 All radiation and industrial safety requirements and procedures associated with the site are to be followed.

1.6.2.1 Radiation protection requirements are developed and instituted by the site Radiation Protection Group (RPG). The RPG is responsible for:

- Taking measurements of the radiation levels of all sampling sites and associated activities, during and prior to initiating sampling activities
- Monitoring personnel dosimeter readings and responses
- If needed due to levels of radiation, escorting sampling personnel
- Dictating the protection requirements for entering and working in a radioactively contaminated sampling area, by developing and implementing a Radiation Safety Plan (RSP) and Radiation Work Permit (RWP)
- Stopping any activity to protect personnel from overexposure to radiation or from radioactive material contamination

1.6.2.2 Industrial safety requirements are developed and instituted by a designated safety individual (e.g., Safety and Health Officer [SHO]). The SHO is responsible for:

- Assessing all site activities for potential safety concerns
- Ensuring that personnel are informed regarding potential hazards in a sampling area and dictating the requirements for safely working in the area
- Stopping any job or activity to protect personnel from a dangerous situation
- Developing and implementing an HASP for individuals working in the area to read and follow

1.6.3 Personal Protective Equipment (PPE) is worn as designated by radiation protection personnel and the designated site safety individual. PPE should be used during all sample collection and equipment decontamination activities. Results of a site assessment or incident evaluation should be used to determine the type and amount of PPE used. The SCP should include a written HASP following OSHA guidelines (U.S. Department of Labor, 2008), and/or hazard evaluation of the area to be sampled.

1.6.3.1 Typical types of PPE are listed in Appendix A6 (Personal Protective Equipment).

1.6.3.2 The amount of PPE used should be designed and designated to provide the maximum personal protection and mobility for the task being performed. The machinery used to sample outdoor building and infrastructure materials can be heavy which can result in injury if dropped. In addition, the use of some of this equipment can generate dangerous levels of noise. The minimal amount of PPE typically used includes:

- Protective Helmet (i.e., hard hat)
- Protective Gloves (i.e., thick work gloves)
- Coveralls that cover the arms and legs
- Water proof or water resistant safety boots
- Impact resistant eye protection with side protection (i.e., safety goggles)
- Hearing protection (i.e., ear plugs or ear muffs)

- Fall protection for ladders and scaffolding (i.e., personal fall-arrest systems or guardrail systems)
- Dosimeter or milliroentgen (mR) survey meter to measure personnel exposure
- Respiratory protection
- Lapel air samplers

1.6.3.3 Care should be taken to ensure that PPE is not damaged. If PPE damage is suspected, work must be stopped. Uncontrolled PPE damage can result in contamination of personnel.

1.6.3.4 Care should be taken to ensure that the PPE is sufficient to protect against contamination exposure that can result from wicking when working in a wet environment.

1.6.3.5 It is highly recommended that respiratory PPE be worn when working on older structures that may contain lead paint (NYSDOH, 2013) and asbestos (OSHA, 1995). The level of respiratory PPE should be directed by the HASP and/or RSP. Appendix A6 (Personal Protective Equipment) lists the various types of respirators that may be required.

1.6.4 First aid kits should be available at all times during the sampling event. At least one kit should be carried in any vehicle transporting the sampling team. At least one kit also should be located at the primary sampling site office.

> NOTE: The accident potential is greater when collecting samples from outdoor building and infrastructure materials than it is for traditional environmental sampling; therefore, it is strongly recommended that more substantial first aid equipment (e.g., ANSI [American National Standards Institute] and Occupational Safety and Health Administration [OSHA] Compliance Kit; 29 CFR 1910.266) be available during sampling. It is also recommended that phone numbers to local Emergency Medical Technician (EMT) services be made available to all workers. Contact information and procedures for communicating with emergency responders should be identified and available for use at all times.

2.0 Equipment and Materials

2.1. General Requirements

2.1.1 Only equipment that has been certified (clearly identified) by the Field Team Leader for use should be used to perform the procedures described in this document. Substitution of materials or equipment must be approved and documented prior to use. All instruments should have current calibrations or inspections clearly identified. Any corresponding certification documentation should be copied and available to the sampling personnel, as appropriate.

> NOTE: It is highly recommended that sampling equipment be properly and routinely maintained and organized before responding to an event. This maintenance and organization will allow the sampling team to enter and exit the suspected contaminated area in the shortest and most effective amount of time. Sample materials should be contained in a controlled area or vehicle with shelving/space sufficient to contain all PPE, sample bottles, materials, supplies, and forms needed to perform sample collection, documentation, and packaging activities.

2.1.2 Staging of Equipment, Supplies and Samples

2.1.2.1 Pre-staging allows for a minimized time in the contamination zone and maximized sample collection and processing efficiency.

2.1.2.2 As practical, all equipment, containers, PPE, and documentation for a sampling event should be combined into single sampling kit. The common practice is to place each piece of sampling equipment for an individual sampling event into separate plastic bags. Each of these bags (up to a maximum number that can be physically handled) can be combined in a larger bag or container that holds additional PPE (boots, gloves) and tape or other items needed. Carrying the larger container into the field, an individual can control contamination and sample materials with minimal concern for cross contamination and exposure.

2.1.2.3 Each sampling team should be aware of the SCP for their designated assignment, including being informed of the location and conditions for the specific sampling point(s) prior to entry. Sampling locations are often marked with fluorescent paint, flags, stakes and/or frames. It is recommended that sample locations be bar-coded in order to facilitate identification of the locations for resurvey.

2.1.2.4 Step-off pads are used to designate the point for exiting a contaminated area. Personnel are required to perform a given level of personal monitoring and decontamination at the step-off pads to ensure contamination is not spread outside the contaminated area. Step-off pads may be pre-established prior to site entry by the sampling team. These pads should be clearly designated and allow for easy egress out of the contaminated area.

2.1.2.5 Once samples are collected, they must be maintained under controlled conditions through shipment to the analytical laboratory(ies). This is required to control exposure to personnel and to ensure that samples are not compromised prior to analysis. Samples should be stored in a staging area where they can be observed or are under lock and key to prevent tampering. See Module I, Sections 3.6 and 6.4.3 for additional information regarding on-site sample control and storage.

2.2. Sampling Equipment Summaries

This section provides summaries of equipment that can be used to collect samples of outdoor building and infrastructure materials. Additional information regarding sampling equipment is provided in Appendices A1 – A6 (tables of sampling equipment and materials). The actual sampling tools, materials, and equipment used depend on the type of sample needed (e.g., core, chips, powder), equipment availability, site conditions, and the depth and size of sample needed, and will be specified in the site-specific SCP. A summary of the types of equipment used for collection of specific building and infrastructure materials is provided in Appendix C.

NOTE: Collection of outdoor building and infrastructure materials requires the use of manual and/or power tools for physical removal of samples. In many cases, powerful tools and equipment similar to those used for decontamination are used for sample collection, and specific skills, training and precautions may be required. It is also recommended that samplers become familiar with using the equipment first in a staging area under supervision of Health and Safety personnel, prior to use in contaminated areas. In all cases, user manuals should be consulted prior to use of equipment in the field.

2.2.1 In addition to sample collection equipment, equipment is needed to identify sampling locations (e.g., GPS, sampling frames, fluorescent paint, flags, stakes). Air and surface wipe sampling also may be required for respiratory protection due to the possibility of hazardous material resuspension (i.e., asbestos, lead, or particulates containing radionuclides) during sampling. Wooden or metal stakes, flags, and sampling frames are used to mark areas for collection of samples during Final Status Survey Phase sampling.

a. Frames must be large enough to cover an area larger than the area to be sampled and act to prevent intrusion of surrounding material into the sample. They must be controlled to prevent movement during sample collection and are properly dispositioned after the sampling event.

b. Frames are constructed of plastic sheeting that is labeled to clearly indicate the presence of radioactive material (for example, a large yellow plastic bag labeled as "radioactive material" in magenta lettering) and contain an opening to designate a given surface area from which a sample is to be taken. Plastic frames reduce the volume and weight of material taken into the field.

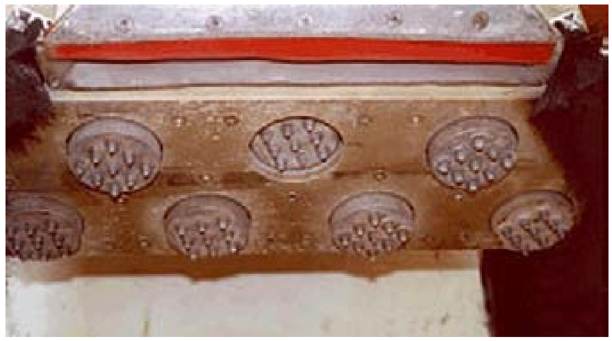
c. Frames can be approximately 0.5 to 1 m^2 (5 to 11 ft^2), with an opening for sampling of approximately 100 centimeter $(cm)^2$ (16 inches $[in.]^2$).

2.2.2 Chisels, hand drills or hole saws are used to collect chip samples representative of porous surfaces (Los Alamos, 2008; CS Unitek, Inc., 2008). Chip sampling can be used to sample concrete walls, pavement or sidewalks in cases where only small amounts of sample are needed, or when techniques involving minimal noise or dust generation are preferred. This sampling equipment is usually hand-held and can be handled easily by one individual. For the purposes of this sampling procedure, a porous surface is defined as a surface capable of allowing the passage of liquid through pores or small crevices. Examples of porous materials include concrete, brick, limestone, granite, stucco, and some conditions of asphalt.

2.2.3 Rotary hammers (hammer drills) use a hammering action to make circular cuts. The hammering action provides a short, rapid hammer thrust to pulverize relatively brittle material, with more rapid and less effort than hand drilling.

2.2.4 Needle scalers are used to collect samples from tight, hard-to-access areas (e.g., corners, metallic inserts, pipe penetrations) (Archibald, 1995; Trelawny, 2009) . These are hand-held tools that are usually pneumatically driven and use uniform sets of 2-, 3- or 4-millimeter (mm) (0.08-, 0.1-, or 0.2-in.) needles to obtain a desired sample profile. The 3-mm and 4-mm (0.1-in. and 0.2-in.) needles are designed to clean and remove concrete surfaces. Special copper-beryllium needles that are designed to prevent sparks also may be purchased. Needle sets use a reciprocating action to chip contamination or samples from a surface. The particulates generated are considered the sample. Most needle scalers have specialised shrouding and vacuum attachments to collect removed debris. Certain needle scalers, such as the Pentek CornerCutter® (Pentek, Inc., Upper Saddle River, NJ) are ergonomically designed with a pivoting vacuum head for work in difficult areas. Needle scalers do not introduce water, chemicals or abrasives into the waste stream.

2.2.5 Scabbling is a scarification process used to remove concrete or other porous surfaces (EC-CND, 2009; Jannik, 2007; NEA, 2011; Pentek, 1997; EPA, 2006). Scabbling tools (scabblers) typically incorporate several pneumatically operated piston heads that strike and chip a concrete surface. Scabblers are best suited for removing up to 2.5-cm (1-in.) thick layers of contaminated concrete (including concrete block) and cement. Available scabblers range from 1- to 7-headed hand-held scabblers to electro-hydraulic and remotely-operated scabblers, with the most common incorporating 3 to 7 scabbling pistons mounted on a wheeled chassis (see Figure 1). For pavements, 5- to 7-headed scabblers are normally used, while handheld 1- and 3-headed types are traditionally applied to concrete walls. Because scabbling may cause a cross-contamination hazard, vacuum attachments and shrouding configurations have been incorporated. Before scabbling, combustibles must be stabilized, neutralized, and/or removed. In practice, floor scabblers may be moved to within 5 cm (2 in.) of a wall, and other hand-held scabbling tools are needed to remove the last 5 cm (2 in.), as well as surface concrete on walls.

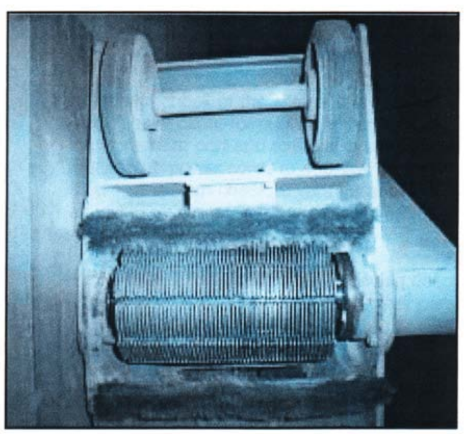


Piston head with bits for scabbler.

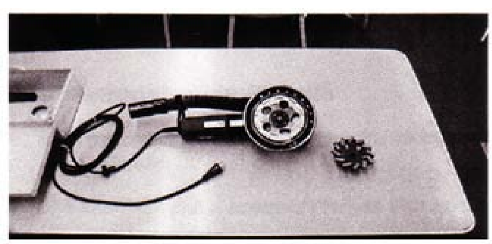
Figure 1. Scabbler Tool

(from U.S. EPA "Technology Reference Guide for Radiologically Contaminated Surfaces." EPA-402-R-06-003. 2006)

2.2.6 Shavers are used for large-area removal of thin concrete or cement layers on flat or slightly uneven surfaces. Most units contain a vacuum port to collect particulates. Several types of shavers exist, including electric-powered, self-propelled horizontal surface shavers and manual wall shavers (see Figure 2) (CS Unitec Inc., 2006; Dickerson, 1995; EC-CND, 2009; U.S. Department of Energy, 1998). The self-propelled shaver is suited for large open areas (over 10 m^2 or 100 ft^2) with few obstructions. The depth of shaving is set by a manual rotary wheel, and varies between 0.01 cm (0.004 in.) to 1.3 cm (0.5 in.). The unit weighs 150 kilograms (kg). In cases where contamination has penetrated and layers up to 1 cm or more have to be removed, the use of shavers will require several passes.



Shaver and the shaving drum.



Grinder and Spare Wheel.

Figure 2. Shaver and Grinder

(from U.S. EPA "Technology Reference Guide for Radiologically Contaminated Surfaces." EPA-402-R-06-003. 2006)

2.2.7 Hand-held grinders use a ~13-cm (5-in.) diamond grinding wheel that can be applied to flat or slightly curved surfaces (see Figure 2) (Desiel, 2014; EPA, 2006). The grinders weigh 6 lbs, are portable, and can grind concrete surfaces to a depth of 1.5 to 3 mm (0.06 to 0.12 in.). The grinder wheel spins at 10,000 revolutions per minute (rpm) and needs to be replaced after approximately ten hours of use. The unit is cooled by internal and external air intakes, which reduce debris feed into an attached vacuum hose. The depth of grinding depends on the number of passes on a given area. Operators should be careful not to apply the tool onto the surface with excessive strength, as this can result in faster wearing of the segments and overheating the engine.

- Application of hand-held grinders on vertical surfaces or ceilings can be eased by vacuum assist (under-pressure) and counter-weight systems. These disks are also very sensitive to the presence of metallic inserts on the surface.
- Hand-held grinders are not suitable for rough surfaces and their production rate is strongly impaired on uneven surfaces.

2.2.8 Hydraulic/pneumatic hammers are commonly used in areas where contamination has penetrated deeply into a concrete surface (Jannik, 2007). Hydraulic or pneumatic hammers can either be hands-on or through use of an electrically powered, hydraulically controlled robot. The latter may be equipped with a hydraulic hammer, an excavator bracket, or other tools, and is well suited for cutting pavement, sidewalks and walls. A mini electro-hydraulic hammering unit (weighing 350 kg) can be used to obtain thicker samples where contamination has penetrated deeply, reducing the workload for the operators when compared to other equipment (i.e., scabblers or shavers).

2.2.9 Core drills (Byrne, 2008; Chicago Pneumatic, 2012; CSIR, 2002; CS Unitec, 2008; EC-CND, 2009)

a. Core drills are designed to remove cylinders of material, much like a hole saw, and are typically used when precise, circular cuts are needed. Core drilling is the preferred sampling technique in cases where deep contamination is suspected and large surface area sampling is not required. Core drills can be operated in any orientation (i.e., vertically or horizontally), and can be powered by electric, hydraulic or air power sources. Drill bits range in diameter from 1 – 152 cm (0.5 − 60 in.) and drilling depths are virtually unlimited with barrel extensions. Core drills can achieve greater depths of cut than any other technique with the exception of wire sawing. Typically, a core sample of up to 10.1 cm (4 in.) long is collected.

b. Diamond core drills are generally used for concrete sampling. If contamination can be controlled, water flushing is highly recommended when using diamond core drills. Although these drills are designed to avoid the formation of ice, ice can form in the machine when the ambient air temperature is 0 – 10 °Celsius (°C) (32 − 50 °Fahrenheit [°F]) and the relative humidity is high. Use of antifreeze agents and a water separator (hose) can counteract this risk. If using an electrically powered drill, operators should ensure that water does not enter the unit; if water does enter, the unit should be shut off immediately.

2.2.10 Saws (Chicago Pneumatic, 2013a; CS Unitec, 2003; Los Alamos, 2008; Chicago Pneumatic, 2013b; Hilti, 2012; Husqvarna, 2006; Tractive AB, 2012)

a. Concrete saws can be used to collect samples with thicknesses of up to 1 m (~3 ft) (with a diamond wire saw) (Chicago Pneumatic, 2013a; CS Unitec, 2003). They are ideal for cutting depths of 300 mm (~12 in.) in metal and 1000 mm (~39 in.) in concrete, and for cutting cores into segments (at different depths) or trimming cores or bricks. For most materials, diamond or abrasive blades can be used. While diamond blades last longer, abrasive blades are less expensive and do not require coolant. Motor-driven diamond or carbide saw blades are recommended for cutting through concrete walls or reinforced concrete, masonry and other composite material, but are not recommended for cutting through steel pieces, such as rebar. An abrasive blade should be used in cases where cutting through steel is required to access sample material. Since most concrete saw blades are water-cooled, the water is a secondary waste concern. Depending on the size of the guide bar and its cutting performance, the recommended amount of water is 1.5 to 8 liters (L)/minute (min) (0.4 to 2 gallons [gal]/min). Dry cutting can be used instead of wet cutting to obtain small- to medium-sized samples, especially in cases where the particulates are to be collected. Dry cutting normally requires lower wire speed.

b. Handheld saws (Los Alamos, 2008) should be used when sawing to less than 100 mm (~4 in.) deep. Circular saws should be considered the primary option if precise cuts are needed.

- For deeper cuts, a handheld power saw (e.g., chainsaw) can be used, but a track-mounted saw should be used if the larger blade size makes the hand saw impractical (Chicago Pneumatic, 2013a; CS Unitec, 2003). Although newer technologies include remotely-operated systems, most heavy-duty concrete saws are track-mounted and guided on a bar-track mechanism that needs to be manually operated with a defined feed motion. A normal thickness of cut is about 1/3 the diameter of the blade, with about 1 m (~3 ft) of concrete being the maximum thickness.

- Circular saws (Chicago Pneumatic, 2013b) are ideal when very precise cuts are needed. Circular sawing also enables flush cuts (e.g. along walls). Appropriate guiding devices are required to control the cutting forces and avoid locking the blade. Preparation for use of these saws requires a good deal of effort, which reduces their popularity compared to other types of saws. The maximum cutting depth is 1,000 mm (~39 in.), which can be achieved by using saw blades with diameters of 2,200 mm (~87 in.). Dry cutting is feasible for small to mid-size assignments, but when the production rate is the main concern water flushing is recommended, as for any diamond-tipped cutting tools.

- For chainsaws, the abrasion is very high, such that the lifetime of one chain is limited to a surface area of approximately 2 m^2 (~22 ft^2). In special cases, the mechanical lifetime of the chain can be lower than that of the diamond coating. Unlike a wire or circular saw, the chain saw can be used to quickly create openings in thin walls and ceilings without installing much equipment. It is also possible to plunge into the surface and, in some cases, pre-drilling can be omitted.

- Cut-off saws are designed for cutting through concrete, asphalt and steel with cutting blades for both dry and wet cutting (Chicago Pneumatic, 2013b). These saws can be used with both diamond blades and abrasive discs. A dust collector can be connected to the blade guard for operation when the use of water is not possible or recommended. A cart with wheels for the cut-off saw is recommended when precise and clean cutting jobs are required.

c. Diamond wire saws are not hand-held; a cart mounted unit drives a wire that carries diamond impregnated beads (Hilti, 2012; Husqvarna, 2006; Tractive AB 2012). These saws are often used to cut through reinforced concrete and can be used when large samples are needed. Diamond wire sawing is typically used with water cooling, but it is also possible to cut in dry conditions. Dust emissions can be reduced using a sealed collection system. In contrast to most other cutting techniques, there are few limitations concerning the size and thickness of the material to be cut. The equipment required includes the basic machine with electrical or hydraulic actuation, the control cabinet, at least two deflection rollers and a wire storage capability in the case of larger cuts. Diamond wires are typically about 11 mm (0.4 in.) in diameter. Depending on the cutting length, the width of the cut is about 15 to 20 mm (0.6 to 0.8 in.). If the rear side of a structure is not accessible, cuts can also be accomplished by plunge cutting. To make plunge cuts in pavements or sidewalks, blind holes averaging between 160 and 250 mm (6 to 10 in.) are needed. An extraction system to exhaust debris out of the holes is required to prevent the roller system from clogging up. Plunge cutting is restricted to cut dimensions of about 250 cm (~98 in.) in depth and 250 cm (~98 in.) distance between the blind holes. Concrete composition and reinforcement strongly influence wire wear and cutting rates. Diamond saw blades should be cooled by a constant stream of water.

2.2.11 Plastic bags and containers (plastic, steel, wood or fiberboard) can be used to contain samples, sample containers, packing ice, equipment and materials, or waste.

a. Plastic bags in a variety of sizes and types (e.g., zip-locked, open bag with twist ties) are used as needed to accommodate sample collection, double bag storage and equipment storage.

- Bags containing samples are sealed with tape and double bagged.
- Bags without zip-locking capabilities can be used for sample shipment or waste containment.

b. If elevated levels of radioactivity are suspected, use of a plastic container is recommended to prevent sample loss and cross-contamination that could occur if a bag becomes damaged.

c. Refer to Appendix A3 (Sampling Containers) for typical sizes and dimensions.

2.2.12 Other materials – Based on the nature of the incident and the area affected, other materials or equipment may be needed for sample collection. These materials include items such as chipping tools, hammers, tape, paint scrapers, and waste vacuum cleaners. A list of some of the additional equipment that may be needed is included in Appendix A5.

2.3. Closures and Seals

2.3.1 Masking or other adhesive tape is used for sealing containers during sample shipment.

2.3.2 Security seals are attached over the cap or lid of each sample container to provide an indication of sample tampering and ensure sample integrity. Security seals also can be used for sample shipping or transport containers, to ensure package integrity is not compromised during transport. Typically, one seal is placed on each sample container and multiple seals (e.g., two seals placed on opposite ends) are used on shipping containers.

a. Security seals may be commercial or tape seals that contain the signature or initial of the sample collector, and date and time of sample collection.

b. The seal must break or tear if it is removed.

c. Metal seals are usually crimped into place and require cutting or breakage for removal.

2.4. Sampling Equipment Decontamination

> NOTE: Materials that have been used for decontamination or for carrying samples should be segregated until they have been decontaminated and surveyed as clean. Unless determined to be free of contamination, water and other materials used for decontamination must be retained and removed from the sampling site for proper disposal. Rinsate water may be required to be collected and analyzed for quality control purposes. Additional stages for washing should be used when elevated radiological contamination is suspected. Waste generation should be minimized whenever possible, especially as it relates to segregating liquid from solid wastes and minimizing the generation of liquid waste. Information on waste minimization strategies and techniques can be found in the WMP (see Appendix D).

2.4.1 Buckets and pails serve as tote containers and portable sinks.

a. Buckets and pails should be constructed of plastic.

b. Lids are needed for containment, but are generally not taken into the field.

c. Typically, 5-gal and 20-gal buckets are used.

d. Several buckets or pails are used in decontamination.

- The number used is dependent on the degree of cleanliness required. At a minimum, one is used for the initial wash and one is used for the final rinse.
- Rinse water may be required to be collected as a quality control sample (rinsate sample).

2.4.2 Drums or large garbage cans are used to contain contaminated PPE, accumulated wastes, clean bags, containers, or equipment. Waste segregation and minimization strategies should be included in the incident WMP.

2.4.3 Brushes are used to remove deposits of solids from sampling equipment. Both bottle brushes and flat brushes are used. Brush handles should be sufficient to prevent direct contact with the brush during use.

2.4.4 Cloths are used to remove solids from or dry sampling equipment. Cloths should be certified as clean for use in drying equipment, and may be pretreated to contain a cleaning agent, if approved for the sampling event. Paper towels may be used, but lint-free cloths are preferred.

2.4.5 Water is used to wash and rinse contamination from equipment, materials, and sampling personnel. At least 16 L (~4 gal) is recommended for every 20 samples collected.

> NOTE: Solid and liquid wastes should be segregated to the greatest extent possible in preparation for the disposal of decontamination wastes. The generation of liquid waste should be minimized as much as possible.

2.4.6 Soap and other non-ionic detergents are used for decontamination and washing. Soap can be in either powder or liquid form, and must be non-reactive, anionic, phosphate-free, and low-foaming. Stainless steel polishers or cleaners may be used, provided they contain no petroleum distillates and leave no residue.

2.4.7 Sufficient containers should be located at step-off pads to allow for disposal and control of contaminated equipment and clothing. Additional information concerning proper waste containment and disposal can be found in the incident WMP (see Appendix D).

2.4.8 Tote containers should not be used as final rinsate containers, as the materials carried may contaminate the rinsate.

2.4.9 Other materials – Based on the nature of the incident, the area affected, and the extent of contamination, other materials may also be needed in equipment decontamination. Additional materials may include items such as chemical abrasive cloths, sand paper, grinders, solvents, alcohol, and dilute acids. The requirements for use of these items should be reviewed and discussed prior to use.

2.5. Communications

2.5.1 Radios or any two-way communication device capable of transmitting the sampling team's concerns or requests to the standby person or Field Team Leader shall be employed.

2.5.2 A standby person (individual stationed outside the zone) is required to observe and respond to the sampling team if problems arise.

3.0 Quality Control

Sample collectors should refer to the SCP to determine the kind and number of QC samples that should be collected or procedures that should be performed. In some cases, additional samples or sample volume will be needed to support laboratory QC sample analysis (e.g., matrix spikes, field replicates). Because QC samples may be shipped to the laboratory as either known QC or blind samples, sample collectors should refer to the SCP to determine how these samples are to be labeled for transport to the laboratory.

3.1. Field Blanks

3.1.1 Field blanks are used to monitor contamination that may be introduced into samples during collection.

a. If required, the field blank is prepared in the field at the same location, using the same procedures that are used to collect and process the sample. Field blanks are typically prepared prior to sample collection.

b. The field blank is submitted to the laboratory for analysis with the collected samples.

3.1.2 Field blanks are prepared by filling a sample container with blank matrix material using the same collection and processing procedures and equipment that are used to collect the samples.

> NOTE: Field blanks for outdoor building and infrastructure materials may not be practical to obtain. Efforts should be made to obtain analyte-free materials that have similar composition to the samples to be analyzed. Uncontaminated concrete or brick material may be acceptable blank material for plutonium (Pu), americium (Am), and strontium (Sr) analyses, but these materials will typically contain background levels of uranium (U) and radium (Ra) isotopes.

3.2. Rinsate Blanks

3.2.1 Rinsate blanks are samples collected from rinse water running off decontaminated piece(s) of equipment, and are used to determine and document that equipment have been adequately decontaminated.

a. The rinsate blank may or may not be preserved in the field, as described in the SCP.

b. If the rinsate blank is preserved, a field blank is required.

3.2.2 Depending on the radiochemical of interest, rinsate and rinsate blanks are preserved using hydrochloric or nitric acid (see Appendix E) and submitted to the analytical laboratory to evaluate equipment decontamination.

3.3. Field Replicates

3.3.1 Field replicates are collected in the same manner, location, and time as the initial sample. Sample collectors must ensure that the replicates are as equivalent in proximity, and mass or volume as possible. Variations can affect QC evaluations.

3.3.2 The location from which a replicate sample is collected should be the space adjacent to the initial sample or the space of the initial sample enlarged to allow for a greater volume of sample to be taken.

3.3.3 A field replicate is used to evaluate sample heterogeneity, sample collection methodology, and analytical procedures.

3.3.4 The replicate sample is handled and documented in the same manner as the initial sample.

3.3.5 Field replicates will be sampled and remain in separate packages throughout transport to and storage in the laboratory.

3.4. Background samples

3.4.1 Background samples are collected from a known uncontaminated area to allow for the determination of natural or "background" radionuclide concentrations.

3.4.2 Background samples are collected under the same control requirements as Final Status Survey Phase samples (see Module III).

3.5. Equipment

3.5.1 All equipment that is used to measure or analyze samples in the field requires calibration, routine maintenance, and at least annual standardization/verification. This equipment is calibrated following procedures included in the manufacturer's product/equipment manual or performed in the laboratory.

a. Balances or scales are routinely used in the field and require calibration and standardization/verification or certification to ensure measured sample weights are accurate.

b. Linear measuring devices (e.g., tape measures, rulers) are used to measure the length, width and depth of samples. These devices should meet National Institute of Standards and Technology (NIST) requirements (NIST Handbook 44, 2014).

3.6. Sample Control

3.6.1 Once samples are collected, they must be maintained under controlled conditions through shipment to an analytical laboratory. This control is required to ensure that samples are not compromised and that analytical data generated are representative of site conditions.

3.6.2 Sample custody requirements

a. Keep samples in an area where they can be observed or are under lock and key to prevent tampering.

b. Maintain samples in the same configuration or condition in which the sample arrived from the sampling site (e.g., containers sealed) until additional procedures are required.

3.6.3 Sample tracking

a. As samples are transferred from collection through processing, packaging, and shipment, record sample progress.

b. The person(s) performing each step is required to record their initials or signature on the label, sample tracking log, Chain of Custody (COC) form, and any other document associated with the sample to qualify the condition of the sample at that point of sample progression. See Module 1, Section 4.0 (Documentation) regarding documentation requirements.

3.6.4 All sampling personnel are required to perform sample collection, processing, and packaging activities in a manner that does not compromise the integrity of the samples or the requirements associated with the sampling event.

a. Follow documented procedures and adhere to requirements.

b. Notify supervision of problems or concerns.

c. Adhere to all requirements regarding documentation of activities, conditions, observations, and measurements.

3.6.5 Unused swipes are to be sent to the laboratory with each batch of samples to be analyzed for radioactive analytes. These materials provide the analytical laboratory with a suitable blank or with information that will determine if any activity measured is the result of inherent radioactivity of swipes used, and the results may be used in assessment of the final field sample results.

4.0 Documentation

> NOTE: ALL documentation produced in collecting and processing samples is considered a legal record and is to be treated as such. Legibility and permanence are to be maintained. If errors are made, either the document error is struck out using a single line and initialed and dated, or it is re-written, checked for accuracy, initialed and dated, and attached to the original for record keeping.

4.1. General Considerations

4.1.1 Pens and markers should be of black indelible ink capable of writing on damp labels and containers. Pens and markers taken inside the contamination zone should be discarded with waste or used disposable PPE.

4.1.2 Logbooks, forms and reports should be assembled and maintained as permanent records.

a. If taken to the sampling area, they should be controlled outside of the contaminated zone to prevent contamination. If needed in the contaminated zone, take only a blank copy of the form or page. Once out of the contaminated area, they are to be rewritten into the original permanent records and verified as transcribed correctly once outside of the zone.

b. Required records include:

- Sample identification codes (SICs)
- Field Logbook
- Field report forms
- COC forms
- Photographs, when practical
- Make, model, and accuracy information for any equipment used

.

c. Written documents are generated and maintained as the primary records of the sampling event. However, information also may be entered into an electronic record during or, as soon as practical, following sample collection.

4.1.3 Control of written and electronic records is detailed in the SCP.

4.2. Sample Labels

4.2.1 Sample labels must be applied to each sample container (including any container that holds a blank or quality control sample), with information that identifies and describes the sample. Sample labels are to include the following information at a minimum:

- SIC
- Time and date sample collected
- Sample dimensions, mass and/or volume (for decontamination rinsate samples) and matrix
- Sample collection location (GPS coordinates or brief description)
- Signature or initials of the sample collector

4.2.2 If samples are placed in two containers (e.g., double bagged), a duplicate (DUP) label may be placed on the outside of the first bag or container, but inside the second bag or container, for legibility. If a duplicate label is used, it must be identified as a duplicate label or copy. If samples are triple-bagged, the duplicate label should be placed on the outside of the second bag or container, and inside the third.

4.3. Sample Identification Codes (SICs)

4.3.1 SICs are required for all samples collected, including rinsate blanks.

4.3.2 Each sample must have a unique SIC.

a. SICs typically consist of an alpha-numeric sequence code that includes a coded date and location marker.

b. All assigned SICs are used to document the sample location, type of sample, date and time of sample collection, and sample collector.

4.3.3 The SIC is recorded on all field documentation, sample container labels, COC forms, and any other documents pertaining to the sample.

4.4. Field Logbooks

4.4.1 Field personnel, including sample collectors, are responsible for recording data and maintaining Field Logbooks with adequate information to identify a specific sample and to provide information that may be necessary for interpreting analytical results.

4.4.2 Information that should be recorded in a Field Logbook entry includes:

- Number of samples collected, method of sample collection
- Date and time of collection
- Any pertinent observations
- Names of sample collectors and/or observers
- Description of sample location
- GPS coordinates
- Field screening data, if available

A Field Logbook Entry is provided in Appendix B1. Electronic data recording devices may also be used as a means of recording information in the field. If electronic recording devices are to be used, however, they should be selected based on durability, accuracy, backup capability, and ease of decontamination.

4.4.3 If photographs are included as part of the sampling documentation, the name of the photographer, SIC, date, time, site location, and site description are to be recorded sequentially in a logbook as each photograph is taken. After the photographs are developed, the associated information included in the logbook entries is to be written on the back of the photograph.

4.5. Field Sample Tracking Form

4.5.1 Field personnel, including sample collectors, are responsible for recording data and maintaining Field Sampling Tracking Forms with adequate information to identify a specific sample.

4.5.2 Copies of these forms accompany samples during shipment.

4.5.3 Information recorded on these forms includes:

- SIC
- Sample matrix
- Chemical decontamination of matrix (and identification of agent used)
- Sample description and location
- Sample dimensions, mass or volume (if decontamination rinsate)
- Sample depth
- Sample type
- Number of containers

An example Field Sample Tracking Form is provided in Appendix B2.

4.6. Chain of Custody (COC)

4.6.1 Tracking samples from collection to receipt at the analytical laboratory is documented on a COC form. A COC form is provided in Appendix B3 (Chain of Custody Form).

> **CAUTION**: Documentation of changes in sample custody is important. This is especially true for samples that may be used as evidence of intentional contamination or to establish compliance with a release criterion. In such cases, there should be sufficient evidence to demonstrate that the integrity of the sample is not compromised from the time it is collected to the time it is analyzed. During this time, the sample must either be under the physical custody of a responsible individual who is currently listed on the COC or be secured and protected, under lock and key, from any activity that would change the true value of the results or the nature of the sample. Each individual responsible for sample custody is required to provide signatory documentation each time a sample(s) is received or relinquished.

4.6.2 Information contained on the COC form is to include:

- Site information – Address of the site, contact person, telephone number, and emergency contact number
- SIC for each sample
- Date and time of sample collection
- Sample volume or mass
- Sample matrix

- Contact gamma reading or any additional radiological screening results of the sample, if available, and as provided by radiation protection personnel
- Analyses requested – general analyses or specific isotopic tests
- Printed names and signatures of all persons accepting and relinquishing sample custody, and the date and time of transfer
- The printed name of the certified courier, courier company, and the name and signature of person(s) relinquishing and accepting custody of the samples

4.6.3 If deemed necessary, the following information also should be contained in the COC form:

- A brief description of the sample(s)
- Initials of the sample collector(s)
- Method of shipment (ground, air, or both)
- Any other pertinent information or comments regarding the sample(s)

4.6.4 At the time of transport, the individual relinquishing the sample(s) must sign and date the COC form. The receiver also must sign and date the form.

4.6.5 The COC is copied and usually has carbonless copies attached to the original that are specified as to use.

a. A copy of the COC is to be retained by the individual or organization relinquishing the samples.

b. A copy of the COC is to be placed into a sealed plastic bag. The sealed bag is placed inside of the sample transport packaging prior to sealing for transport.

c. The original COC is sent to the analytical laboratory in a separate envelope.

4.6.6 The receiving laboratory is required to submit a signed copy of the completed COC to the Field Team Leader after receipt of the samples, and the original is to be returned with the data package. The laboratory should include the following information with or on the completed COC:

- Time and date received and signature of the person receiving the samples (appears on the COC)
- Condition of the packaging and the security seal, and condition of security seals, where applicable
- Condition of and any problems with the individual samples, such as a broken container, missing samples, or illegible information

4.7. Verbal Discussions

4.7.1 All verbal discussions pertinent to the sampling event, samples, or transport and receipt of the samples by the analytical laboratory are to be documented in the Field Logbook.

4.7.2 If sample collectors are contacted by the laboratory, the following information is to be documented:

- Name of the person who called
- Name of the person who received the call and answered the questions
- Content of the conversation, including any specific data or information discussed or provided
- Time and date of the call

4.8. Transport Documents

4.8.1 Common Carrier documents should be included with each shipment and completed as required by the individual carrier.

4.8.2 All packages must securely display the following:

- Sampling contact information, mailing address, and phone number
- Laboratory name(s), mailing address, and phone number
- Quantity and description of contents
- Date of shipment
- Appropriate U.S. Department of Transportation (DOT) radioactive/radiation, Nuclear Regulatory Commission (NRC), and/or International Air Transport Association (IATA) labeling.

4.9. Waste Documentation

Documentation needs and requirements pertaining to waste generated during sampling are addressed in the incident WMP (see Appendix D).

5.0 Personnel/Equipment Decontamination

NOTE: The instructions in this section are intended to provide general information and guidelines. Requirements set forth by site radiation protection personnel also must be consulted and followed for site-specific requirements and procedures.

5.1. Surface Contamination

Surface contamination can usually be detected by radiation protection personnel, using direct monitoring equipment and methods. In areas of high background radiation levels, however, surface swipes should be taken (see Module II, Section 10.0) and provided to radiation protection personnel for assessment of removable surface contamination prior to exiting the site. Alternatively, suspected contaminated equipment should be controlled in an area of lower background levels for direct reading.

5.2. Personnel and Equipment Decontamination

5.2.1 All personnel, equipment, materials, tools, or other objects exiting a controlled area will be surveyed by radiation protection personnel to determine the presence of contamination and, if necessary, will be decontaminated prior to leaving the controlled area. This survey and decontamination includes any large pieces of equipment used in the process of procuring building or infrastructure material samples (i.e. scaffolding, ladders, etc.).

5.2.2 Any material or personnel exhibited survey readings that exceed the site's release limits, as detailed by radiation protection (e.g., 2x background levels), are to be controlled to prevent the spread of contamination.

5.2.3 Any personnel decontamination is to be handled by radiation protection personnel.

5.2.4 Contaminated sampling materials are to be decontaminated per procedures described in Module I, Sections 5.3 and 5.4, and subsequently surveyed by radiation protection personnel for controlled release.

5.2.5 Complex equipment (e.g., has recessed areas or crevices, air flowing through it for cooling, or water pumps) is to be fully surveyed by radiation protection personnel to determine if and how decontamination should be performed.

5.3. Dry, Wet and Chemical Wiping

NOTE: All wastes produced from wiping off a contaminated surface are to be considered contaminated until proven otherwise. Placing plastic sheeting beneath the equipment to be cleaned facilitates waste collection and disposal. Additional information regarding the management of wastes generated from these activities can be found within the incident WMP (see Appendix D).

5.3.1 Clean surfaces of equipment and sampling containers with single wiping motions, starting with equipment handles or outer edges and moving to the most contaminated areas.

5.3.2 Dry wiping with clean cloths or paper towels should be used to remove all visible solids contamination.

5.3.3 Swiping with cloths or paper towels dampened with deionized water should be used to remove additional contamination. Additional swipes can be used as necessary.

5.3.4 Chemically treated swipes (soap swipes, alcohol prep pads, or other approved cleanser) may be used to remove heavy grime.

5.3.5 If radiation is detected and is not removed by additional wiping, proceed to Section 5.5 for washing and rinsing.

5.4. Decontamination of Pumps and Hoses

5.4.1 Pre-rinse the pump and associated piping/tubing/hose by operating the pump in a deep basin containing approximately 30 to 40 L (8 to 10 gal) of potable water for approximately 5 minutes.

5.4.2 Wash the pump and associated piping/tubing/hose by operating the pump in a deep basin containing approximately 30 to 40 L (8 to 10 gal) of potable water containing a non-phosphate detergent (e.g., Alconox® cleaner [Alconox, Inc., White Plains, NY]) for 5 minutes.

5.4.3 Repeat the wash with a fresh solution of detergent.

5.4.4 Rinse the pump and associated piping/tubing/hose by operating the pump in a deep basin containing approximately 30 to 40 L (8 to 10 gal) of potable water for 5 minutes.

5.4.5 If practical, take a sample of the rinse water (1 L [0.25 gal]) and have the sample evaluated by the Radiation Protection Team for gross alpha and beta radiation. If gross alpha and beta screening is impractical, disassemble the major pump components and allow to dry. Take a swipe of the internal openings of the pump suction and discharge and the associated piping/tubing/hose and have the swipes counted for alpha and beta contamination.

5.5. Washing and Rinsing

> NOTE: All wastes produced from wiping off a contaminated surface are to be considered contaminated until proven otherwise. Placing plastic sheeting beneath the equipment to be cleaned facilitates waste collection and disposal. Additional information regarding the management of wastes generated from these activities can be found within the Pre-Incident WMP (see Appendix D).

5.5.1 Place the equipment in a container with sufficient room for washing. Add the minimum amount of water needed for washing.

5.5.2 Using a cloth, wash the piece of equipment.

5.5.3 Rinse the equipment with a minimal amount of water, collecting the rinsate into a wash container. Spray bottles can be used to minimize the amount of water used.

5.5.4 Wipe off the equipment with a clean paper towel or cloth.

5.5.5 Give the equipment a final rinse with a minimum of rinse water, collecting the rinse water in a separate clean sample container.

> NOTE: Deionized or distilled water should be used for all final rinsing. The final rinsate is collected and submitted as a sample. Depending on the radiochemical of interest, rinsate samples are preserved using hydrochloric or nitric acid (see Appendix C).

5.5.6 Dry off the equipment with a clean paper towel.

5.5.7 Take a swipe of the equipment and submit the swipe to radiation protection personnel for analysis to ensure the equipment is properly decontaminated. If radiation is detected and is not removed by additional rinsing (e.g., with rinse water or with 1% nitric acid [HNO_3] or hydrochloric acid [HCl]), bag and seal the equipment for delivery to a decontamination station or laboratory.

5.5.8 The management of wastes generated during washing and rinsing of sampling equipment is addressed within the incident WMP (see Appendix D).

6.0 Waste Management

The majority of waste generated as a result of sample collection activities, including equipment and personnel decontamination, will be considered low level radiological waste (LLRW). Prior to the initiation of sample collection activities, a WMP should be in place to address waste management considerations (see Appendix D). Waste compiled for disposal is to be documented. Appendix B4 (Example Waste Control Form) presents a typical format for documenting wastes for disposal.

6.1. General

6.1.1 All waste containers are to be clearly labeled or identifiable as waste. Waste containers may be bottles, drums, plastic bags, or garbage cans, depending on the type of waste.

6.1.2 Clean trash is to be clearly segregated from potentially contaminated or contaminated waste.

6.1.3 Waste material should not penetrate or be capable of chemically reacting with the containment used. To prevent leakage or loss, use waste containers that are durable, can be sealed, and are composed of materials that will not be affected or compromised.

6.1.4 After each addition, the waste container should be closed. After final insertion of material, the container should be sealed.

6.2. Solids

6.2.1 Dry Wastes

a. Place dry material in a labeled plastic bag or container that is appropriate for containing the waste material.

b. Material should not cut through or penetrate the containment. If necessary, sharp edges should be taped or otherwise wrapped.

c. After each addition, the container should be closed. After final insertion of material, the container should be sealed.

6.2.2 Wet or Damp Wastes

a. Place wet or damp material in a labeled plastic bag or container that is appropriate for containing the waste material.

b. Material that emits fumes or odors should be evaluated by the authorized safety individual regarding the need to control vapors, as some vapors may cause explosions of the container.

6.3. Liquids

6.3.1 Liquids should be segregated based on material (e.g., water should be contained with water, oils with oils). Wastes should be evaluated by the authorized safety individual for compatibility to ensure that hazards are not produced from mixing.

6.3.2 Liquid wastes that emit fumes or odors should be examined for possible vapor control problems as some vapors may cause explosions.

6.3.3 Use a liquid containment vessel to collect wet decontamination waste (i.e., decontamination rinsate that is not submitted as a sample).

> NOTE: Wet decontamination may involve use of a pump to transfer liquid wastes, and drums or other containers with liners for storing liquid wastes. The drums should have secondary containment. Decontamination rinsate containing solvents or acids may need to be analyzed for pH and/or ignitability prior to disposal.

6.4. Segregation

6.4.1 As waste material is produced and collected, segregation must be used to prevent and control additional contamination and radiation exposure levels.

6.4.2 Radiation and radioactivity levels in the materials used for decontamination will normally be insignificant.

6.4.3 Storing samples in a single location may result in radiation levels that could potentially affect background radiation levels, or result in personnel exposure. Care should be taken to monitor radiation levels according to applicable regulatory or radiation protection requirements. If necessary, move or shield the samples. If radiation levels from unshielded samples exceed applicable limits, the samples should be placed in shielded containers. If radiation levels in an area where samples are being stored exceed manageable levels, refer to the appropriate radiation protection guidelines.

a. The potential for decontamination materials to spread contamination is often higher than the potential of contamination from the actual samples taken. Materials used for decontamination should be handled in a manner such that its accumulation and movement will not result in the potential for release.

b. If breached, waste containers can release loose material, vapors, or liquids. Waste containers should be handled in a manner such that they will not be breached.

6.5. Disposal

6.5.1 Refer to EPA's Selected Analytical Methods for Environmental Remediation and Recovery (SAM) Companion *Laboratory Environmental Sample Disposal Information Document* (U.S. EPA, 2010) for information regarding disposing of small volume wastes containing radiological, non-radiological and mixed hazards.

6.5.2 Procedures or mechanisms for control or disposal should be determined prior to generation of any waste. The Field Team Leader will instruct the sampling team regarding the actions needed to control or remove the waste generated.

6.5.3 A sample of each waste stream may be required to be packaged and shipped to a laboratory for characterization.

6.5.4 Wastes may be required to be left on site for disposal during remediation.

7.0 Sample Packaging and Transport

NOTE: Boxes constructed of hard plastic, wood or metal make excellent packaging for low-level radioactive samples. Drums (30- or 55-gal) meeting Type A packaging requirements (addressed in 49 CFR 173.412) (identified by markings on the drum) are required for samples meeting U.S. DOT placard requirements for Radioactive White I, Radioactive Yellow II, or Radioactive Yellow III.

WARNING: Samples should be considered contaminated, and the appropriate PPE worn, during sample packaging and loading. All samples being shipped for radiochemical analysis are to be properly packaged and labeled before transport off site or within the site, in accordance with U.S. DOT regulations in 49 CFR parts 170 – 189 or IATA Dangerous Goods Regulations. Any individual involved in transporting hazardous materials, including packaging hazardous materials for transport, must be trained in and comply with these regulations (DOT 49 CFR 172.700; IATA 1.5). Packages shipped within the U.S. must be verified by a DOT-certified Class 7 shipper. Courses to train individuals regarding these regulations are available in several states. A summary of related requirements is provided in Module I, Sections 7.1 through 7.5 below. The primary concerns are incidents that can occur during sample transport and result in the breakage of the sample containers or increase the possibility of spills and leaks (e.g., bumping, jarring, stacking, wetting, and falling). In addition to loss of samples and cross contamination, the possible release of hazardous material poses a threat to the safety of persons handling and transporting the package and to laboratory personnel receiving the package.

7.1 Regulations and Requirements

7.1.1 Various agencies have controls over the transport and shipment of radioactive material, including the DOT, the NRC and IATA.

7.1.2 All requirements for transport and shipment included in this document reflect the requirements of these agencies.

NOTE: Regulations are subject to change over time; therefore, they should be verified immediately prior to performing the procedures described in this document.

7.1.3 Definitions of terms pertinent to transportation of materials are stated in the Code of Federal Regulations (CFR) at 49 CFR Parts 171 through 173.

a. Class – The hazard classification of the material for transport purposes. Radioactive material is defined as Class 7.

b. Labels – Indication and signs on a packaging or on material contained in a packaging that designate a hazard or hazardous condition or handling requirements inherent to the packaging or package.

c. Markings – Indication signs pertaining to design or specifications of a package, irrespective of its use.

d. Overpack – An enclosure that is used by a single consignor (the site) to provide protection or convenience in handling of a package or to consolidate two or more packages for shipping purposes.

e. Package – The packaging with its radioactive contents as presented for transport. For example, a sample cooler used to transport a single sample or multiple samples.

f. Packaging – The assembly of components necessary to enclose completely the radioactive contents. It may, in particular, consist of one or more sample containers, absorbent materials, spacing structures, radiation shielding, service equipment for filling, emptying, and venting and pressure relief devices integral to the package. The packaging may be a box, drum, or similar receptacle or may also be a freight container consistent with the required performance standards for transport.

g. Transport index (TI) – The dimensionless number (rounded to the next tenth) placed on the label of the radiation level measured in millisieverts (mSv)/hour (hr) or in millirem (mrem)/hr at 1 m (3.3 ft).

7.1.4 The NRC provides regulations governing packaging, preparation, and shipment of licensed and special nuclear materials at 10 CFR Part 71.

a. Samples containing low levels of radioactivity are exempted as set forth in 10 CFR Part 71.14.

b. Low specific activity (LSA) material is defined and discussed in 10 CFR Parts 71.4 and 71.77.

c. Samples classified as LSA need to meet DOT, NRC and/or IATA requirements, as appropriate.

7.1.5 DOT provides regulations governing the transport of hazardous materials within the U.S. at 49 CFR Parts 171 through 189.

a. Requirements for marking and labeling packages and placarding transport vehicles for shipment are detailed in 49 CFR Part 172.

b. Accident Reporting is discussed in 49 CFR Part 171.

c. Packaging definitions and requirements are in 49 CFR Part 173.

d. Requirements for training shippers, what is to be included in the shipping papers, and what emergency information is necessary for the shipment are detailed in 49 CFR Part 172.

7.1.6 IATA provides Dangerous Goods Regulations (DGR) for the international transport of hazardous materials, as well as transport of these material to or from U.S. territories.

a. Requirements for marking and labeling packages are detailed in IATA DGR 7.1 and 7.2.

b. Requirements for preparing overpacks in accordance with the packing rules are in IATA DGR 5.0.

c. Packaging definitions and requirements are in IATA DGR 5.0.

d. Requirements for training shippers are detailed in IATA DGR 1.5.

7.2. Packaging and Transport of Radiological Samples

7.2.1 Alert and Hazard Labels

a. Color-coded alert labels can be used to assist in processing a sample by identifying a sample emitting elevated radiation levels and/or designating sample analysis priority in order to facilitate compliance with sample-segregation requirements specified in the Manual for the Certification of Laboratories Analyzing Drinking Water (U.S EPA, 2005). Similar to DOE's Federal Radiological Monitoring and Assessment Center's (FRMAC's) Monitoring Manual (U.S. Department of Energy, 2015), samples should be labeled as follows:

- Red denotes radiation levels are equal to or greater than 0.005 mSv/hr (0.5 mrem/hr) and the highest analysis priority
- Yellow denotes radiation 5x above background but below 0.005 mSv/hr (0.5 mrem/hr) secondary analysis priority
- Blue denotes the lowest analysis priority
- Labels are typically circular with a diameter of 2.54 cm (1 in.)

b. Hazard labels are required by DOT and IATA for shipment and transport purposes. They are specified as to appearance, wording, dimensions, and coloring to be recognizable to handlers during their transport from the site to the analytical laboratory. These labels include:

- Radioactive Material
- Surface Contaminated Object (SCO) – SCO-I and SCO-II
- LSA (Low Specific Activity) – LSA-I, LSA-II, and LSA-III
- Radioactive White I, Radioactive Yellow II, and Radioactive Yellow III
- Special Nuclear Material (SNM)[3]
- Corrosive
- Red or black arrows ("This Way Up") indicating either direction the package is to be maintained to prevent damage or spillage

c. All shipments of radioactive material, with the exception of those containing exempted materials as defined in 10 CFR part 71 (typical in the Final Status

[3] Special Nuclear Material (SNM) ia defined as Plutonium, Uranium, and Uranium-233 enriched in Uranium-235; material capable of undergoing a fission reaction (U.S. EPA, MARSSIM, December 1997)

Survey Phase of sampling), are to bear two identifying hazard labels affixed to opposite sides of the outer package.

d. A single hazard or alert label, or a combination of these labels, may be required to be placed on a sample container or package based on the hazards identified or considered to be contained in the sample container or package.

e. DOT regulations at 49 CFR Parts 171 – 173 (for shipping within the U.S) or IATA (for international shipments or shipments to or from U.S. Territories) should be consulted for specific packaging and labeling requirements. Several vendors and government agencies, including DOT and IATA, offer specific training on these regulations.

7.2.2 Strong tight containers (packaging) should be used to transport samples.

a. Packages are to meet DOT or IATA design requirements (e.g., Type IP-I, II, or III, Type A, or Type B).

b. Packages should survive incidents that can occur during transport, without a release of the contents.

c. Packages should be easy to handle and properly secured.

d. Each lifting attachment, if contained on the packaging, should have a minimum safety factor of triple (3x) strength and provide non-structural damage if failure occurs.

e. The external surface of the container should be smooth, free of unnecessary protrusions, dents, or gouges, and easy to clean.

f. All construction materials should be compatible and able to withstand radiation.

7.2.3 Absorbent Material

a. The transport container must contain triple (3x) the amount of absorbent material required to absorb the entire amount of liquid being shipped.

b. Absorbent material should not degrade when exposed to the liquid being absorbed or from conditions incident to transport.

7.2.4 Cushioning Material

a. The material must be able to absorb impact placed on samples during transport.

b. It must be sufficient to prevent damage from occurring to samples.

c. Absorbent material may also be used as a cushioning material.

7.2.5 Shielding

a. Shielding materials range from plywood to tin or lead sheets. Shielding also may be accomplished by placing low-level samples around high-level samples. However, combined shipment of samples containing disparate levels of contamination should be avoided, or extra precautions should be taken to prevent cross-contamination.

b. The amount of shielding used is dependent on radiation levels, packaging strength, and weight limits of the package.

7.3. Preparing Samples for Transport

7.3.1 Field and Sample Data Compilation

a. Original Field Logbooks and Field Sample Tracking Forms are to be maintained in a secure location.

b. Copies of the appropriate pages of the Field Logbooks and Field Sample Tracking Forms are to be sent to the laboratory with the samples. Appropriate pages include information regarding sample volume or weight, screening results, and potential hazards.

c. Ensure SIC labels are on each sample container.

7.3.2 Wipe each individual sample container with a damp cloth or paper towel to remove any exterior contamination.

a. If directed, or if contamination levels on the sample container cannot be removed to levels specified in the HASP/RSP or SCP, then: (1) place the sample container in a bag, and (2) place the bagged sample container in a second clean bag.

> NOTE: Double bagging is more efficient than wiping containers with absorbent material, and is a more effective method for preventing the spread of contamination and generation of additional waste.

b. If the sample container is not wiped or if contamination is not removed, it must be documented in the Field Logbook and on the COC.

7.3.3 Ensure contamination and radiation levels of the outer container are measured. Sample radiation and contamination readings are performed by radiation protection personnel. The following information is provided as guidance for steps to be performed prior to sample transport:

a. Perform a surface gamma exposure rate measurement and a surface alpha and beta contamination survey of sample containers. Record the results on the Field Sample Tracking Form.

- If surface contamination exceeds allowed limits, decontaminate the container and repeat the survey.
- If surface gamma exposure is greater than background levels, record the reading on the sample container and the Field Sample Tracking Form.
- Place Alert labels on containers that exceed 5x background radiation levels.

b. Based on gamma levels and types of samples, pre-stage samples for loading into the sample transport packaging. Samples with higher radiation levels are to be in the center of the packaging.

> NOTE: When determining loading of packaging (i.e., arrangement, weight, and stabilization), allow for the addition of packing materials.

c. The final package cannot exceed:

- 2 mSv/hr (200 mrem/hr) at any point on the outside of the package
- A TI of 10
- 0.4 becquerel (Bq)/cm^2 (22 disintegrations per minute [dpm]/cm^2) beta – gamma loose surface activity
- 0.04 Bq/cm^2 (2.2 dpm/cm^2) alpha loose surface activity

d. Once the samples have been screened and selected for transport, create a list of the samples and SICs that will be placed in the packaging container and record the order of their arrangement in the packaging.

7.4. Packing the Transport Packaging

7.4.1 Avoid cross contamination of samples and sample containers during packing.

7.4.2 Ensure the sample containers are controlled and sealed to prevent spillage.

a. Double bagging of sample containers is recommended prior to packing the samples. Heavy plastic bags, with or without zip-locking seals, can be used.

b. Bags should be large enough to allow the upper ends to be twisted to seal the top closed. Tape is applied to the area of the twist, and the top is folded over and sealed with tape. One continuous piece of tape can be used, tabbing the end to allow for removal.

c. Caps on containers holding liquid samples (i.e., rinsates) should be secured with tape that is sufficiently strong to secure the container (e.g., duct tape, electrical tape), placed into plastic bags containing liquid absorbing material (i.e., must be able to absorb 3x the volume of the sample), and the bags sealed.

7.4.3 Pack the samples in the sample transport packaging.

> NOTE: DOT has design specifications for each type of packaging; however, the construction of the packaging, as certified by the manufacturer, limits the total weight and the capability to retain shielding. The shipping transporter will also have limitations as to the maximum weight of any one package that they will transport. These considerations will be determined prior to sample shipment, but the sampling team needs to be aware of any restrictions that apply.

a. Use the packing list and pre-determined packing order (see Module I, Step 7.3.3.d) as guidance in loading the packaging, noting that changes may be required based upon actual radiation levels and weight considerations.

b. If necessary, add shielding to the outer sides of the inside of the packaging.

c. Place shock absorbing material (e.g., bubble wrap, packing peanuts, or vermiculite) or liquid absorbing material (e.g., vermiculite) around the samples, as appropriate, including the bottom of the transport packaging and the area above the samples. Samples should be in contact with the shock or absorbent materials, and should not be in contact with each other.

d. Ensure that heavier materials are placed on or near the bottom of the packaging.

e. DO NOT jam or overload packaging.

f. DO NOT pack the packaging to an overweight condition.

7.4.4 Assign the package an identification number. Record the package number, samples contained within, and conditions of the contents in the Field Logbook. Record the sample package number on the package.

7.4.5 Obtain results of a surface contamination and radiation survey of the exterior of the filled transport package from the site radiation protection personnel.

a. If surface contamination exceeds allowed limits, decontaminate the package and repeat the survey. Record the results of the survey in the Field Logbook.

b. Record the highest and lowest gamma readings on contact, the highest reading at 1 m (~3 ft.), and the location where the reading was noted on the Field Sample Tracking Form.

7.4.6 Complete the COC form with all necessary information, per Section 4.6, and place a copy of the COC in a zip-locked bag taped to the top of the inside lid of the packaging.

a. If more than one package is used, place separate sample documentation in each package.

b. If using a cooler, instructions for returning the cooler should be documented inside the cooler lid. Write a return name and address for the sample cooler on the inside of the cooler lid in permanent ink to ensure return of the cooler.

7.4.7 Close and seal the transport package.

a. Apply a security seal in such a manner that it will be torn (broken) if the package is opened. The tape should include the signature of the sender, and the date and time the seal was applied, so that it cannot be removed and replaced.

b. Place a completed custody seal on the package. If using a cooler, place completed custody seals across the top and sides of the cooler lid so that the lid cannot be opened without breaking the seal. Place clear tape over the seal to prevent inadvertent damage to the seal during shipment. Insure that the tape cannot be lifted off and reaffixed without breaking the seal.

c. The container is to be secured with a locking mechanism or a method of securing closure.

- If a White I, Yellow II, or Yellow III label is required, the package is to have a locking mechanism and a security seal.
- Industrial Type I packaging, such as a cooler, may be secured with clear packing tape or duct tape. If using a cooler, tape the cooler shut using strapping tape over the hinges.

d. Write the following information on the outside of the package.

- Weight of the package
- Sender’s name and address

e. Attach “This Way Up” labels and any other required labels, 180° apart from each other (opposite sides) on the package.

7.5. Transfer of Custody to an Authorized Carrier

7.5.1 Samples, by federal law, may be transported only by authorized carriers.

a. Authorized carriers must be identified prior to sample shipment. Authorized carriers of hazardous materials must be certified and, as of September 2005, DOT-certified carriers must also be certified by the U.S. Department of Homeland Security according to DOT's Hazardous Materials Regulation Unit.

b. Transport by an individual or sample collector is not authorized by federal regulations.

c. The U.S. Postal Service will not ship radiological samples.

d. Government-specified carriers may be used. FedEx® and United Parcel Service are typical authorized carriers. There are other carriers that specifically transport high-level radioactive materials.

e. Shipment of high-level radioactivity samples should be coordinated in advance to avoid delays that could impact response.

7.5.2 Transfer custody of the samples to the carrier, obtaining a signature from the authorized agent on the COC form.

a. It is the responsibility of the carrier and the shipper to ensure packages are properly loaded for transport prior to departure from the site.

b. Packages loaded into a vehicle are to be secured from movement during transport.

c. Packages of varying contamination levels are segregated. Packages containing samples that are above background (greater than or equal to 5x background) are stored in a shielded area of transport vehicles as far away from transport personnel and meters (e.g., dosimeters) as possible.

d. A pre-determined loading plan may be required prior to loading samples into transport vehicles.

e. The vehicle is surveyed prior to transport to ensure that the limits for radiation levels outside the vehicle are met.

- Not to exceed 2 mSv/hr (200 mrem/hr) on the external surface of the vehicle
- Not to exceed 0.1 mSv/hr (10 mrem/hr) at any point 2 m (~7 ft) from the outer lateral surfaces of the transport vehicle
- Not to exceed 0.02 mSv/hr (2 mrem/hr) in any normally occupied space on the transport vehicle

f. The vehicle should remain locked at all times during transport.

7.5.3 The original COC form (after custody transfer signature), copies of corresponding Field Logbook entries and Field Sample Tracking Form(s), and a copy of the shipment paperwork should be sealed in a plastic bag and sent overnight to the analytical laboratory.

MODULE II – SAMPLING PROCEDURES – SITE CHARACTERIZATION AND REMEDIATION PHASES

1.0 Collection of Samples

1.1. Overview

1.1.1 This module outlines procedures, equipment, and other considerations specific to the collection of representative outdoor building and infrastructure material samples for the measurement of radiological contaminants during the Site Characterization and Remediation Phases of a contamination incident.

1.1.2 The intent of any sampling event is to maintain sample integrity by preserving physical form and chemical composition as much as possible. Sample collectors should rely on training, experience, and supervisory guidance to ensure the sampling event provides the best samples possible to determine the extent and nature of the hazards encountered.

1.1.3 Materials exposed to a release of radioactive contamination can contain four types of contamination: (1) loose surface contamination from the deposition (fallout) of airborne material, (2) fixed surface contamination from deposited material that has been absorbed or physically impregnated into a surface, (3) contamination that is being transported by a liquid or solvent, and (4) activated material. The latter is a result of the release of neutron radiation, which transforms the material from non-radioactive radionuclides into radioactive radionuclides. Generally, activated materials will be found only at ground zero of a nuclear detonation.

1.1.4 The following issues should be considered by the sample collection team and the Field Team Leader during implementation of the procedures described in this document and the requirements of the site-specific Sample Collection Plan (SCP).

> NOTE: Radiation surveys of surfaces are performed by the radiation protection personnel. The sampling team is required to review survey results prior to taking a sample.

a. The amount of sample collected should exceed or equal the required volume or mass. In general, large volumes or numerous samples are more representative than small volumes.

NOTE: Large samples can contain higher radiation levels, however, and may cause problems with shipping, storage, and disposal; these samples may require shielding or more numerous smaller sample shipments. Large amounts of sample also can cause problems in the laboratory due to increased radiation, the potential for contamination, and impacts on laboratory instrumentation (e.g., dead time in gamma spectrometers).

b. During the Remediation Phase, the sample volume may increase, decrease, or both. Variations depend on the results found during Site Characterization Phase sampling, specifically the radionuclides and activities/concentrations found.

1.1.5 During the Characterization Phase, measurement quality objectives (MQOs) corresponding to the specific event are based on unknown contaminants or on-site assessment and screening. MQOs set during the Remediation Phase will be based on the knowledge obtained from samples taken during the Characterization Phase.

1.1.6 The sample sizes listed in Tables 1 and 2 (for building materials and asphalt shingles, respectively) have been determined to be necessary for analysis using the analytical methods listed in SAM, and are to be collected unless otherwise specified by the SCP.[4]

NOTE: The sample sizes are provided as guidance with respect to laboratory requirements for current analytical methods. Sample sizes will be site- or event-specific, and sample collectors should consult the SCP regarding requirements for the number and volume/mass to collect. The sample sizes listed below should be considered to be the minimum; additional sample may be necessary to satisfy laboratory requirements. Sample sizes also may vary depending on the effectiveness of the equipment and collection procedure used.

Table 1. Sample Sizes Based on Rapid Methods for Building Materials (all except asphalt shingles)

Target	Sample Size	Rapid Building Material Method - Stated Method MQOs
Americium-241	1 gram	Method is capable of achieving a required method uncertainty of 0.20 pCi/g (0.074 Bq/g) at an analytical action level (AAL) of 1.5 pCi/g (0.56 Bq/g).
Plutonium-238, 239/240	1 gram	Method is capable of achieving a required method uncertainty of 0.25 pCi/g (0.0093 Bq/g) at an AAL of 1.89 pCi/g (0.070 Bq/g).

[4] Measurement quality objectives (MQOs) are based on sample amounts needed to meet the analytical and QC requirements of the methods listed in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery* (SAM) (http://www.epa.gov/homeland-security-research/sam).

Uranium	1 gram	Method is capable of achieving a method uncertainty of 1.9 pCi/g (0.070 Bq/g) at an AAL of 14.7 pCi/g (0.54 Bq/g).
Radium-226	1 gram	Method is suited for low-level measurements using alpha spectrometry and is capable of satisfying a method uncertainty of 0.83 pCi/g (0.031 Bq/g) at an AAL of 6.41 pCi/g (0.24 Bq/g).
Strontium-90	1.5 gram	Method is capable of satisfying a method uncertainty of 0.31 pCi/g (0.011 Bq/g) at an AAL of 2.4 pCi/g (0.089 Bq/g).

Table 2. Sample Sizes Based on Rapid Methods for Asphalt Shingles

Target	Sample Size	Rapid Building Material Method - Stated Method MQOs
Americium-241	25 g*	Method is capable of meeting a required uncertainty of 0.194 pCi/g (0.0072 Bq/g) at and below the AAL of 1.495 pCi/g (0.055 Bq/g) for a 500-minute counting time and a 1-g ash sample of the ~25-g sample.
Plutonium-238, 239/240	25 g*	Method is capable of meeting a required uncertainty of 0.23 pCi/g (0.0085 Bq/g) at and below the AAL of 1.803 pCi/g (0.067 Bq/g) for a 500-minute counting time and a 1-g ash sample of the ~25-g sample.
Uranium	25 g*	Method is capable of meeting a required uncertainty of ~1.6 pCi/g (0.059 Bq/g) at and below the AAL of 12.0 pCi/g (0.44 Bq/g) for a 500-minute counting time and a 1-g ash sample of the ~25-g sample.
Radium-226	25 g*	Method is capable of meeting a required uncertainty of 0.34 pCi/g (0.013 Bq/g) at and below the AAL of 2.613 pCi/g (0.097 Bq/g) for a 1000-minute counting time and a 1 − 1.5-g ash sample of the ~25-g sample.
Strontium-90	25 g*	Method is capable of meeting a required uncertainty of0.61 pCi/g (0.023 Bq/g) at and below the AAL of 4.702 pCi/g (0.17 Bq/g) for a 100-minute counting time and a 1 − 1.5-g ash sample of the ~25-g sample.

AAL – Analytical action level
* Asphalt shingle procedures start with ashing 25 grams of material, to obtain a 1−1.5-gram ash sample aliquant.

1.2. Precautions and Limitations

1.2.1 General Precautions and Limitations

a. ALL Personal Protective Equipment (PPE) is to be donned, worn, and properly disposed of during the sampling event.

- Improper use of the PPE can result in contamination of or injury to the individual.
- Improper use of the PPE may result in the spread of contamination beyond the incident sampling site.

b. If possible, collect samples from a relatively open area. Unless otherwise instructed in the SCP, samples should not be taken from areas located under trees or large growths of vegetation. These features can prevent surface deposition and can act as absorbers of deposited material.

c. Avoid contacting equipment and materials with any contaminated or potentially contaminated surface. Use a plastic bag to cover the surface and place materials onto the plastic bag or sheeting. This practice reduces carryover, contamination, and exposure.

d. Note locations and landmarks in the Field Logbook. Any information that can be used to clearly ascertain the position of a sample location is important. Clearly mark the sampled surfaces with fluorescent paint, a pin flag or a wooden or metal stake. The mark should include the sample location identification number. Document the site with photographs, if appropriate. For horizontal surfaces, GPS coordinates can be used to specify an exact sampling point.

e. Always refer to the instructions provided in the SCP or by the Field Team Leader prior to taking any samples. In addition, the operator's manual for each sampling device should be reviewed for specific operating instructions and safety recommendations.

f. Building materials can contain asbestos, and paint on painted surfaces can contain lead. Asbestos, asbestos products and lead present health risks to those with whom they come into contact. In addition to other precautions, when working with materials containing asbestos or lead, minimize air-borne particulates or use a vacuum system to collect any particulates that are generated during sample collection.

g. Contamination of samples is a particular concern due to the procedures used for collection of building and infrastructure materials. The use of drills, hammers, grinders, etc. tends to generate significant dust which can cause cross contamination. It is highly recommended that a vacuum system and/or shield be used during sample collection to minimize contamination.

h. The collection of building and infrastructure materials often involves the use of heavy machinery such as scabblers, grinders, saws, hammers and drills. The following are safety and health concerns that should be considered when operating heavy machinery:

- Tripping hazards – Electric cords, air lines, and vacuum hoses needed to operate the equipment are tripping hazards. The need for stringent housekeeping should be evaluated.

- Electrical hazards – Generators and electric cords necessary to operate the equipment can present electrical hazards. The need for ground fault circuit interrupters, grounding, and strain relief should be evaluated. Sampling locations should be checked for live electrical wiring near the cutting area or in the material to be sampled.

- Dust – Most of the sampling equipment will generate dust or air-borne particulates which can contaminate other samples or pose a health risk to sample collectors. It is recommended that a vacuum system and/or shield be used to collect dust that is generated during sample collection. At a minimum, sample collectors should use respiration PPE such as a respirator or dust mask that can filter out microscopic particles.

- Noise – Some of the sampling machinery will generate noise at damaging decibel levels. The use of hearing protection such as ear plugs or ear muffs is strongly recommended. Due to the noise generated during operation, communication can be difficult. Personnel working in the area should be knowledgeable and proficient in the use of hand signals.

- Fumes – Exposure to diesel fumes should be taken into consideration when a diesel engine is used to operate ancillary equipment such as an air compressor.

- Vibrations –Sampling equipment such as scabblers and hammers can generate vibrations sufficient to cause bodily harm. It is strongly recommended that anti-vibration PPE such as gloves, shoe insoles and matting be used when possible. Also, machine handles should not be placed against other parts of the body during operation.

i. If possible, damaged or otherwise unusable equipment, equipment accessories and packaging material should be recycled.

j. Environmentally hazardous drill dusts (depending on the material to be drilled) must be completely extracted and disposed of in compliance with local regulations. Contaminated cooling water (depending on the material to be drilled) must be collected and disposed of in compliance with federal, state and local regulations.

1.2.2 Collection of Concrete (ASTM, 2007; ASTM 2013a), Brick (ASTM, 2012 and 2013C), Limestone (ASTM, 2013b; U.S. GSA, 2012) Granite (Anderson, 2012), Stucco (ASTM, 2012) and Asphalt (Swiertz, 2010; ASTM, 2014; wikiHow) Samples

a. Building and infrastructure material samples require minimal preparation in the field and are not preserved.

b. Samples can be collected by drilling, chiseling, sawing, shaving, scabbling, needle scaling or hammering. The collection procedure will depend on the sample location (pavement vs. wall). Factors such as noise, vibrations, and dust and debris generation should be considered when deciding on a sampling technique.

c. Samples can be comprised of bulk pieces, cores, cuttings, chips and/or particulates. The equipment used to collect discrete samples will depend upon the type of material encountered. Therefore, various sampling tools should be available. Refer to Module I, Section 2.0 (Equipment and Materials) and Appendix A1 (Sampling Equipment) for information regarding sampling equipment.

d. If directed in the SCP, paint may need to be physically removed from the matrix surface prior to sample collection. Containers for paint samples are generally the same as those recommended for soil samples (e.g., 250 milliliter [mL] Nalgene plastic bottles).

1.2.3 Collection of Paint from Painted Surfaces (EC-CND, 2009; NYSDOH, 2013)

a. Check the SCP to determine whether paint needs to be removed from surfaces and collected for determination of lead content. If paint needs to be tested for the presence of lead, use one of the following techniques for paint removal:

- Wire brushing or wet hand scraping with the aid of a non-flammable solvent or abrasive compound. It is important for workers to use personal protective equipment, such as gloves, safety glasses and disposable coveralls when using some paint removers.

- Wet hand sanding and/or power sanding with high-efficiency particulate air (HEPA) filters. Only wet hand sanding and/or an electric sander equipped with a HEPA filtered vacuum attachment should be used. Dry hand sanding should never be done.

- Heat stripping, using a low temperature (below 593.3 ^{o}C [1100 ^{o}F]) heat gun, followed by hand scraping.

b. Transfer the sample to an appropriate sample container (see Appendix A3). Refer to ASTM International (ASTM) D3618 (ASTM, 2010) for the analytical method to detect lead in paint.

2.0 Equipment and Materials

NOTE: The equipment and materials used for sample collection will depend on the type and construction of the building or infrastructure material to be sampled. Refer to Module I, Section 2.0 and Appendices A1 through A6, and Appendix D for information supporting equipment selection.

All sampling equipment and PPE are to be pre-staged and available prior to entering a sampling area. The sampling team is to set up a step-off pad at the entrance to the survey point, and to don appropriate PPE prior to entering the area. Personnel outside of the area may hand materials to, and retrieve materials from, personnel in the area using appropriate contamination control techniques. All steps that will reduce the time in the area, such as pre-writing of labels or sample containers, are to be used to minimize exposure.

If collecting samples from multiple locations, avoid cross-contamination by decontaminating all sampling tools and equipment before sampling at each location. If the sampler's gloves come in contact with the sampled material during sampling, gloves should also be changed prior to collecting samples at each location.

NOTE: Collection of outdoor building and infrastructure materials requires the use of manual and/or power tools for physical removal of samples. In many cases, powerful tools and equipment similar to those used for decontamination are used for sample collection, and specific skills, training and precautions may be required. In all cases, user manuals should be consulted prior to use of equipment in the field.

3.0 Collection of Surface Area Samples Using Swipes

Swipe samples are used to evaluate the extent of contamination of surfaces prior to sample collection, and in support of Characterization and Final Status Survey Phases. These samples can be taken from surfaces that are adjacent to sample locations or as part of surface contamination removal prior to sample collection. Appropriate swipe materials and sizes to be used for the collection of surface area samples, along with the number of swipes that should be taken, are selected based on requirements included in the SCP.

Prior to collection of swipe samples, radiation safety personnel within the RPG should take radiation measurements of all sample locations (see Module 1, Section 1.6.2) according to the site-specific SCP. To determine the amount of radiation that is from fixed contamination vs. loose contamination, any debris (loose material that is separate from the material to be sampled) is removed from the location of sample collection, isolated to prevent cross contamination and saved for possible analysis.

3.1. Dry Swipes

3.1.1 Measure or determine by observation the total surface area to be sampled and record the area on the Field Logbook.

3.1.2 Using a large area swipe, e.g., at most 300 centimeters $(cm)^2$ (47 inches $[in.]^2$), wipe the surface area in parallel strokes. Place the swipe into a glassine envelope or bag, and place a sample label on the envelope or bag.

3.1.3 Using a smaller area swipe (e.g., 100 cm^2 [16 $in.^2$]) disc or square, wipe the surface in one continuous stroke of approximately 40 cm (16 in.) in length , or a 10 x 10 cm (4 x 4 in.) square area, so that an area of approximately 100 cm^2 is sampled. An “S” pattern, or moving from one edge to the other without overlap, is the preferred method. Place the swipe into a glassine envelope or bag, and place a sample label on the envelope or bag.

3.1.4 Proceed with Module II, Section 3.4 (Swipe Handling).

3.2. Wet Swipes (for tritium sampling)

3.2.1. Measure or determine by observation the total surface area to be sampled, and record the area on the Field Logbook.

3.2.2. Dampen either a large- or small-area swipe with the solvent prescribed by the SCP. DO NOT soak the swipe. If necessary, allow the swipe to dry slightly before use.

3.2.3. If a volatile solvent is used, proceed with speed to prevent evaporation of the solvent.

3.2.4 Wipe the area per the procedures described in Module II, Section 3.1 (Dry Swipes) for either large area or small area swipes.

3.2.5 Proceed with Module II, Section 3.4 (Swipe Handling).

3.3. Tape Swipes

In some cases, tape swipes may be collected for field screening to identify the presence of hot particles, and are not intended for transport to and analysis in the laboratory. When analyzed for radioactivity, the glue side of the tape must face the detector, because the paper backing of the tape will attenuate any alpha particles. Measure or determine by observation the total surface area to be sampled, and record the area on the Field Logbook.

3.3.1. Create a tape swipe by laying successive strips of 5 cm (2 in.) duct tape sufficient to collect an area of 100 cm^2 (16 $in.^2$) or less. The edges of the tape should be folded over or covered with tape to prevent them from sticking to the surface of the object. This procedure will create a “picture frame” around the actual sample.

3.3.2. Lay the tape swipe on the surface to be sampled and press down over the sample area.

3.3.3 Carefully remove the tape and cover the exposed area with a piece of plain paper.

3.3.4 Place the swipe in a plastic bag or envelope. A sample label is to be placed on the bag or envelope.

3.3.5 Proceed with Module II, Section 3.4 (Swipe Handling).

3.4. Swipe Handling

3.4.1 Exit the sampling area using proper techniques to minimize the spread of contamination.

3.4.2 Record the required information on the Field Logbook, Field Sample Tracking Form, and the sample label(s). Include the following information at a minimum:

- SIC
- Time and date sample collected
- Sample location
- Sample area collected
- Percent of total area (calculated from surface area recorded in the Field Logbook)
- Sample collector's initials

3.4.3 Place a sample label on the container.

3.4.4 Once outside of the area and back at an appropriate location, process the sample for direct reading by radiation protection personnel or, if required in the SCP, for transport to a radiochemistry laboratory per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

4.0 Building Material Sample Collection Technologies/Methodologies

4.1. General Considerations

4.1.1 Sample collectors are to refer to the site-specific SCP to determine the type, amount and location (including depth) of samples to be collected. If not already specified, use this information to select the sample collection equipment that will be used.

4.1.2 The removal technique will depend on the sample location, material type and equipment available. The most common surface removal techniques for building materials with hard surfaces include chip sampling using manual chisels, hole drills, or saws and scarifying techniques using heavier machinery. Scarifiers physically abrade both coated and uncoated concrete surfaces, removing the top layers down to the depth of sound and uncontaminated surfaces. The sampling equipment used in scarifying tends to be hydraulic, pneumatic, electric, or diesel powered heavy machinery; however, hand-held versions are also available. Scarifying techniques include needle scaling, scabbling, shaving, hydraulic/pneumatic hammering. Each technique has its advantages and disadvantages (see Appendix A2).

4.1.3 All techniques should be accompanied by a dust collection procedure, to minimize cross-contamination.

4.1.4 In some cases, sample material may need to be collected from structures that are considered to be of significant value or importance (e.g., historical structures or monuments). In these cases, sample collectors should make attempts to cause minimal damage while still meeting requirements included in the site-specific SCP.

4.2. Chip Sampling (Jannik, 2007; Los Alamos, 2008)

4.2.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.2.2 Using a chisel, drill, hole saw, or similar tool, collect sample to a depth of ~3/8 in. (0.4 cm), or to an alternate depth specified in the SCP. As long as the minimum required amount of sample is collected, the chips may be of any convenient size, unless otherwise specified in the SCP.

> NOTE: If collecting multiple samples using this method, avoid cross-contamination by decontaminating all sampling tools prior to collecting the next sample.

4.2.3 Transfer the collected sample to an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.3. Drilling (by hand, hammer drill or rotary hammer drill) (Archibald, 1995; CP Pneumatic, 2012; CS Unitek, Inc, 2008; Los Alamos, 2008)

4.3.1 A simple, cost effective method for sampling building material surfaces such as concrete, brick, limestone, granite, or stucco, involves use of a hand drill or rotary hammer drill and a 13-millimeter (mm) (0.5-in.) diameter (or larger) drill bit. Samples are generated as drill powder that is collected at various depths.

4.3.2 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.3.3 Drill shallow holes of approximately 6 mm (0.25 in.) in depth. The number of holes drilled depends on the amount of sample required. If contamination is suspected at deeper depths, drill deeper holes. Drill cuttings and particulates should be collected separately at each depth. Clean the drill bit after collection of sample from each depth to prevent cross contamination.

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> NOTE: Drill cuttings are deposited on the surface by the drilling equipment. Many drills use compressed air to blow the drill cuttings out of the drill hole. These cuttings collect on the surface in a circular mound surrounding the hole. Recirculated drill cuttings are produced from another type of drilling equipment using compressed air to blow the drill cuttings through the hollow center of equipment drill steel into a collection chamber. Empty this chamber at intervals specified in the SCP.

4.3.4 Place the samples from each depth into separate appropriate sample containers (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.4. Core Drilling (Byrne, 2008; Chicago Pneumatic, 2012; CSIR, 2002; CS Unitec, 2008; EC-CND, 2009)

4.4.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.4.2 Place the core drill and drill bit in position. A 16 mm (5/8 in.) diamond drill bit is recommended; however, the drill bit size will depend on the sampling requirements and or thickness of the material.

4.4.3 Let down the bit until it rests on the surface and then adjust it so that it is exactly perpendicular to the surface.

4.4.4 Connect a water supply to the drill, turn on the water supply and start drilling. Apply a steady pressure to the core barrel. The rate at which the drill penetrates the material will depend on the hardness of the material and on the condition of the bit. The rate should be controlled so that the drill does not lose speed but also does not turn too fast. If the drill bit jams, release the throttle handle and any axial pressure on the core drill, gradually turn the throttle handle and re-apply axial pressure when the drill bit is rotating again. Check regularly that the drill is well lubricated and there is sufficient water flushing. The water supply must be under sufficient pressure to wash out the borings and cool the bit. Remove the core barrel from the hole every few minutes to ensure that drill cuttings do not interfere with collection of the core sample. If instructed in the SCP, these drill cuttings can be collected as part of the sample, in addition to the core.

4.4.5 As soon as the core depth has been reached, withdraw the drill slowly while it is still turning. If the core comes away with the barrel, remove it carefully by tapping the sides of the barrel with a hammer until it drops out. If the core remains in the hole, carefully loosen it by inserting a suitable lever into the drill groove and wiggling the core free.

4.4.6 Tightly wrap the core in aluminum foil, then place it into a large plastic zip-locking bag. If the core has sharp edges, trim the edges using a concrete saw. After sealing the bag, attach a sample label and custody seal and immediately place into an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.5. Needle Scaling (Archibald, 1995; Trelawny SPT Limited, 2009)

4.5.1 Maintain contact with the work surface with sufficient pressure to keep the tool from bouncing. Excessive pressure can prevent the tool from working to its full capacity. Do not allow the tool to run continuously when it is not in contact with the material surface.

4.5.2 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.5.3 Place a flat surface shroud on the needle gun. To operate the tool, pull the throttle lever towards the handle and then apply the needles to the material surface. Do not place the needles on the surface before pulling the throttle, as it will result in the tool bouncing off the surface.

4.5.4 Scale the surface until the needle scaler has passed over the entire area that comprises a sample. Check the SCP to determine the depth that needs to be sampled. The needle scaler will remove approximately 2 mm (1/16 in.) per pass. Perform additional passes if sample is required from deeper depths.

4.5.5 Once the surface comprising a sample has been scabbled, turn off the scabbler by releasing the throttle lever.

4.5.6 Tranfer the collected particulates into an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.6. Sawing (Power or Chainsaw) (Chicago Pneumatic, 2013a; CS Unitec, 2003)

4.6.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.6.2 Outline the cutting area with a permanent marker for a visual guide. Cut the bottom of the opening first, then the top, and then the sides. Save the easiest cut for last. Take actions to secure the cut portion in place, to ensure it cannot fall and injure the sample collector or bystanders.

4.6.3 Always operate a diamond chainsaw at full throttle. Apply enough feed force so that the free running RPM drops 20 to 30%. If too much force is applied, the saw will lug or stall and the chain will not have enough speed to cut effectively. If too little force is applied, the diamonds will skid and glaze over.

4.6.4 For straight cuts use the “step cut” method. First, score the entire cut line with the nose of the bar approximately 12 mm (0.5 in.) to 25 mm (1 in.) deep. Next, deepen the cut by about 55 mm (2 in.); this groove will help guide the bar. Then plunge all the way through and complete the cut.

4.6.5 A lever system (e.g., Wallwalker® lever system [Acme Tools, Grand Forks, N.D.], or equivalent) can be used to cut efficiently and reduce user fatigue. The system converts inward force to downward force and gives a 4-to-1 mechanical advantage. To use correctly, plunge the saw into the wall, engage the point of the lever system into the cut and push straight in. The lever system will force the saw to feed down. Apply an upward force on the trigger handle to keep the lever system engaged properly, otherwise the pick will skid, which will reduce the effectiveness. When the lever system bottoms out, pull the saw out of the cut a few inches and allow the system to spring back into its starting position.

4.6.6 Once the sample has been cut, use forceps (if necessary) to remove if from the material. Then transfer the sample to an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.7. Sawing (Circular) (Chicago Pneumatic, 2013a)

4.7.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.7.2 Outline the cutting area with a permanent marker for a visual guide. Cut the bottom of the opening first, then the top, and then the sides. Save the easiest cut for last. Take actions to secure the cut portion in place, to ensure it cannot fall and injure the sample collector or bystanders.

4.7.3 Before starting the circular saw, stand in such a way that the body is clear of the cutting attachment and hold the concrete saw firmly with both hands. Avoid standing in direct line with the blade.

4.7.4 Check that the blade is not in contact with anything when the saw is started. Then, without forcing the blade, ease it into the material being cut. Start cutting with the saw running at maximum speed, and move the blade slowly back and forth, using a small part of the blade's cutting edge. If the saw has a blade guard, adjust it so that the rear section is flush with the work piece. Sparks, dust and cut material are collected by the guard and led away from the operator.

4.7.5 To avoid pinching, support the work piece so that the cut remains open during operation.

4.7.6 Once the sample has been cut and removed (using forceps, if necessary), transfer it to an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.8. Sawing (Cut off) (Chicago Pneumatic, 2013b)

4.8.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.8.2 Outline the cutting area with a permanent marker for a visual guide. Cut the bottom of the opening first, then the top, and then the sides. Save the easiest cut for last. Take actions to secure the cut portion in place, to ensure it cannot fall and injure the sample collector or bystanders.

4.8.3 Activate the water supply or the dust collector, if they are being used. Place the cut-off saw at a right angle to the surface to be cut and activate the trigger.

> NOTE: Always hold the machine in a firm grip with both hands with the thumbs and fingers around the handles. Stand in a stable position with your feet well away from the cutting blade. Check that the cutting blade is not in contact with anything when the machine is started. Never cut at a speed that is higher than the maximum speed that is marked on the blade.

4.8.4 Start cutting smoothly, allowing the machine to work without forcing or pressing in the blade.

4.8.5 Move the blade slowly back and forth to achieve a small contact area between the blade and the material to be cut.

4.8.6 Feed the machine down in line with the blade. The cutting blade guard must be adjusted so that the rear section is in line with the work piece. Splinters and sparks from the material being cut are then collected by the guard and led away from the operator. If the cutting blade gets jammed in a cut, shut off the grinder and ease the wheel free.

4.8.7 Once the sample has been removed (using forceps if necessary), transfer it to an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.9. Sawing (Diamond wire) (Hilti, 2012; Husqvarna, 2006; Tractive AB 2012)

4.9.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.9.2 Outline the cutting area with a permanent marker for a visual guide. The bottom of the opening should be cut first, then the top, and then the sides, saving the easiest cut for last. Take actions to secure the cut portion in place, to ensure it cannot fall and injure the sample collector or bystanders.

4.9.3 To use the saw, turn on the water supply, then turn on the electric motor. Use the instrument controls (see manufacturer's instructions) to ensure there is slight tension in the diamond wire. Use the potentiometer to start the drive wheel motor slowly and, at the same time, adjust the advance speed control knob to maintain or increase tension. As soon as the saw is running correctly, the speed of the drive wheel can be increased to maximum by adjusting the potentiometer. A visible indication of correct tension is provided by the wire tensioning arm. Make sure the saw is operating at the manufacturer's recommended pressure to achieve optimum performance without excessive strain on the diamond wire. WARNING: The wire needs to be cooled with water at all times to prevent damage; readjust the water supply, if necessary, making sure the instrument is off while doing so. Also, readjust the pressure if necessary.

4.9.4 Once the sample has been cut and removed (using forceps, if necessary), transfer to an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.10. Scabbling (Archibald, 1995; Pentek, 1997; EC-CND, 2009)

4.10.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.10.2 Place the scabbler onto the surface of the material to be sampled.

4.10.3 Turn on the scabbler and remove surface layers by slowly moving the scabbler in a circular motion across the entire surface to sampled. Continue until about 3 mm (1/8 in.) has been removed. If the SCP calls for deeper sampling, continue this procedure until the appropriate depth has been scabbled.

4.10.4 Collect the particles generated, and transfer the sample into an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.11. Shaving and Grinding (CS Unitec, 2006; Dickerson, 1995; EC-CND, 2009; U.S. Department of Energy, 1998)

4.11.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.11.2 Connect the power cords to a power source, and perform a system check to verify that all of the components are operating.

4.11.3 Switch the machine on and place it carefully on the surface to be sampled. Hold the tool with both hands and work with circular (grinders) or linear (shavers) movements. For best working results, do not apply too much pressure. All other areas should be accessed with the dust guard in place.

4.11.4 Continue this procedure until the appropriate depth has been shaved.

4.11.5 Collect the particles generated, and transfer the sample into an appropriate sample container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

4.12. Hydraulic/Pneumatic Hammering

> NOTE: Avoid operating on extremely hard materials (e.g., granite and reinforcing iron [re-bar]) which would cause substantial vibrations.

Check regularly that the machine is well lubricated. When the machine is lifted, the start and stop device must not be activated. Any form of idling, operating without insertion tool or operating with an uplifted machine must be avoided. Hold the inserted tool firmly against the work surface before starting the machine. Let the machine do the work; do not press too hard.

4.12.1 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

4.12.2 Press the machine against the working surface before turning it on.

4.12.3 Start the machine by squeezing the trigger while firmly holding the handle.

4.12.4 Start hammering at such a distance from the edge that the machine is capable of breaking the material without levering. Never try to break off large pieces. Adjust the breaking distance so that the inserted tool does not get stuck.

4.12.5 Once the sample has been removed from the surface, stop the machine by releasing the trigger.

4.12.6 Collect the sample pieces (rubble) generated, and transfer the sample to an appropriate container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

5.0 Collection of Concrete Samples

Experiences at nuclear plant decommissioning sites indicate that contamination is typically confined to within 3 mm (~1/8 in.) of concrete surfaces (Sato, 2014). An exception is where cracks or joints are present. Other studies detected certain radionuclides (cesium [Cs]-137 and strontium [Sr]-90) in the entire 50 mm (2 in.) concrete core sampled, although over 90% of the radionuclides were present within the first 5 mm (0.2 in.) (Farfán, 2011). Therefore it is recommended that a minimum sample depth of 50 mm (2 in.) be collected in cases where Cs or Sr are known or expected to be present. If possible, take the initial 5 mm (0.2 in.) as one sample, and the remaining 45 mm (1.8 in.) as a second sample to more adequately characterize the Cs and Sr distributions.

5.1. Concrete Walls

Check the SCP for the sampling technique required to sample concrete walls and refer to the appropriate sampling procedure in Module II, Sections 4.2 – 4.12.

5.2. Horizontal Concrete Surfaces (e.g., walkways, parking lots, driveways, roads)

Check the SCP for the appropriate sampling technique required to sample horizontal concrete surfaces (e.g., walkways, parking lots, driveways, roads) and refer to the required sampling procedure in Sections 4.2 – 4.12.

NOTE: The equipment used should be appropriate for sampling perpendicular to the

5.3. Concrete Sample Handling

Concrete samples will be in the form of particles, cores, rubble or bulk pieces. Refer to Appendix A3 for the appropriate sample container and Module II, Section 12.0 for sample handling procedures.

6.0 Collection of Brick Samples

6.1. General Considerations

Bricks will be sampled as whole brick or broken pieces, depending on the condition of the sample location. The type of sample preparation performed by the laboratory will be determined upon the laboratory's assessment of the type of brick (e.g., clay fired versus concrete). However, most types of brick should be amenable to use of the preparation procedures described in the SAM methods (U.S. EPA, 2012a). The techniques will generally exclude faux brick material which may be classified as shingles, depending on the exact composition. Mortar between bricks will be sampled as it adheres to the sampled bricks or as designated by the site-specific sample collection plan.

6.2. Brick Walls

6.2.1 Check the SCP for the appropriate sampling technique required to sample brick walls and refer to the required sampling procedure in Module II, Sections 4.2 – 4.12.

6.2.2 Remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

6.2.3 Samples from brick walls with a nominal thickness of 100 mm (4 in.) are normally removed with a power-driven circular saw with a diamond-tipped blade having a diameter of 300 to 350 mm (12 to 14 in.) (See Module II, Section 4.7). Rough ends of the brick tile can be sawed off by concrete saw (Module II, Sections 4.6 – 4.8) to achieve a smooth end which will facilitate sample transport.

6.3. Outdoor Brick Surfaces (e.g., walkways, roads, driveways)

Check the SCP for the appropriate sampling technique required to sample brick walls and refer to the required sampling procedure in Module II, Section 4.0.

6.4. Painted Surfaces

Check the SCP to determine whether lead determination is in the painted surface is required. If lead is to be determined, refer to Module II, Section 1.2.3 for procedures on paint removal.

6.5. Brick Sample Handling

Brick samples will be in the form of whole bricks or pieces of whole bricks. For larger pieces, the outward facing side should be noted on the sample. If project data quality objectives (DQOs) specify that brick and binding materials (mortar, cement, grout) should be analyzed separately, these matrices should be separated in the field or laboratory prior to analysis. Refer to Appendix A3 for the appropriate sample container and Module II, Section 12.0 for sample handling procedures.

7.0 Collection of Limestone Samples

7.1. General Considerations

Limestone can vary greatly in texture and porosity, and is widely used in architectural applications for walls, decorative trim and veneer (U.S. GSA, 2012). It is less frequently used as a sculptural material, because of its porousity and softness, however, it is a common base material. It may be found in both bearing (structural) and veneer applications and is also used as an aggregate for the base of roads. Its softness makes it relatively easy to cut or drill. Limestone samples will be in the form of chunks, bores or rubble.

7.2. Limestone Sample Collection

Limestone is normally sampled by hand drilling (Module II, Section 4.3) or core drilling (Module II, Section 4.4.); however, its softness makes it easy to chip (Module II, Section 4.2) or saw cut (Module II, 4.6 – 4.8). If project DQOs specify that limestone and binding materials (mortar, cement, grout) should be analyzed separately, these matrices should be separated in the field or laboratory prior to analysis. Check the SCP for the appropriate sampling technique required to limestone and refer to the required sampling procedure in Module II, Sections 4.2 – 4.12.

7.3. Limestone Sample Handling

Once the sample has been collected, transfer it to an appropriate container (see Appendix A3). Proceed to Module II, Section 12.0 for sample handling.

8.0 Collection of Granite Samples

8.1. General Considerations

It is important to distinguish whether the granite is polished or unpolished. Polished granite is not permeable; therefore, unless crack or crevices are visible, all radiological contamination is expected to be located only on the surface. In this case, surface sampling techniques such as swiping[5] or scabbling only a thin layer of the surface are recommended (see Module II, Section 4.10).

8.2. Granite Sample Collection

Granite is normally cut using circular saws (Module II, Section 4.7), cut off saws (Module II, Section 4.8) or hand grinders (Module II, Section 4.11). If project DQOs specify that granite and binding materials (mortar, cement, grout) should be analyzed separately, these matrices should be separated in the field or laboratory prior to analysis. Check the SCP for the technique required to sample granite and refer to the required sampling procedure in Module II, Section 4.2 – 4.12. Prior to sample collection, remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

8.2.1 Circular and Cut Off Saw (Anderson, 2012)

Water cooling is recommended if cutting granite with a circular saw to keep the blade from overheating. Granite tile can be cut dry. Cutting granite will produce a lot of dust; therefore it is recommended that the appropriate respiratory PPE (Appendix A6) be worn during cutting. All granite edges chip out due to vibration, especially if using a circular saw. This vibration leads to the blade jogging loose imperfections in the edge of the cut. Cover the cut edge with masking tape or duct tape before you cut to help hold the cut edge together and avoid large fragments chunking off.

8.2.2 Hand Grinder (Desiel, 2014)

The hand grinder must be water cooled when cutting to avoid cracking the granite. Before beginning the cut, lay masking tape along the cut line and trace the line on the tape. This practice prevents losing site of the cut line. Set a bucket of water nearby, soak a sponge in the water and allow it to weep onto the stone to prevent the blade from overheating.

8.3. Granite Sample Handling

Granite samples will be in the form of chunks, bores or rubble. Refer to Appendix A3 for the appropriate sample container and Section 12.0 for sample handling procedures.

9.0 Collection of Asphalt Shingles

9.1. General Considerations

Asphalt shingles may be collected whole or in pieces. Prior to sample collection, remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

[5] Sample Collection Procedures for Radiochemical Analytes in Environmental Matrices, Section 7.0, EPA/600/R-12/56. July 2012.

9.2. Asphalt Shingles Collection

9.2.1. Refer to the SCP to determine whether exposed portions of shingles or whole shingles should be collected.

9.2.2. If removing whole shingles, it is best to remove them during the coolest part of the day when they are more brittle than moldable. Removing all the shingles is usually done with a large hay fork, or rake-sized scraper. If only a few shingles are to be removed, loosen the adhesive under the tabs two rows above the shingles to be removed.

a. Use a pry bar, crow-bar, or the claw of a hammer to get under and carefully pry up the shingles, separating the adhesive and revealing the nails underneath.

b. Loosen and remove the selected shingles. Loosen the adhesive underneath the tabs of the shingle, then pull them free. Continue removing the shingles until all selected shingles have been removed.

9.2.3 If removing exposed portions of shingles, use a razor knife to cut away the exposed shingle at the drip edge of the overlaying shingle.

9.3 Asphalt Shingles Sample Handling

Refer to Appendix A3 for the appropriate sample container and Module II, Section 12.0 for sample handling procedures.

10.0 Collection of Asphalt Road Samples

10.1. General Considerations

The specific composition and condition of the asphalt, as well as the compaction method used to prepare the roadway or pavement, will determine the sampling technique (Swiertz, 2010; WSDOT SOP 734. 2009). Prior to sample collection, remove any foreign material (e.g., dust, debris) that is not part of the sample material to be collected from the sampling location by brushing or wiping (see Module II, Section 3.0).

10.2. Asphalt Road/Driveway Material Collection

10.2.1 Sawing using a chainsaw or core drilling using a core drilling machine are most commonly used for sampling asphalt road materials. If sawing is used for sample collection, follow the procedures in Module II, Section 10.2.2 and Module II, Section 4.6. If core drilling using a pavement core drilling machine, follow the procedure in Module II, Sections 4.4 and 10.2.3. Check the SCP for the appropriate sampling technique required to sample outdoor asphalt surfaces and refer to the required sampling procedure in Module II, Section 4.2 – 4.12. Once the asphalt sample has been collected, transfer to an appropriate sample container (see Appendix A3). Then proceed to Module II, Section 12.0 for sample handling.

10.2.2 Sawing (CSIR, 2002)

Blades used in a power saw shall be either hardened metal with embedded diamond chips or an abrasive blade such as carborundum or similar material. A 300 mm (12 in.) blade can be used to sample asphalt layers up to 100 mm (4 in.) in thickness. Blades with larger diameters must be used to collect thicker layers. A source of cooling water, dry ice, liquid nitrogen, or other cooling material may be needed, but in some cases, may be omitted when only a single sample is to be obtained. At any time there is evidence of damage to the edge of a sample due to the generation of heat caused by friction, a cooling material should be applied to the cutting tool or to the pavement surface to minimize sample damage. If separation of the pavement courses is required, separate the courses by cutting them apart with a saw blade while spraying cooling water on the blade to minimize generation of excessive heat. As an alternative, separation of two pavement courses can be achieved by striking a swift heavy blow on a chisel at the point of bonding between the two courses. Separation by this procedure is more effectively achieved if the sample is cooled below freezing.

10.2.3 Core Drilling (Chicago Pneumatic, 2012; WSDOT SOP 734. 2009)

a. The cutting edge of the core drill bit should be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge or as recommended by the bit manufacturer. Check the SCP for the core dimensions required for sampling to determine the drill bit size needed. Typically core drill bits have an inside diameter of 4 in. ± 0.25 in. (102 mm ± 6 mm) or 6 in. ± 0.25 in (152 mm ± 6 mm).

b. Place the core drill and core bit over the selected location. Keep the bit perpendicular to the surface during the coring process.

> NOTE: If any portion of the drill shifts during operation, the core may break or distort. Constant downward pressure should be applied. Too much pressure or failure to apply constant pressure may cause the bit to bind or distort the core.

c. Continue the coring operation until the desired depth is achieved. If necessary, use a retrieval device, such as forceps, to remove the core. Clearly identify the core’s location with a lumber crayon or grease pencil.

> NOTE: To ensure that the core will come away easily, it is preferable to drill to a level of separation between layers (i.e., the level between an asphalt layer and a gravel layer). If a sample of an asphalt surface overlying an asphalt base is required, it would be better to drill through both the surface and the base, and then to separate the two asphalt layers using a diamond saw.

10.3. Asphalt Road/Driveway Material Sample Handling

Asphalt road/driveway material samples will be in the form of chunks and cores. If cores are taken, it is recommended that the ends be trimmed with a saw to avoid damaging the sample container. Refer to Appendix A3 for the appropriate sample container and Module II, Section 12.0 for sample handling procedures.

11.0 Collection of Stucco Samples

11.1. General Considerations

Stucco or render is a material made of an aggregate, a binder, and water. Traditional stucco is made of lime, sand, and water. Modern stucco is made of Portland cement, sand, and water. Stucco is applied wet and hardens to a very dense solid. It is used as decorative coating for walls and ceilings and as a sculptural and artistic material in architecture. Stucco may be used to cover less visually appealing construction materials such as metal, concrete, cinder block, or clay brick and adobe. The appropriate sampling procedure to collect stucco samples will depend on the following factors:

- Whether the wall or surface is completely comprised of stucco or it is a brick wall with stucco (mortar) keeping the brick layers together.
- Whether the stucco material is hard (like Portland cement) or softer (in cases where lime has been added).

Stucco material samples will be in the form of rubble and chunks.

11.2. Painted Surfaces

Check the SCP to determine whether lead determination of the painted surface is required. If it is to be identified, refer to Module II, Section 1.2.3 for procedures on paint removal.

11.3. Stucco Material Collection

If the wall is comprised completely of stucco then samples may be collected using a prybar, a wide cold chisel, or a stiff putty knife with a 76- mm (3-inch) or 100- mm (4-inch) blade. If the stucco is as hard as Portland cement, refer to the appropriate sampling procedure in Module II, Section 4.2 – 4.12. If the sample will be comprised of brick as well as stucco, refer to Module II, Section 6.0 (Collection of Brick Samples). Check the SCP for the appropriate sampling technique required to sample stucco material from walls.

11.4. Stucco Material Sample Handling

Refer to Appendix A3 for the appropriate sample container and Section 12.0 for sample handling procedures.

12.0 Sample Handling

a. Label the sample container.

> NOTE: Most of the analytical radiochemistry methods listed in SAM require that the sample be ground or pulverized. This is to be performed at a laboratory with the appropriate equipment (i.e., jaw crusher, mechanical pulverizer) and controls necessary for pulverizing building and infrastructure materials.

b. Weigh the sample(s) or determine the volume based on the container size.

c. Sample containers should be placed in separate zip-locked bags to protect other containers in case of spillage during transport.

d. Record the required information on the Field Logbook, Field Sample Tracking Form, and the sample label(s). The following information is to be included at a minimum:

- SIC
- Time and date sampled
- Sample location
- Area sampled
- Sample depth
- Sample volume or weight collected
- μR reading of the sample container
- Sample collector's initials

e. Decontaminate the sampling equipment or place it into a bag for decontamination outside of the sampling area per the requirements of Module I, Section 5.0 (Personnel/Equipment Decontamination).

f. After sample collection, place the sample container securely into a transport container for transport out of the sampling area.

g. Recover all wastes, placing them in appropriate waste containers for transport out of the sampling area. Handle wastes per the requirements of Module I, Section 6.0 (Waste Control).

h. Exit the sampling area using proper techniques to minimize the spread of contamination.

i. Once outside of the area and back at an appropriate location, prepare the sample(s) for transportation per the requirements of Module I, Section 7.0 (Sample Packaging and Transport).

MODULE III - SAMPLING PROCEDURES – FINAL STATUS SURVEY PHASE

1.0 Collection of Samples

1.1. Overview

1.1.1 This module outlines procedures, equipment, and other considerations specific to the collection of representative samples during the Final Status Survey Phase of sample collection following a radiological contamination incident. This Final Status Survey Phase involves collecting samples to support decisions in determining site release.

1.1.2 Samples collected during the Final Status Survey Phase can be assumed to contain zero to slightly above background levels of radioactive material. For this reason, specific precautions are needed to ensure samples are not compromised or contaminated.

1.1.3 During the Final Status Survey, samples can be collected using the same procedures described in Module II, Sampling Procedures Sections 3.0 and 5.0 – 11.0 (Characterization and Remediation Phases). In most cases, it is likely that samples will be collected at depths that are closer to the exposed material surfaces; equipment will be selected with depths in mind. The MQOs are modified for all sample matrices. Sample collectors will consult the site-specific SCP for requirements and procedures for collection of samples for the Final Status Survey as these may differ from the site characterization and remediation phase in number and locations.

1.1.4 A Final Status Survey is performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for site release. The survey provides data to demonstrate that radiological parameters do not exceed the established Derived Concentration Guidance Levels (DCGLs). For the Final Status Survey, survey units represent the fundamental elements for compliance demonstration.

1.1.5 Site surveys of the sampling units dictate the samples required.

a. A scale drawing of each survey unit is prepared and included in the Sample Collection Plan (SCP), along with the overlying planar reference coordinate system or grid system (normally the global positioning system [GPS] coordinates).

- Any location within the survey unit is identified by a unique set of coordinates.
- The maximum length (X) and width (Y) dimensions of each survey unit are determined and included in the SCP.

b. Identifying and documenting a specific location for each field measurement performed and each sample collected is an important part of a Final Status Survey to ensure that measurements can be reproduced if necessary. Part of this identification is the measurement of radiation levels by hand-held survey instruments, such as walk-over surveys of the area (building roofs, roads, parking lots, sidewalks) and direct reading surveys of walls.

1.1.6. The following sample weights, volumes, and requirements have been determined to be necessary to meet the MQOs in the Final Status Survey Phase of sampling and are to be the volumes/masses taken unless otherwise specified in the SCP:

- ~1 kilogram (kg) of building material is to be collected for gamma scans
- ~100 grams (g) of building material is to be collected for radiochemistry methods

Discussions with the analytical laboratory will determine if separate additional sample amounts are needed, or if only one sample is required.

1.2. Precautions and Limitations

1.2.1. Sample collection activities during Final Status Survey Phase sampling may be observed and/or duplicated for quality control purposes by an independent agency, from the start of collection through sample packaging, including evaluations of documentation (both historical and incident-specific).

1.2.2. Although Final Status Survey samples could be considered clean and radiation and contamination levels should be at or near background levels, personnel are to use radiation protection precautions. All equipment and materials, as well as areas where samples are handled, are to be surveyed by radiation protection personnel for contamination and released prior to unrestricted use.

1.2.3. If, during the sampling process, levels of radiation and contamination are measured above levels that are allowed or expected in the SCP, **STOP** sampling and notify the Field Team Leader prior to continuing sample collection activities.

1.2.4. Survey points are located within a grid, and should be marked using flags, stakes, or paint markings. These markings must not be disturbed during sample collection.

2.0 Equipment and Materials

NOTE: The equipment and materials used for sample collection will depend on the type and construction of the building or infrastructure material to be sampled. Refer to Module I, Section 2.0 and Appendices A1 through A6 for information supporting equipment selection.

All sampling equipment and PPE are to be pre-staged and available prior to entering a sampling area. The sampling team is to set up a step-off pad at the entrance to the survey point, and to don appropriate PPE prior to entering the area. Personnel outside of the area may hand materials to, and retrieve materials from, personnel in the area using appropriate contamination control techniques. All steps that will reduce the time in the area, such as pre-writing of labels or sample containers, are to be used to minimize exposure.

NOTE: Collection of outdoor building and infrastructure materials requires the use of manual and/or power tools for physical removal of samples. In many cases, powerful tools and equipment similar to those used for decontamination are used for sample collection, and specific skills, training and precautions may be required. In all cases, user manuals should be consulted prior to use of equipment in the field.

3.0 Collection of Outdoor Building and Infrastructure Materials

Sample collection is performed per the procedures and requirements of Module II, Sections 3.0 through 11.0.

APPENDIX A: List of Sampling Equipment and Materials

APPENDIX – A1 Sampling Equipment

Sample Matrix	Sampling Tools	
Concrete Brick Limestone Granite Stucco Asphalt (road, pavement)	• Pneumatic scabbler (pneumatic hand-held or remotely operated or laser) • Core drill (hand-held; electric or pneumatic) • Core drill machine • Rotating coring device • Stainless-steel drill • Saw (pneumatic concrete, chainsaw, floor, cut-off or stainless-steel hole) • Needle scaler • Stainless-steel chisel	• Grinder (hand-held) • Shaver (heavy duty or hand-held, wall or floor) • Hammer (pneumatic, hydraulic or drive) • Tape measure • Vacuum System
Asphalt Shingles	• Pry bar • Crow bar	• Hammer

APPENDIX – A2 Sampling Equipment Application Advantages and Disadvantages

TOOL	MATRIX	ADVANTAGE	DISADVANTAGE	STANDARDS
Building Material Sampling Equipment				
Stainless-steel chisel	Concrete Brick Limestone Granite Stucco Asphalt (road, pavement)	• Cost efficient • Minimal noise and dust production • Safe technique • Requires minimal training	• Time consuming • Difficult with hard surfaces • Difficult to obtain uniform samples • Difficult to collect deep samples	ASTM C1532/C1532M–12
Stainless-steel drill		• Cost efficient • Minimal noise and dust production • Safe technique • Requires minimal training	• Time consuming • Difficult with hard surfaces	ASTM C50/C50M–13 ASTM C67–13a
Stainless-steel hole saw		• Cost efficient • Minimal noise and dust production • Safe technique • Requires minimal training	• Time consuming • Difficult with hard surfaces	None found
Needle scalers		• Ideal for hard-to-access areas (e.g., corners, metallic inserts, pipe penetrations etc.) • Easy to use	• High level of vibration • Limited surface area • Dust generation	None found

TOOL	MATRIX	ADVANTAGE	DISADVANTAGE	STANDARDS
Scabbler (electric or pneumatic)	Concrete Brick Limestone Granite Stucco Asphalt (road, pavement)	• Ideal for sampling thin layers (up to 15 or 25 mm [0.6 or 1.0 inches]) • Especially useful on walls and ceilings • Suitable for both large open areas and small areas	• Produces large amounts of dust (use of dust collection systems highly recommended) • High physical load on operators due to machine vibration	None found
Paving or rock breaker hammer (hydraulic or pneumatic)		• Can collect thick samples (where deep contamination is suspected) • Cost efficient • Designed for removing small pockets of contamination or to reach areas not otherwise accessible	• Jack-style hammer produces large amounts of dust • Not recommended for walls • High physical load on operators due to machine vibration • Causes more damage to surfaces than other techniques	None found
Chipping hammer (pneumatic)		• Suitable for hand-held use on walls and ceilings • Cost efficient • Ideal for collecting samples in small areas where contamination may have penetrated several cm • Designed for removing small pockets of contamination or to reach areas not otherwise accessible	• Small nail size and heavy weight make them cumbersome	None found

TOOL	MATRIX	ADVANTAGE	DISADVANTAGE	STANDARDS
Shaver (wall) or grinder	Concrete Brick Limestone Granite Stucco Asphalt (road, pavement)	• Ideal for sampling thin layers • Especially useful for walls and ceilings • Faster work rate than scabbler • Much less physical load on the operators due to the absence of machine vibration • Capable of cutting through bolts and metal objects • Results in a smooth surface • Generates small quantities of waste	• Installation of the equipment can be difficult and time consuming • Almost impossible to use wall shaver in small cells or in cells with irregular shapes.	None found
Core drill (hand-held)/ Core drill machine		• Fast technique • Cost efficient • Minimal noise and debris created • Achieves greater depths of cut than any other technique with the exception of wire sawing • Can sample in tight spaces	• Portable drills may not produce enough torque to sample all types of material • Tend to bind if choked with dust, or if allowed to wander from the central axis of the hole • Kick-back may be severe under some conditions • Core often binds inside the hole, and must be pried out after each hole is cut	ASTM C42/C42M ASTM C823/C823M –07 ASTM C50/C50M–13 ASTM D5361/D5361M–14

TOOL	MATRIX	ADVANTAGE	DISADVANTAGE	STANDARDS
Rotary hammer (hammer drill)		• More cost efficient and quicker method than core drilling • Data quality from the US Department of Energy Savannah River Site (SRS) was better than traditional deactivation and decommissioning methods[1]	• Sample is generated as drill powder which needs to be collected • Potential contamination issues with uncollected dust	None found
Concrete (chain or wire) saw	Concrete Brick Limestone Granite Stucco Asphalt (road, pavement)	• Produces minimal waste (powder or chips) • Cost effective	• Coolants and lubricants needed for wet cutting, creating secondary waste • Airborne contamination (dust and particulates) • Slow procedure • Limited application • May result in collecting too much sample (past the point of contamination) • Requires space to operate (1.5 x 2.5 m [5 x 8 ft.]) • Heavy (between 150 and 600 kg)	ASTM C67-13a ASTM C823/C823M–07 ASTM D5361/D5361M–14 ASTM C42/C42M–13

TOOL	MATRIX	ADVANTAGE	DISADVANTAGE	STANDARDS
Concrete (circular) Saw		• Best option for precise cutting • Enables flush cuts along walls • Small pieces can be dry cut (no coolant, therefore no waste)	• Short durability of diamond blade (~15 m^2 [~161 ft^2] in reinforced concrete) • Slow cutting for large depths • Preparation requires a lot of time and effort • Coolants and lubricants are needed for wet cutting, creating secondary waste • Airborne contamination (dust and particulate)	ASTM C1532/C1532M–12
Pry bar	Asphalt shingles	• Flat point allows ease of access below shingles	• Not always available • Shorter length provides less leverage	None found
Crow bar		• Longer length provides greater leverage	• Not always available • Some difficulty getting under shingles due to rounded point	
Hammer		• Readily available	• Difficulty getting under shingles due to hammer head • Shorter length provides less leverage	

1 Jannik, G.T. and Fledderman, P.D., Sampling and Analysis Protocol. U.S. Department of Energy. WSRC-STI-2007-00077. February 2007.

APPENDIX – A3 Sampling Containers

Procedure	Vacuum Attachment Option	Sample Type Produced	Sample Container[1]
Surface wipe	–	Swipe	Glassine envelope or plastic bag
Chip sampling	No	Chips, rubble, particulates	250 mL or larger plastic jars or sample bottles
Drilling (by hand, hammer drill or rotary hammer drill)	No	Particulates, cuttings	250 mL or larger plastic jars or sample bottles
Core Drilling	No	Core, cuttings	Large zip-locking or plastic bag with ties, and/or box (steel, wood, or fiberboard)
Needle Scaling	Yes	Particulates	250 mL or larger plastic jars or sample bottles
Sawing (Power or Chainsaw)	No	Bulk materials, cuttings, particulates	Large plastic bag with ties, and/or box (steel, wood, or fiberboard)
Sawing (Circular)	No	Bulk materials, cuttings, particulates	Large plastic bag with ties, and/or box (steel, wood, or fiberboard)
Sawing (Cut off)	No	Bulk materials, cuttings, particulates	Large plastic bag and/or box (steel, wood, or fiberboard)
Sawing (Diamond wire)	No	Bulk materials, cuttings, particulates	Large plastic bag with ties, and/or box (steel, wood, or fiberboard)
Scabbling	Yes	Particulates	250 mL or larger plastic jars or sample bottles
Shaving (Grinding)	Yes	Particulates	250 mL or larger plastic jars or sample bottles
Hydraulic/Pneumatic Hammering	No	Chips, rubble, particulates	Large plastic bag with ties, and/or box (steel, wood, or fiberboard)
Decontamination Rinsate	No	Decontamination rinsate water	High density polyethylene (HDPE) bottles, 500 mL or 1 L, or Cubitainer®

1 Samples collected for analysis of tritium contamination should be contained in high density plastic or glass.

APPENDIX – A4 Shipping Materials and Packaging

Type	Potential Materials
Cushioning and Packing	• Polystyrene foam packing peanuts and pieces • Bubble Wrap • Vermiculite
Absorbents	• Vermiculite • Chem-sorb
Industrial Package Type 1	• Fiberboard Box or Drum • Plywood or Natural Wood Box or Drum • Plastic Drum or Jerrican • Plastic Cooler
Industrial Package Type 2	• Steel Box or Drum • Aluminum Box or Drum • Any Industrial Package Type 2, Type A, or Type B container
Type A	Steel Box or Drum
Type B (U) or (M)	Specific Steel Container

APPENDIX – A5 Additional Equipment to Consider for Sampling Operations

Additional Sampling Equipment	
Item	***Item Description***
Alternating Current (AC) Generator	Gasoline powered – 1500 Watts
Aluminum foil	Collecting concrete cores
Antifreeze	Prevent freezing in water lines for air (pneumatic) tools
Bottle	16 ounce (oz) squeeze bottle with nozzle
Brushes	Long handle, scrub or wire
	Galvanized, stainless-steel
	Brush and dust pan
Bucket	Plastic w/handle – 5 gallon (gal). For carrying tools and materials; can be used for carrying samples or for equipment decontamination
Digital camera	————
Chainsaw lever system	Wallwalker® (Acme Tools, Grand Forks, ND) or equivalent (helps chainsaw cut more efficiently and reduce user fatigue)
Cleaning wipes	————
Disposable gloves	————
Drum hand truck	Transport 30- and 55-gal drums
Garden pressure sprayer or squeeze bottle sprayer	————
First Aid Kit	————
Flags	Sample location markers
Flashlight	————
Forceps	15 cm (6 in.)
Sample frames	Composed of plastic sheeting, and used to delineate sampling areas. 0.5 to 1 m^2 (5 to 11 ft^2). Opening should be at least 100 cm^2 (0.1 ft^2)
Funnels	240 mL; 960 mL; plastic
Gasoline containers	5 gal with spark arrest and safety cap closure
GPS Unit	Hand held; Preferably able to tie into the radiation detection equipment for logging sample radiation readings at location
Hose and water supply	For coring drill, hand grinder, and certain saws (cut off, circular and diamond wire)
Labels	Labels and markings for required shipping and samples
Ladder	6 ft and 10 ft
Lubricant	Tool oil or mineral oil for air (pneumatic) tool lubrication
Spray paint	Fluorescent
Pens and Markers	Indelible; Water proof; Black and Red

Additional Sampling Equipment	
Item	***Item Description***
Plastic Bags	• (Non-sealable) 15, 30, and 55 gal for general wastes • (Non-sealable) 15, 30, and 55 gal for contaminated wastes
Plastic Sheeting	Preferably in a large roll (6.1 m x 10.1 m [20 ft x 33.3 ft])
Powdered Detergent	Alconox® cleaner (Alconox, Inc., White Plains, NY) or equivalent (heavy duty, concentrated detergent)
Rope – Nylon	White – 1.0 cm and 1.3 cm (3/8 in. and 1/2 in.); nylon or weatherproof cotton
Rope – Nylon	Yellow and Magenta; 1.0 cm (3/8 in.)
Salvage and Over Pack Drums	————
Screw drivers	Flat and Philips head; small and large
Shielding material	Sheet steel, plywood, lead blankets and bricks
Sieves	Stainless steel Number (No.) 4 (100 mm mesh [3.9 in.])
Signs	Yellow and Magenta for radiation work
	Red, White, and Black for safety concerns
	Blue and White for entry and other instruction
Soap and Cleansers	————
Spill Kit	————
Stakes	Wooden construction
Stakes w/ flag	Wire with flag for marking
Step-off pads	Yellow and Magenta for radiation work
Tape	Yellow and Magenta for radiation work
Tape	Duct tape; Packing Tape; 5.1 cm and 7.6 cm (2 in. and 3 in.) wide
Tape measure	15.2– 61.0 m (50–200 ft) preferably with metric scale as well
Trash bags and ties	————
Tripod	For mounting air samplers
Tripod	For retrieving material from pits or excavations
Utility Carts	————
Vacuum (VAC) System	HEPA filtered; attachable to sampling equipment (e.g., VAC-PAC® HEPA-filtered waste collection unit [Pentek, Inc., Upper Saddle River, NJ] or equivalent)
Wash tub	————
Weigh scale	Hanging pull type; kg with gram divisions capable of weighing up to 5 kg

APPENDIX – A6 Personal Protective Equipment

Personal Protective Equipment (PPE)	
Item	***Description***
Boot / Shoe Covers	Plastic
Boots	Rubber with safety toes (steel, aluminum, or composite), Tyvek® (E. I. du Pont de Nemours and Company, Wilmington, DE) or rubber outer covers
Coveralls	Paper - Tyvek®
Coveralls - Cotton	————
Coveralls – Water-resistant/proof	————
Ear Protection	Ear plugs or ear muffs
Eyewear	May require sunshades for outdoor work in bright conditions
Face Shields	————
Fall Protection	For ladders and scaffolding (i.e., personal fall-arrest systems or guardrail systems)
Gloves – Exam	Latex or Nitrile; Powder Free
Gloves – Work	Heavy cotton
Goggles	Eye protection
Hard Hats	————
Monitoring Devices	Radiation Dosimeter
	Lapel Sampler
Respirators	Full Face Air Purifying
	Full Face Powered Air
	Airline Full Face
	Self-Contained Air Supplied

APPENDIX B: Forms

APPENDIX – B1 Field Logbook Entry

This logbook entry format is provided to demonstrate the minimum information to be recorded in a bound logbook. Illustrations or pictures of the site also should be included with annotations, and should accompany or be referenced in the entry. Pagination (Page X of Y) should correspond to each day of sampling in each survey unit. The logbook should also contain pagination to demonstrate logbook maintenance.

Site Name			Page X of Y	
Sample Collection:	Number Taken	Matrix	Date	Time:
Sample Collectors (Print Names)			Observed By Initials (if observed)	
Location of Sample Collection:				
Landmark Description Compass Point				

Sample Identification Code (SIC)	Sample Location Global Positioning System (GPS) Coordinates	Sample Package Contact Gamma mR/hr	Remarks
1 -			
2 -			
3 -			
4 -			
5 -			
6 -			
7 -			
8 -			
9 -			
10 -			
11 -			
12 -			
13 -			
14 -			
15 -			
16 -			
17 -			
18 -			
19 -			
20 -			

Comments: Note sample number and describe problem or information. Add pictures or illustrations on separate page.

APPENDIX – B2 Field Sample Tracking Form

Field Sample Tracking Form									
Site Name					**Date**			Page X of Y	
No.	Sample Identification Code (SIC)	Matrix[1]	Chemical decontamination used on matrix? (if yes, identify agent used)	Sample Location / Description[2]	Volume (mL) / Mass (g)	Area Sampled (cm^2/ft^2)	Depth (m/ft)	Sample Type[3]	Number of Containers
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Remarks:

Notes:	Reviewed By Initials	Date
1 – Matrix codes: C=Concrete; A=Asphalt; AS=Asphalt shingle; B=Brick; L=Limestone; G=Granite; S=Stucco; SW=Swipe 2 – Describe the sample location by compass point relative to landmark or Global Positioning System (GPS) coordinates. 3 – Sample Type Code – REG – Regular; DUP – Duplicate; RIN – Rinsate; BLK – Field Blank; BKG - Background		

APPENDIX – B3 Chain of Custody

	EPA	**USEPA** **Radionuclide Analysis Traffic Report & Chain of Custody Record**	**Case No.:** **DAS No.:** **SDG No.:** **Page of**

Date Shipped	**Chain of Custody Record:**	**Sample Collector Signature:**	**For Lab Use Only**
Carrier Name	**Relinquished By: (Date/Time)**	**Received By: (Date / Time)**	**Lab Contract No.:**
Airbill:	**1)**		**Unit Price:**
Shipped To:	**2)**		**Transfer To:**
	3)		**Lab Contract No.:**
	4)		**Unit Price:**

Sample Identification Code		**Sample Collector**	**Matrix / Type**	**Volume / Mass**	**Analysis Required**	**Sampling Location / Sample Depth**	**Date / Time**	**Laboratory Sample No.**	**FOR LAB USE ONLY Sample Condition on Receipt**
1									
2									
3									
4									
5									
6									

Additional Sample Collector Signature(s) / Date:		**Sample(s) to be used for laboratory QC?**	**Cooler temperature Upon Receipt:**	**Chain of Custody Seal Number:**
			Shipment Iced? (Yes/No)	**Custody Seal Intact? (Yes/No)**

Analysis Key:	**Type: (e.g., particulates, cuttings, chips, rubble, core)**	**Analysis Required: Gross Alpha, Gross Beta, Alpha Scan, Gamma Scan, Specific Isotopes or Radionuclides, Other**
	Matrix: (e.g., concrete, brick, limestone, stucco, granite, asphalt, swipe) **DAS – Delivery as Analytical Services; SDG – Sample Delivery Group**	

APPENDIX – B4 Example Waste Control Form

All material sent for disposal will need to be manifested with approved FULL analytical documentation. A full listing of all contaminants is required for Disposal Approval Codes.

Waste Control Form

Site Name:			
Waste ID Number:			
Date Opened:		Signature:	

Instructions: Cross out unused items with "X". If the term "Other" is used, indicate by name in blank space an item description appropriate for shipping information. Mixed wastes (i.e., radioactive material and chemical wastes), explosives, and gases are NOT allowed, unless specific permission is granted in writing. All material shall be made as inert as practical (e.g., liquids solidified, acids or bases neutralized) for shipment.

Waste Container:

Industrial Package 1	Industrial Package 2	Industrial Package 3
Type A	Type B (U)	Type B (M)
Markings found on approved containers:		UN Code:
Volume: ft^3 / gal / L	Container to have less than 5% void space after filling.	

Waste Type

UN ID No.	Soil	Aqueous Liquid	Flammable
	Solids	Non-Aqueous Liquid	Other (identify below)
	PPE	Hazardous Material	

Hazard Level

(state known internal levels or assumptions/calculated values)

Chemical	% or parts per million (ppm)	Radioactive Material	dpm / 100cm^2
Chemical	% or ppm	LSA-I / LSA-II / LSA-III	A_1 or A_2

External Radiation and Contamination Levels

Surface	dpm / 100cm^2	Attach Copy of Survey Map	
Radiation on Contact	mR / hr	At 1 meter (3.3 ft.)	mR / hr

Container Labels Required:

(Package Orientation is mandatory for any package capable of being hand carried or trucked)

Toxic Substance	Gas – Flammable	Radioactive LSA-I	Radioactive I
Corrosive	Gas – Non-Flammable	Radioactive LSA-II	Radioactive II
Solid – Flammable	Gas –Toxic	Radioactive LSA-II	Radioactive III
Liquid – Flammable	SCO-I	SCO-II	Fissile

Date Closed:	Signature:
Disposal Approval Code:	Overpacking Required/Completed
Transportation Company: *Name, Contact Name and information*	
Disposal Company: *Name, Contact Name and information*	
Date Disposed:	Date Disposal Certificate Received:

A1 – Special form; **A2** – Normal or other form
LSA – Low Specific Activity
PPE – Personal Protective Equipment
SCO – Surface Contaminated Object

APPENDIX C: Building Material Sample Collection Technologies/Methodologies

APPENDIX – C Building Material Sample Collection Technologies/Methodologies

Technology	Tools	Depth/Size*	Materials	Module Section(s)
Chip Sampling	Chisel, hand drill, hole saw, or similar tool	Sample to a depth of ~ 10 millimeters (mm) (3/8 inch [in.]) As long as minimum required amount of sample is collected, chips may be of any convenient size, unless otherwise specified in the SCP. Collect chip samples representative of porous surfaces	Concrete Brick Limestone Hard stucco	**Module I** 2.2.2 **Module II** 4.2 5.1, 5.2 7.2 11.3
Drilling (by hand, hammer drill or rotary hammer drill)	Hand drill or rotary hammer drill and a 13-mm (0.5-in.) diameter (or larger) drill bit	Drill shallow holes of approximately 6 mm (0.25 in.) in depth The number of holes drilled depends on the amount of sample required. Drilling should continue until the depth to which contamination is expected	Concrete Brick Limestone Hard stucco Relatively brittle material	**Module I** 2.2.3 **Module II** 4.3 5.1, 5.2 7.2 11.3
Core Drilling	Electric, hydraulic or air powered drills Drill bits range in diameter from 1 – 152 cm (0.5 – 60 in.) Bits inside diameter of 102 mm ± 6 mm (4 in. ±0.25 in.) or 152 mm ± 6 mm (6 in. ± 0.25 in.)	Drilling depths are virtually unlimited with barrel extensions Core sample of up to 100 mm (4 in.) long is collected If instructed in the SCP, drill cuttings can be collected as part of the sample, in addition to the core	Concrete Brick Limestone Hard stucco	**Module I** 2.2.9.a **Module II** 4.4 5.1, 5.2 7.2 10.2.3 11.3

Technology	Tools	Depth/Size*	Materials	Module Section(s)
Diamond Core Drilling	Drill bit - hardened steel or other suitable material with diamond chips embedded in the metal cutting edge Concrete: 16 mm (5/8 in.) diamond drill bit Asphalt road material: 102 ± 6 mm (4 ±0.25 in.) or 152 ± 6 mm (6 ± 0.25 in.) inside diameter drill bit	Asphalt road material: Check the SCP for the core dimensions required	Concrete Brick Limestone Asphalt road material Hard stucco	**Module I** 2.2.9.b **Module II** 4.4 5.1, 5.2 7.2 10.2.3 11.3
Needle Scaling	Needle gun with flat surface shroud Uses uniform sets of 2-, 3- or 4-mm (0.08-, 0.1- or 0.2-in.) needles Concrete surfaces: 3- and 4-mm (0.1- and 0.2-in.) needles	The needle scaler will remove approximately 2 mm (1/16 in.) per pass. Perform additional passes if sample is required from deeper depths The particulates generated are considered the sample	Concrete Brick Hard stucco	**Module I** 2.2.4 **Module II** 4.5 5.1, 5.2 11.3
Sawing (Power)	Concrete saw	Thicknesses of up to 1 m (~3 ft)	Metal Concrete Brick Limestone Hard stucco	**Module I** 2.2.10.a **Module II** 4.6 5.1, 5.2 7.2 11.3

Technology	**Tools**	**Depth/Size***	**Materials**	**Module** Section(s)
Sawing (Chainsaw)	Diamond chainsaw Asphalt road material: 300 mm (~12 in.) blade of hardened metal with embedded diamond chips or an abrasive blade such as carborundum or similar material	Concrete: Normal thickness of cut is about 1/3 the diameter of the blade, with about 1 m (~3 ft) of concrete being the maximum thickness. Surface area of approximately 2 m^2 (~22 ft^2) Asphalt road material: Layers up to 100 mm (~4 in.) in thickness	Concrete Brick Limestone Asphalt road material Hard stucco	**Module I** 2.2.10.b **Module II** 4.6 5.1, 5.2 7.2 10.2.2 11.3
Sawing (Circular)	Circular saw with: 300 mm (~12 in.) blade can be used to sample asphalt Diamond-tipped blade having a diameter of 300 to 350 mm (12 to 14 in.) used to sample brick walls	Sawing to less than 1 meter (m) (~40 in.) deep achieved by using saw blades with diameters of 2.2 m (~87 in.) Asphalt: Layers up to 100 mm (~4 in.) in thickness Brick: nominal thickness of 100 mm (~4 in.)	Concrete Asphalt Brick Limestone Granite Hard stucco	**Module I** 2.2.10.b **Module II** 4.7 5.1, 5.2 6.2.3 7.2 8.2 10.2.2 11.3
Sawing (Cut off)	Cut-off saw	Pre-determined cutting area	Concrete Asphalt Brick Limestone Granite Steel Hard stucco	**Module II** 4.8 5.1, 5.2 7.2 8.2 11.3

Technology	**Tools**	**Depth/Size***	**Materials**	**Module** Section(s)
Sawing (Diamond wire)	Diamond wire saw with 11 mm (~0.4 in.) in diameter wire (typically)	Depending on the cutting length, the width of the cut is about 15 to 20 mm (~0.6 to 0.8 in.) Plunge cutting is restricted to about 250 cm (~98 in.) in depth and 250 cm (~98 in.) distance between blind holes. Blind holes averaging 160 to 250 mm (~6 to 10 in.) are needed for plunge cuts in pavement	Reinforced concrete (large samples) Brick Hard stucco	**Module I** 2.2.10.c **Module II** 4.9 5.1, 5.2 11.3
Sawing (Cut off)	Cut-off saw	Pre-determined cutting area	Concrete Asphalt Brick Limestone Granite Steel Hard stucco	**Module II** 4.8 5.1, 5.2 7.2 8.2 11.3
Sawing (Diamond wire)	Diamond wire saw with 11 mm (~0.4 in.) in diameter wire (typically)	Depending on the cutting length, the width of the cut is about 15 to 20 mm (~0.6 to 0.8 in.) Plunge cutting is restricted to about 250 cm (~98 in.) in depth and 250 cm (~98 in.) distance between blind holes. Blind holes averaging 160 to 250 mm (~6 to 10 in.) are needed for plunge cuts in pavement	Reinforced concrete (large samples) Brick Hard stucco	**Module I** 2.2.10.c **Module II** 4.9 5.1, 5.2 11.3
Scabbling	Scabbler with 1 to 7 piston heads that strike and chip a concrete surface	3 mm (1/8 in.) material removal across the entire surface Removes up to 2.5-cm (1-in.) thick layers of contaminated concrete (including concrete block) and cement	Concrete (including concrete block) Cement Brick Polished granite Hard stucco	**Module I** 2.2.5 **Module II** 4.10 5.1, 5.2 8.1 11.3

Technology	**Tools**	**Depth/Size***	**Materials**	**Module** Section(s)
Shaving	Shaver	Large open areas (over 10 m^2 or 100 ft^2) with few obstructions Depth of shaving is set by a manual rotary wheel, and varies from 0.01 to 1.3 cm (0.004 to 0.5 in.) Large-area removal of thin concrete or cement layers on flat or slightly uneven surfaces	Concrete Cement Brick Granite Hard stucco	**Module I** 2.2.6 **Module II** 4.11 5.1, 5.2 8.2 11.3
Grinding	Grinder with ~13-cm (5-in.) diamond grinding wheel	Depth of grinding depends on the number of passes on a given flat or slightly curved surface	Concrete Brick Hard stucco	**Module I** 2.2.7 **Module II** 4.11 5.1, 5.2 11.3
Hydraulic/ Pneumatic Hammering	Hydraulic/Pneumatic Hammer	Areas where contamination has penetrated deeply into a surface	Concrete Brick Hard stucco	**Module I** 2.2.8 **Module II** 4.12 5.1, 5.2 11.3

* The Sample Collection Plan (SCP) may specify an alternate depth or sample sizes which take precedence over the information provided in this table.

APPENDIX D: Framework for Waste Management Plan Development for Waste Generated During Radiological Sampling of Building Materials and Infrastructure

APPENDIX – D Framework for Waste Management Plan Development for Water Generated During Radiological Sampling of Building Materials and Infrastructure

The purpose of this appendix is to provide a framework to assist incident commanders, project managers, state and local authorities, contractors, and enforcement divisions in developing and implementing an approach for the management of waste generated during building and infrastructure sampling activities after a contamination event. Information in this appendix can be used to develop a systematic and integrated methodology for the management of waste generated from as part of the overall radiological response. This appendix presents the key waste management considerations associated with sampling activities that should be addressed, prior to an incident if possible, and documented within a Waste Management Plan (WMP).

1.0 Background

During a radiological/nuclear incident, the waste generator is responsible for characterizing on-site waste, including waste that has been treated on-site. Most of the waste generated during the sample collection process, depending on the activity level of the radiological release, would likely be characterized as low level radioactive waste, and a smaller subset of the generated sampling process waste would be characterized as hazardous, non-hazardous, or mixed waste. The characterization of sampling activity waste is often driven by state requirements, both in the state of the incident as well as the state where the waste management facilities exist. It should be noted that states may have more restrictive requirements than the federal government for some of the waste streams, which is why it is so important to identify these within a WMP.

Coordinating the characterization of sampling activity waste with the overall response sampling activities for environmental and building material samples will save time, effort, and analysis costs, and reduces the burden on the radioanalytical laboratories. Laboratory capacity is expected to be exceeded in a wide-area release scenario, and laboratories are likely to prioritize analysis of samples for use in determining the extent of contamination and re-occupancy decisions over analysis of samples to characterize sampling activity waste. Coordinating sampling activity waste characterization with other sampling needs in the overall radiological response sampling and analysis plan (SAP) will help to address capacity issues.

At the time of publication of this document, there are only four commercial facilities in the United States that accept Low Level Radioactive Waste (LLRW), complicating the waste management decision making process. While there are some additional Resource Conservation Recovery Act (RCRA) Subtitle C (Hazardous Waste Facilities) that can handle mixed waste and potentially could handle some LLRW, it would require state, facility, and public acceptance as well as permit modifications to do so. Liquid LLRW is especially difficult and expensive to manage and therefore may require some solidification/ evaporation treatment prior to acceptance by a LLRW disposal facility. Finally, because of the limited waste management (WM) facilities for LLRW, and extensive transportation requirements associated with LLRW, transportation costs can become quite high and multiple methods of transportation may need to be considered (e.g., trucks, railways, etc.).

2.0 Waste Management Plans

Waste generation and management begin as soon as the response to a radiological or nuclear contamination incident is initiated. Since this waste is considered a potential source of contamination, proper sampling of waste generated during the sampling process, to characterize the waste for management and disposal, is essential. Personal Protective Equipment (PPE) and clothing, materials from sampling activities, and liquids from personnel and equipment decontamination activities associated with sampling collection activities could potentially be generated by first responders, crime scene investigators, and environmental and building material sampling personnel. Generation of these waste streams will continue throughout the response and recovery phases. Planning for waste management is critical to an effective response and can help eliminate double-handling of sampling activity waste and facilitate a smooth, timely, safe and efficient response. A WMP for waste generated due to environmental and building material sampling should be developed, either prior to or early in an event, that outlines the waste management requirements, procedures, strategies, and processes from the point of generating sampling waste to final deposition.

NOTE: Experience has shown that the development of a Pre-Incident WMP can improve waste management activities during an incident by addressing many of waste management decisions outside of the time sensitive activities and decisions that have to be made during the incident. An Incident Specific WMP can be developed using the Pre-Incident WMP to tailor the elements of that plan with the site and incident specific considerations as well as to integrate it with the other overall radiological response plans.

The WMP should address:

WM Strategies: Information regarding waste management strategies should focus on:

- Relevant federal, state and local WM regulations
- Identification of WM facilities to support disposal of waste generated from sampling activities
- Projections of the magnitude and types of potential wastes expected to be generated from sampling activities during the different phases of the incident
- Potential types of waste
  - ***Inorganic*** (solids: building material residue, used PPE, sampling equipment, supplies)
  - ***Organic*** (sampling supplies that are petroleum based)
  - ***Liquids*** (decontamination water, wastewaters from sampling activities)
  - ***Low Level Radiological Waste (LLRW)*** (any radioactive waste that does not belong in one of the following categories: [1] high-level waste, [2] spent nuclear fuel, [3] uranium and thorium mill tailings, and [4] transuranics)
  - ***Hazardous Materials*** (asbestos, PCBs, or other toxic industrial chemicals which may be combined with sampled building materials)
  - ***Mixed Waste*** (hazardous waste combined with LLRW that is generated during sampling activities)

WM oversight: Activities including health and safety, radiological exposure reduction, contamination control, and quality control/assurance should be discussed in general terms as they relate to the generation of sampling activity waste handling. On-site WM discussions should focus on:

- Waste segregation strategies (e.g., liquids, solids, clean, contaminated, mixed) and optimization strategies
- Minimization of sampling activity waste
- Waste characterization to meet the waste acceptance criteria associated with disposal of sampling activity waste at disposal facilities identified to support the overall response
- Physical and/or chemical assessment of the waste generated during sampling activities to determine whether the waste was successfully solidified or requires further treatment to facilitate packaging decisions, identify handling and processing requirements, and provide additional information related to the particular waste generated
- Reducing potential hazards which may be encountered during WM processes, such as treatment, characterization, packaging and labeling of the waste generated during sampling activities

Off-Site WM: Discussions of the disposal of potential sampling activity waste generated at off-site facilities which could be used to treat solid, liquid, or mixed radiological waste and disposal of laboratory sample waste after analysis.

Waste Transportation: Discussion of logistics related to moving waste generated from sampling activities from the contaminated site to an interim location or final facility for treatment and/or disposal. Since transportation of radiological waste is tightly regulated, the WMP should address:

- Coordination with State Radiation Protection and WM Officials involving the states in which the waste is generated, the states in which the waste will be transported through, and the states in which the facilities reside that will be accepting this waste
- Coordination with multiple federal agencies
- Coordination with the facilities that will be accepting the sampling activity waste

Tracking, Reporting, and Data/Records Management for Waste Management: Discussion of process to ensure proper and complete tracking of all sampling activity waste including:

- Sampling logs
- Chain of custody forms
- Disposal packages (including accumulation data, waste composition, volumes, weight, DOT or IATA hauler information)
- Worker training
- Audits and reviews of waste disposal activities
- WMP and associated procedures

APPENDIX E: Preservation of Rinsate Samples

APPENDIX – E Preservation of Rinsate Samples

According to EPA's *Manual for the Certification of Laboratories Analyzing Drinking Water*[6] , sample preservatives provided by the laboratory should be screened for radioactive content by lot number prior to their use in the laboratory, and the results documented. Rinsate samples preserved in the field, with reagents that are not provided by the laboratory, are to be accompanied by a radioactive free field blank sample that is preserved in the same manner as the submitted sample.

CAUTION: Refer to the Sample Collection Plan to determine the type of acid that should be used for sample preservation. There are several limitations to the type of acid used based upon the isotope of interest. Table E.1 lists acids that should be used for preservation of isotopes that are included in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery* (SAM) 2012.

WARNING: Concentrated and dilute acid solutions must be handled with caution, and appropriate personal protective equipment (PPE) should be worn. Nitric acid should not be allowed to dry on paper towels or absorbent materials at full strength. A fire may result. Ensure that any spills are properly cleaned up and that any spill on absorbent materials is properly processed prior to disposal. Refer to site safety personnel for proper disposal requirements.

If a sample requires preservation, perform these steps in a controlled designated area.

1. Ensure the area is set up for the addition of acid by performing the following:
    a. Clear the work area.
    b. Place a sufficient amount of absorbent material to cover the area, and secure it with duct tape.
    c. Ensure another person knows you are working with acid.

2. Open the sample container and the acid bottle.

3. Using a pipette or dropper, transfer approximately 8 mL of concentrated (12 M) hydrochloric acid (HCl) or 6 mL of concentrated (16 M) HNO_3 per liter of sample. (Adjust the amount added, as needed, for sample volumes other than one liter.)

4. Place the pipette or dropper in a secure location to prevent dripping, and close the acid and sample bottles.

5. Carefully agitate the sample, remove the lid, and check the pH with pH paper (recommended for contamination control) or a pH probe. Add additional acid as necessary to reach a sample pH of less than or equal to 2.
    a. DO NOT add more than 5 additional mL of concentrated acid.

[6] U.S. EPA. Manual for the Certification of Laboratories Analyzing Drinking Water. EPA 815-R-05-004. January 2005.

b. If the sample pH cannot be lowered sufficiently after the addition of an extra 5 mL of acid, close the sample container and record the information in the Field Logbook and on the Sample Label.
c. If pH paper is used, indicate less than 2, or best estimate if pH is not less than 2.

6. Once the sample pH is less than or equal to 2.0, close the sample container and note the following in the Field Logbook and on the sample label.
   - Acid added – Type, concentration, and volume
   - pH of the sample
   - Date and time of preservation
   - Initials of the person who added the acid

7. Package the sample per the requirements of Module I, Section 7.0.

8. Clean the area of materials, ensuring any drips or spills of acid are contained and processed per the requirements of Site Safety.

Table E.1: Acids for Preservation of Samples Collected for Measurement of Radioisotopes included in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery* (SAM) 2012.

Analyte	**Preservative**
Note: Preservation requirements taken from EPA's *Manual for the Certification of Laboratories Analyzing Drinking Water* (EPA 815-R-05-004).	
Gross Alpha	Concentrated HCl or HNO_3 to pH <2
Gross Beta	Concentrated HCl or HNO_3 to pH <2
Cesium-137 (Cs-137)	Concentrated HCl to pH <2
Iodine-131 (I-131)	Do not acidify
Radium-226 (Ra-226)	Concentrated HCl or HNO_3 to pH <2
Strontium-89 (Sr-89)	Concentrated HCl or HNO_3 to pH <2
Strontium-90 (Sr-90)	Concentrated HCl or HNO_3 to pH <2
Tritium (Hydrogen-3)	Do not acidify
Uranium-238 (U-238)	Concentrated HCl or HNO_3 to pH <2
Note: The following analytes are not included in EPA's *Manual for Certification of Laboratories Analyzing Drinking Water.* Preservation recommendations for these analytes are based on best professional judgment.	
Gamma	Concentrated HCl or HNO_3 to pH <2
Americium-241 (Am-241)	Concentrated HCl or HNO_3 to pH <2
Californium-252 (Cf-252)	Concentrated HCl or HNO_3 to pH <2
Cobalt-60 (Co-60)	Concentrated HCl or HNO_3 to pH <2
Curium-244 (Cm-244)	Concentrated HCl or HNO_3 to pH <2
Europium-154 (Eu-154)	Concentrated HCl or HNO_3 to pH <2
Iodine-125 (I-125)	Do not acidify
Iridium-192 (Ir-192)	Concentrated HCl or HNO_3 to pH <2
Molybdenum-99 (Mo-99)	Concentrated HCl or HNO_3 to pH <2
Phosphorus-32 (P-32)	Concentrated HCl or HNO_3 to pH <2
Plutonium-238 (Pu-238)	Concentrated HCl or HNO_3 to pH <2
Plutonium-239 (Pu-239)	Concentrated HCl or HNO_3 to pH <2
Polonium-210 (Po-210)	Concentrated HCl or HNO_3 to pH <2
Ruthenium-103 (Ru-103)	Concentrated HCl or HNO_3 to pH <2
Ruthenium-106 (Ru-106)	Concentrated HCl or HNO_3 to pH <2
Selenium-75 (Se-75)	Concentrated HCl or HNO_3 to pH <2
Technetium-99 (Tc-99)	Do not acidify
Total Activity Screening	Do not acidify
Uranium-234 (U-234)	Concentrated HCl or HNO_3 to pH <2
Uranium-235 (U-235)	Concentrated HCl or HNO_3 to pH <2

APPENDIX F: References

APPENDIX – F

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