



DISA Technologies, Inc.

SOP-01 Rev. 0

ALARA

Standard Operating Procedure

Approvals

Chief Executive Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

The purpose of this procedure is to define DISA Technologies, Inc.'s (DISA's) program for reducing exposures to ionizing radiation and radioactive material(s) to levels that are As Low As Reasonably Achievable (ALARA). DISA's policy is to maintain radiation exposure to DISA personnel and the general public to levels that are ALARA from the maximum limits specified in 10 CFR Part 20. DISA shall implement its ALARA policy by training personnel for radiation safety, implementing Standard Operating Procedures (SOPs), using appropriate control measures, Radiation Work Permits (RWPs), good housekeeping practices, administrative control limits, and radiation protection equipment as needed.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Alternate Radiation Safety Officer (ARSO) (RSO Equivalent)–

The RSO and ARSO responsibilities include:

- All appropriate project/site personnel are properly trained on ALARA principles.
- Radiological surveys are performed to provide current information on the radiological environment(s) to which personnel are potentially exposed, as needed.
- Areas that contain licensed material are properly posted.
- Appropriate personal protective equipment (PPE), dosimetry and radiological instrumentation, are prescribed, as needed.
- Radiation Work Permits (RWPs) are used for non-routine operations that has the potential to result in a significant radiological dose based on the radionuclide quantity, form, and work to be performed.
- Stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.2 Field Services Manager (FSM) –

The FSM responsibilities include:

- Support the RSO, ARSO, AU, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.

- Ensure personnel, resources, and support equipment necessary to ensure ALARA are available for project personnel by working with RSO and AU.
- Ensure that stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.3 Radiation Safety Technician (RST) (RSO Designee) –

The RST in the license and other supporting documents is referred to as the RSO Designee. This person's responsibilities include:

- Report to the RSO on all radiological matters. Where appropriate, report to the onsite management for support on implementation of the ALARA program.
- Perform radiological surveys to provide current information on the radiological environments(s) to which personnel are potentially exposed, as needed.
- Manage onsite PPE, dosimetry, and radiological instrumentation, as needed.
- Ensure proper recordkeeping, instrument calibrations, and maintenance.
- Post areas that contain licensed material.
- Ensure that stop work authority is maintained and encourage as necessary to ensure ALARA.

2.4 Authorized Users (AU) –

AU responsibilities include:

- Comply with the Radiation Protection Plan (RPP) and the Standard Operating Procedures (SOP).
- Attend training and briefings on radiation protection and RWPs.
- Comply with all notices, postings, procedures, and instructions from radiation safety staff.
- Properly use and wear all required PPE.
- Follow basic ALARA principles including time, distance, shielding, and contamination control.
- Obey "stop work" and "evacuate" instructions issued by RSO, ARSO, RST, another AU, or FSM.

- Wear and use monitoring devices as required by site procedures and instructions, postings, or the RSO, ARSO, or RST.
- Plan work ahead of performing work. Attempt to minimize exposures, as necessary.
- Leave Radiation Areas or Airborne Radioactivity Areas when not actively working. Use staging or "wait areas", when designated.
- DO NOT eat, drink, or smoke in restricted areas. One-time use water bottles may be used to stay hydrated.
- Perform a personnel scan for contamination when leaving any Restricted Area.
- Report known/potential radiologically unsafe or noncompliance situations to the RSO or ARSO.
- Report prior or concurrent occupational radiation exposures to the RSO.
- Maintain good housekeeping practices to minimize the spread of radiological contamination.
- Exercise stop-work authority and discuss immediately with RSO, ARSO, or RST any circumstance or condition that you believe is contrary the principles of ALARA.

3. PROCEDURE

- Prepare and execute Work Plans, SOPs, and RWPs with consideration for the ALARA concept.
- Establish radiological controls and monitoring requirements in Work Plans, SOPs, and RWPs.
- Make available sufficient PPE, dosimetry, and radiological instrumentation to support the ALARA program.
 - Respirators will help protect from inhalation hazards.
 - Protective clothing helps keep radioactive material off skin and hair.
 - Alarming dosimeters (a personal radiation detector) help manage stay time and track your accumulated doses in an area with elevated radiation levels.
- Develop and maintain a personnel radiation exposure monitoring program.
- Senior DISA management shall maintain a formal policy and commitment to ALARA. This policy will be attached to the RPP.
- When managing doses to workers and the public remember time, distance, and shielding.

- "Time" refers to the amount of time you spend near a radioactive source. Minimize your time near a radioactive source to only what it takes to get the job done. If you are in an area where radiation levels are elevated:
 - Complete your work as quickly as possible.
 - Leave the area.
 - There is no reason to spend more time around the radioactive source than necessary. Example: Imagine spending the day at the beach. If you stay in the sun the entire day, you will likely get sunburned. If you are there for just a short period of time, you are less likely to get sunburned. The amount of time you are there makes a difference.
- "Distance" refers to how close you are to a radioactive source. Maximize your distance from a radioactive source as much as you can. If you increase your distance, you decrease your dose. Example: Imagine sitting very close to a fireplace. You can feel the heat and may even be uncomfortable. If you go to the other side of the room, you would be more comfortable. So as you move away, the intensity decreases.
- To shield yourself from a radiation source, you need to put something between you and the radiation source. The most effective shielding will depend on what kind of radiation the source is emitting. Some radionuclides emit more than one kind of radiation. Depending on the type of radiation something as simple as a sheet of paper may shield you. Other types may require a few inches of lead or another dense substance.
- Hazard Mitigation – When addressing doses to workers or the public, radiological hazards should be addressed using the hierarchy of hazard mitigation steps: Elimination, Substitution, Engineering Controls, Administrative Controls, PPE.
- PPE should always be the method of last resort when addressing hazards.
- Engineering Controls – DISA should use engineering controls to maintain occupational radiation doses (and doses to the public) ALARA is applied after determining that radiation dose will not exceed applicable regulatory dose limits. To the greatest extent possible, administrative controls should not be used as substitutes for engineering controls. Engineering controls, in some cases, may be incorporated into facility design. Some examples of engineering controls are

discussed below, including shielding and interlock systems. In addition, radioactive material containment is sometimes incorporated into shielding, such as in gamma cameras used for nuclear medicine or industrial radiography devices containing a radioactive source.

- Administrative Controls - Administrative controls generally supplement engineering controls. Examples of administrative controls include signage, warning systems, and written operating procedures to prevent, reduce, or eliminate radiation exposure. Operating procedures typically include both normal operating procedures and emergency procedures (i.e., those for spills, leaks, and emergency evacuation). Designating radiation areas is another type of administrative control.
 - Controlled Area: Controlled area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.
 - Radiation Area: Radiation area means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
 - High Radiation Area: High radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates.
 - Very High Radiation Area: Very high radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in 1 hour at 1 meter from a radiation source or 1 meter from any surface that the radiation penetrates.

4. REFERENCES

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- 4.1 Radiation Protection Program (RPP)
 - 4.2 SOP-05 Radiological Access and Posting
 - 4.3 SOP-06 Contamination Surveys and Decontamination



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- 4.4** SOP-12 Contamination Surveys, Removable Swipes, Air Filter Samples
- 4.5** SOP-14 Radiation Safety Training



DISA Technologies, Inc.

SOP-02 Rev. 0

Operational Checkout of Single-Channel Detector with Meter Standard Operating Procedure

Approvals

Chief Operating Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

To provide a method for the operational checkout, or “function check”, of a single-channel meter and detector pair to ensure proper working condition of the instruments.

2. DISCUSSION

A radiological survey detector (detector) is paired with a compatible radiological survey meter (meter) to measure radiation in an integrated scaler count and/or count rate modes. This standard operating procedure (SOP) is specific to single-channel detectors compatible for use with a meter. In some cases, the detector and meter may be contained in a single housing. For this SOP, the detector and meter combination will be referred to as the detector only.

During the operational check-out process (function check), the detector is also inspected for any physical damage that might affect functionality, such as a cracked housing. Calibration of any survey detector is required prior to initial use, at least annually, and after any scheduled or unscheduled maintenance or repair that may affect instrument operation. Initial quality control (QC) source counts are made to established acceptable, baseline, instrument operating ranges (control limits). The detector response is compared against the control limits daily to identify if the instrument is working properly and consistently.

3. PROCEDURE

3.1 Equipment

- Radiological survey detector –
Ludlum Model 19, Ludlum Model 43-5, Ludlum Model 44-9, Ludlum Model 44-10 detector, Ludlum Model 44-20 detector, or similar.
- Calibrated meter –
Ludlum Model 12, Ludlum Model 2221, Ludlum Model 2241, or similar.
- Radiological check sources –
 - For typical function check of an alpha detector, use a thorium-230 (Th-230) source.
 - For typical beta detector function check, use a technetium-99 (Tc-99) or strontium/yttrium-90 (Sr/Y-90) source.
 - For typical function check of a high-energy gamma detector, use a cesium-137 (Cs-137) source.

- For low-energy gamma detector, such as a FIDLER, use an americium-241 (Am-241) source.

Check sources used are dependent upon the goal of the survey. While the sources listed above are for typical function checks, they are not definitive.

- Calibration jig – Used to ensure consistent detector position relative to check source (geometry).
- C-cable – Used to connect detector and meter.
- Forms – SOP-02A *Single-Channel Function Check Log Form* and SOP-02B *Single-Channel QC Counts Form*, as needed.

3.2 Documentation – A function check log form (Form SOP-02A) must be created and maintained for each individual detector. The detector should be function checked before each day of use. The function check log form must be retained.

3.3 Initial Quality Control Counts – This section may be skipped if initial QC counts are determined to be unnecessary or already completed. This process is to identify initial detector response when first used on a project site, and to assist with identifying if a detector response changes over time while in use. If daily function check net counts are found to be within control limit range, the initial detector total efficiency and minimum detectable activity (MDA), where applicable, may be used.

- Fill in the meter, detector, source, and comments information on the SOP-02B *Single-Channel QC Counts Form*.
- SOURCE COUNTS – Place the source on to the calibration jig and place the detector in proper orientation. If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Record each measurement result on the QC log form.
- BACKGROUND COUNTS – Place the detector in proper orientation and position onto a clean calibration jig, where applicable. If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Record each background count on QC log form.
- NET COUNTS – For each set of counts calculate the net count (source count minus background count) and record on QC log form. Average the ten net counts and record on the QC log form in the appropriate location.
- ACCEPTABLE UPPER/LOWER NET COUNT RANGE – The upper and lower tolerances are 120-percent of and 80-percent of the ten net-count average value, respectively. Calculate these values and record in the appropriate location on the QC log form.

- INSTRUMENT EFFICIENCY – *NOTE: If using a non-NIST traceable source for function check then detector efficiency may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only, calculate the total efficiency for the detector using the average net count and source emission rate for the specific source used, then record efficiency in the appropriate location on the form. To calculate alpha and beta efficiencies use the following ISO 7503-1 (NUREG 1575/MARSSIM) equation:

$$E_t = e_i + e_s$$

Where:

- E_t = Total efficiency (cpm/epm)
 - e_i = Instrument efficiency, where efficiency is calculated as the net detector response (cpm) divided by the check source surface emission rate (cpm). *NOTE: The surface emission rate is not the total activity rate (dpm).*
 - e_s = Source efficiency factor, where for alpha = 0.25, low energy beta (< 400 KeV) = 0.25, and high energy beta (> 400 KeV) = 0.50.
- MINIMUM DETECTABLE ACTIVITY (MDA) – *NOTE: If using a non-NIST traceable source for function check then MDA may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only with a scaler (timed counting) meter, calculate the MDA using the following equation:

$$MDA = \frac{2.71 + 3.29 \sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$$

Where:

- MDA = minimum detectable activity with 95% confidence (dpm/100 cm²)
- $C_{background}$ = Counts from background in time, t (counts)
- t_{sample} = Sample counting time (minutes)
- $t_{background}$ = Background counting time (minutes)
- E_t = Total efficiency (cpm/epm)

3.4 Daily Function Check – Not all meters and detectors have the same features or function check needs. When unsure, check the manufacturer’s Technical Manual for confirmation and/or assistance.

- If not already done, fill in the meter, detector, source, and comment information on the function check log form SOP-02A *Single-Channel Function Check Log*. If initial QC counts have been performed, review form SOP-02B *Single-Channel QC Counts Form* associated with the detector to find and record the upper and lower acceptable net count rates (control limits), detector total efficiency, and detector MDA, as needed. If not applicable for the detector type, then record “N/A”.
- PHYSICAL INSPECTION – Check the meter, detector, and cable for any visible damage. If damage is present then repair, or tag and remove from service. Check the meter calibration date and confirm meter and detector are in calibration. If not in calibration, then remove from service until it has been calibrated.
- TURN ON – Connect the detector and meter using the C-cable, then turn the instrument power on.
- BATT CHECK – Turn the instrument to the BATT position. Note the condition of battery as indicated by display. If the battery power is marginal (as indicated by the needle below the BATT OK level on analog meter face, below 4.4 on Ludlum Model 2221, or when battery indicator appears on Ludlum Model 2241), the batteries should be replaced. If battery level is acceptable then indicate on the function check log form with a check mark in the Battery Condition box.
- HV CHECK – Toggle the RESET/TEST HV switch or press the HV button and check the meter operating high voltage (HV). If the HV is within $\pm 25V$ of the recommended operating HV, as found on the detector calibration certificate paperwork and calibration sticker, then record on the function check log form. If not, adjust HV accordingly, or tag and remove from service.
- SOURCE COUNT – Place the source on to the calibration jig and place the detector in proper geometry and orientation. If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Upon completion, record the source counts onto the function check log form.

- BACKGROUND COUNT – Place the detector in proper orientation and position onto a clean calibration jig (where applicable). If using a scaler meter, begin a one-minute count. If using a ratemeter, let value stabilize. Upon completion, record the background counts onto the function check log form.
- NET COUNTS – If the net count result is acceptable (within upper/lower control limit range), then the individual performing the function check should record their initials in the appropriate box on the function check form upon completion of the function check. If the net count result is not acceptable, then repeat counts.

NOTE: If the net results are not within control limit range, then confirm you are using the correct detector-to- jig geometry and perform a repeat count. If the second count is also outside of control limit range, remove detector from service until issue can be resolved. Notify/consult with the Field Services Manager and/or Radiation Safety Officer.

4. REFERENCES

- 4.1 Manufacturer’s Technical Manuals for the meter and detector being checked. NOTE: Ludlum Technical manuals are also available on their webpage; <http://www.ludlums.com>
- 4.2 ANSI N323A-1997, American National Standard Radiation Protection Instrumentation Test and Calibration
- 4.3 ISO 7503-1:2016 Measurement of Radioactivity – ANSI
- 4.4 NUREG 1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

5. ATTACHMENTS

- 5.1 Form SOP-02A – Single-Channel Function Check Log
- 5.2 Form SOP-02B – Single-Channel QC Counts Form



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ATTACHMENTS

Single-Channel Function Check Log

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Comments:
<i>Scaler Count Time:</i>
<i>Distance To Source:</i>

Source: _____ Serial No.: _____ Activity: _____ uCi
 Emission Rate: _____ cpm/emissions Source Date: _____

NOTE: For use as needed. Acceptable upper/lower net counts, detector total efficiency, and detector MDA calculated on Form SOP-02B .

Acceptable Upper Net Counts:		Total Efficiency (E _t):	
Acceptable Lower Net Counts:		MDA (dpm/100-cm ²):	

Date	Time	Battery	High Voltage	Threshold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):

Reviewed by: _____

Review Date: _____

Single-Channel QC Counts Form

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Source: _____ Activity : _____ μCi Source Date: _____
 Serial No.: _____ Emission Rate: _____ cpm/emissions Dist. to Source: _____

Observation	Gross Source Counts (cpm)	Background Counts (cpm)	Net Counts (cpm)	Comments:
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average Net Count Rate(s)				
Upper Acceptable Net Count Rate (Average + 20%)				
Lower Acceptable Net Count Rate (Average - 20%)				

NOTE: For Alpha and Beta Detector only. No efficiency or MDA calculation for Gamma Detectors.

Total Efficiency $E_t = e_i \times e_s$	
$MDA = \frac{2.71 + 3.29 \sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$	

Performed by: _____

Date: _____

Reviewed by: _____

Date: _____

Single-Channel Function Check Log

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Comments:
<i>Scaler Count Time:</i>
<i>Distance To Source:</i>

Source: _____ Serial No.: _____ Activity: _____ uCi
 Emission Rate: _____ cpm/emissions Source Date: _____

NOTE: For use as needed. Acceptable upper/lower net counts, detector total efficiency, and detector MDA calculated on Form SOP-02B.

Acceptable Upper Net Counts:	<input style="width: 90%;" type="text"/>	Total Efficiency (E _t):	<input style="width: 90%;" type="text"/>
Acceptable Lower Net Counts:	<input style="width: 90%;" type="text"/>	MDA (dpm/100-cm ²):	<input style="width: 90%;" type="text"/>

Date	Time	Battery	High Voltage	Threshold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):

Reviewed by: _____

Review Date: _____

Single-Channel QC Counts Form

METER	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

DETECTOR	
Manufacturer:	
Model:	
Serial No.:	
Cal. Due Date:	

Source: _____ Activity : _____ μCi Source Date: _____
 Serial No.: _____ Emission Rate: _____ cpm/emissions Dist. to Source: _____

Observation	Gross Source Counts (cpm)	Background Counts (cpm)	Net Counts (cpm)	Comments:
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Average Net Count Rate(s)				
Upper Acceptable Net Count Rate (Average + 20%)				
Lower Acceptable Net Count Rate (Average - 20%)				

NOTE: For Alpha and Beta Detector only. No efficiency or MDA calculation for Gamma Detectors.

Total Efficiency $E_t = e_i \times e_s$	
$MDA = \frac{2.71 + 3.29 \sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$	

Performed by: _____

Date: _____

Reviewed by: _____

Date: _____

1. PURPOSE

To provide a method for the operational checkout, or “function check” of a dual-channel alpha/beta meter and detector pair to ensure proper working condition of the instruments.

2. DISCUSSION

A radiological survey detector (detector) is used with a compatible radiological survey meter (meter) to measure radiation in integrated scaler count and/or rate modes. This standard operating procedure (SOP) is specific to dual-channel alpha/beta detectors compatible for use with a dual-channel meter. A dual-channel meter counts alpha detections in one channel and the beta detections in another channel. In some cases, the detector and meter may be contained in a single housing. For this SOP, the detector and meter combination will be referred to as the detector only.

During the operational check-out process (function check), the detector is also inspected for any physical damage that might affect functionality, such as punctured mylar or cracked housing. An aluminized mylar window covering (mylar) is used to eliminate light from entering the detector window. If this mylar is punctured, even slightly, it may return inaccurately readings. Repair or replace mylar windows, as necessary, noting the repair/replacement on the Form SOP-03A *Dual-Channel Function Check Log Form*.

Calibration of any survey detector is required prior to initial use, at least annually, and after any scheduled or unscheduled maintenance or repair that may affect instrument operation. Initial quality control (QC) source counts are made to established acceptable, baseline, instrument operating ranges (control limits). The detector response is compared against the control limits daily to identify if the instrument is working properly and consistently.

3. PROCEDURE

3.1 Equipment – The necessary components to function check a radiological survey detector.

- Radiological survey detector –
Ludlum Model 43-93 detector (zinc sulfide + plastic, alpha/beta), Ludlum Model 43-10-1 tray counter, or similar.
- Calibrated dual-channel meter –
Ludlum Model 2360, Ludlum Model 2929, or similar.

- Radiological check sources –
 - For typical function check of an alpha detector, use a thorium-230 (Th-230) source.
 - For typical beta detector function check, use a technetium-99 (Tc-99) or strontium/yttrium-90 (Sr/Y-90) source.

Check sources used are dependent upon the goal of the survey. While the sources listed above are for typical calibrations, they are not definitive.

- Calibration jig – Used to ensure consistent detector position relative to check source (geometry).

NOTE: For tray counter calibration and checkout a calibration jig is not necessary and any reference to one in the steps below may be disregarded.

- C-cable to connect detector and meter.
- Form SOP-03A *Dual-Channel Function Check Log Form* and SOP-03B *Dual-Channel QC Counts Form*, as needed.

3.2 Documentation – A function check log form (Form SOP-03A) must be created and maintained for each individual detector. The detector should be function checked before each day of use. The function check log form must be retained.

3.3 Initial Quality Control Counts – This section may be skipped if initial QC counts are determined to be unnecessary or already completed. This process is to identify initial detector response when first used on a project, and to assist with identifying if a detector response changes over time while in use. If daily function check net counts are found to be within control limit range, the initial detector total efficiencies and minimum detectable activities (MDA), where applicable, may be used.

- Fill in the meter, detector, source, and comments information on the SOP-03B *Dual-Channel QC Counts Form*.
- SOURCE COUNTS – Place the source on to the calibration jig and place the detector in proper orientation. Make ten alpha source count measurements and ten beta source count measurements. Record the α Alpha channel and β Beta channel measurement results on the QC log form in the appropriate channel boxes.

- BACKGROUND COUNTS – Place the detector in proper orientation and position onto a clean calibration jig, where applicable. Record both the alpha and beta channel background counts on QC log form.
- NET COUNTS – For each set of counts alpha and beta channel counts, calculate the net count (source count minus background count) and record on QC log form. Average the ten net counts for each channel and record on the QC log form in the appropriate location.
- ACCEPTABLE UPPER/LOWER NET COUNT RANGE – The upper and lower tolerances are 120-percent of and 80-percent of the ten net-count average value for each channel, respectively. Calculate these values and record in the appropriate location on the QC log form.
- INSTRUMENT EFFICIENCY – *NOTE: If using a non-NIST traceable source for function check then detector efficiency may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only, calculate the total efficiency for the detector using the average net count and source emission rate for the specific source used, then record efficiency in the appropriate location on the QC log form. To calculate alpha and beta efficiencies use the following ISO 7503-1 (NUREG 1575/MARSSIM) equation:

$$E_t = e_i \times e_s$$

Where:

- E_t = Total efficiency (cpm/epm)
- e_i = Instrument efficiency, where efficiency is calculated as the net detector response (cpm) divided by the check source surface emission rate (cpm). *NOTE:* The surface emission rate is not the total activity rate (dpm).
- e_s = Source efficiency factor, where for alpha = 0.25, low energy beta (< 400 KeV) = 0.25, and high energy beta (> 400 KeV) = 0.50.
- MINIMUM DETECTABLE ACTIVITY (MDA) – *NOTE: If using a non-NIST traceable source for function check then MDA may be calculated using the data from the instrument calibration paperwork.* For alpha and beta detectors only with a scaler (timed counting) meter calculate the MDA using the following equation:

$$MDA = \frac{2.71 + 3.29 \sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{Equation\ 3-1.}{t_{background}}\right)}}{t_{sample} \times E_t}$$

Where:

- MDA = minimum detectable activity with 95% confidence (dpm/100 cm²)
- C_{background} = Counts from background in time t (c)
- t_{sample} = Sample counting time (minutes)
- t_{background} = Background counting time (minutes)
- E_t = Total efficiency (cpm/epm)

3.4 Function Check – Not all meters and detectors have the same features or function check needs. When unsure check the manufacturer’s Technical Manual for confirmation and/or assistance.

- If not already done, fill in the meter, detector, source, and comments information on the function check log form SOP-03A *Dual-Channel Function Check Log*. If initial QC counts have been performed, review form SOP-03B *Dual-Channel QC Counts Form* associated with the detector to find and record the upper and lower acceptable net count rates (control limits) for both alpha and beta channels, detector total efficiencies, and detector MDAs, as needed. If not applicable for the detector type, then record “N/A”.
- PHYSICAL INSPECTION – Check the meter, detector, and cable for any visible damage. If damage is present then repair, or tag and remove from service.
- TURN ON – Connect the detector and meter using the C-cable, then turn the instrument power on.
- BATT CHECK – Turn the instrument to the BATT position. Note condition of battery as indicated by display. If the battery power is marginal (as indicated by the needle below the BATT OK level on analog meter face), the batteries should be replaced. If battery power is acceptable then indicate on the function check form with a check mark in the Battery Condition box. *NOTE: For instruments that are AC powered this step may be ignored and an “N/A” recorded in Battery Condition box.*

- HV CHECK – Toggle the RESET/TEST HV switch and check the meter operating high voltage (HV). If the HV is within $\pm 25V$ of the recommended operating HV as found on the detector calibration paperwork and calibration sticker then record on the function check form. If not, then adjust accordingly or tag and remove from service.
- ALPHA SOURCE COUNT – Place the alpha source on to the calibration jig or in tray, place the detector in proper orientation and position over the source or close and lock tray, and begin a one-minute count. Upon completion record the alpha and beta channel counts for the alpha source onto the function check form.
- BETA SOURCE COUNT – Place the beta source on to calibration jig or in tray, place the detector in proper orientation and position over the source or close and lock tray, and begin a one-minute count. Upon completion record the alpha and beta channel counts for the beta source onto the function check form.
- BACKGROUND COUNT – Place the detector in proper orientation and position onto a clean calibration jig (where applicable) and begin a one-minute count. Upon completion record the alpha and beta channel background counts onto the function check form.
- NET COUNTS – The net alpha channel counts are equal to the alpha source alpha channel (α Alpha) counts less the background alpha channel counts. The net beta channel counts are equal to the beta source beta channel (β Beta) counts less the background beta channel counts. If the net count results are acceptable (within upper/lower control limit range) for both channels, then the individual performing the function check should record their initials in the appropriate box on the function check form upon. If the net count results are not acceptable then repeat counts.

NOTE: If the net results are not within control limit range, then confirm you are using the correct detector-to-jig geometry and perform a repeat count. If the second count is also out of control limit range, remove detector from service until issue can be resolved and notify/consult with the Field Services Manager and/or Radiation Safety Officer.

4. REFERENCES

- 4.1** Manufacturer's Technical Manuals for the meter and detector being checked. NOTE: Ludlum Technical manuals are also available on their webpage; <http://www.ludlums.com>

- 4.2** ANSI N323A-1997, American National Standard Radiation Protection Instrumentation Test and Calibration
- 4.3** ISO 7503-1:2016 Measurement of Radioactivity – ANSI
- 4.4** NUREG 1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)

5. ATTACHMENTS

- 5.1** Form SOP-03A – Dual-Channel Function Check Log
- 5.2** Form SOP-03B – Dual-Channel QC Counts Form



Disa Technologies, Inc.

SOP-04 Rev. 0
Guidelines for Handling Radioactive
Material
Standard Operating Procedure

Approvals

Chief Executive Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

The purpose of this procedure is to offer general radiation protection and exposure limiting guidelines when personnel are handling radioactive materials. Work may be performed under additional standard operating procedures during specific activities to control exposures and prevent the spread of radiological contamination.

Radioactive materials must be handled or used in a manner as to prevent radiation exposure greater than regulatory authority limits. Additionally, all workers must attempt at all times to keep personnel exposures within project established administrative limits and As Low As Reasonably Achievable (ALARA), regardless of the regulatory upper limits

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent) –

- All appropriate project/site personnel are properly trained on ALARA principles, as related to handling of radioactive materials.
- Radiological surveys are performed to provide current information on the radiological environment(s) to which personnel are potentially exposed, as needed.
- Appropriate tools and personal protective equipment (PPE), dosimetry and radiological instrumentation are provided, as needed.

2.2 Field Services Manager (FSM) –

- Support the RSO, AU, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.

2.3 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is referred in licensing documents as the RSO designee. References to the RST include references to the RSO designee.
- Report to the RSO and FSM on all radiological matters, where appropriate.
- Perform radiological surveys to provide current information on the radiological environments(s) to which personnel are potentially exposed, as needed.
- Manage onsite PPE, dosimetry, and radiological instrumentation, as needed, and ensure proper recordkeeping, instrument calibrations, and maintenance.

- Properly handle radioactive materials, per guidelines of this procedure.

2.4 Authorized Users (AU) –

- Attend training and briefings on radiation protection and RWPs.
- Properly use, wear, and don/doff all PPE.
- Not handle radioactive material unless trained to properly do so, per guidelines of this procedure.

3. PROCEDURE

3.1 Handling of Sealed Sources and Radiation Producing Devices – Sealed sources and radiation producing devices are external sources of radiation. External radiation dose must be kept ALARA. The following ALARA principles of time, distance, and shielding shall be applied. In addition:

- Take care not to subject the source(s) to physical or thermal shock greater than source design specifications.
- For higher activity sources (i.e., greater than 100 μCi beta/gamma or 10 μCi alpha):
 - Consider handling with tweezers, tongs, or handling tool.
 - When practical, hold the source at arm's length to increase distance from the body, and avoid having the source come in contact with any part of the body.

3.2 Handling of Unsealed Sources - Radioactive materials in any readily dispersible form shall be considered unsealed sources. Unsealed sources present additional potential problems of contamination and human internal intake by adsorption, oral ingestion, and/or inhalation that are not usually present with sealed sources. The following safety precautions shall be followed when working with unsealed sources:

- Do not eat, drink, or use tobacco/vape in area containing unsealed sources.
- Store and transport unsealed sources in such a manner as to prevent spillage or dispersal, and use spill containment, such as trays or secondary containment, whenever possible.
- Wear proper PPE as prescribed by the RSO. PPE could include protective gloves, protective coveralls, booties, respiratory equipment, safety glasses, and/or face shields.
- After working with unsealed sources perform a personnel contamination survey with appropriate radiological survey instrumentation, and wash hands and arms before handling any object that goes to the mouth, eyes, or nose.

- When in doubt of radiological hazards, consult the RSO, ARSO, or RST.

3.3 Guidelines for Control of Contamination – Cleanliness and orderliness are two of the most important methods of minimizing contamination.

- Keep the work area neat and clean, free from equipment and materials not necessary in the operation.
- Spill containment should be used whenever possible when working with unsealed radioactive materials.
- If contamination is suspected contact the RSO, AU, or RST who will survey the area and persons involved to determine the degree of contamination and to institute proper cleanup and decontamination procedures.
- Material and equipment that come in contact with unsealed sources should be kept separate from other uncontaminated equipment. Once equipment and tools are used with radioactive substances, they should be marked appropriately, temporarily stored in controlled access areas limited for radiological use only. Only after a survey to demonstrate that the tools and equipment are free from contamination shall it be allowed for unrestricted use.
- Periodic area radiation surveys and or area removable contamination surveys shall be conducted as specified by the RSO or AU.

3.4 Storage and Shipment of Radioactive Materials – Radioactive materials that are under the jurisdiction of the US NRC, or Agreement State regulatory authority shall be stored and/or shipped in such a manner as to minimize radiation exposure.

- Containers in which radioactive materials are stored shall be properly labeled in accordance with 10 CFR Part 71, 49 CFR Parts 170 to 177, or other appropriate regulatory labeling requirements.
- Radioactive gases or materials with radioactive gaseous daughters should be stored in gas-tight containers and should be kept in areas with good ventilation.
- Unsealed sources should be stored in such a manner as to contain the material in case of spillage or breakage. Radioactive materials that are stored in unrestricted areas shall be secured from unauthorized access and removal (e.g., awaiting pickup for transportation).

- Radioactive materials to be shipped or transported on public highways shall comply with NRC and US DOT shipping regulations. All personnel shipping radioactive material (Class 7) will be trained in accordance with US DOT regulations. Other procedures may further detail the receipt and shipment of radioactive material.
- The RSO or ARSO shall be informed prior to any shipment, transport, or transfer of radioactive material, and will be notified immediately of receipt of receipt of radioactive material.

3.5 Waste Disposal – Any wastes must be controlled for the safety of personnel and the general public in the same manner as other radioactive materials. Classification and disposal of waste must conform to Federal and State regulations.

- Each project creating radioactive waste shall have properly labelled containers for solid and liquid radioactive wastes, as necessary.
- A record of all waste shall be kept by the RSO, ARSO, or RST indicating, as completely as practicable, contents, radionuclide identity and quantity and the principal chemical and physical form. A record of all radioactive waste disposal shall be retained.

4. REFERENCES

4.1 Radiation Protection Program (RPP)

1. PURPOSE

The purpose of this procedure is to provide instruction on controlling access to and posting of radiological area(s) and licensed radioactive materials.

Adherence to this procedure will provide reasonable assurance that licensed material will remain secure at all times, contamination of personnel will be minimized, contamination spread will be minimized beyond the designated controlled areas, and personnel exposures will be As Low As Reasonably Achievable (ALARA).

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) (RSO Equivalent)–

- Radiological areas are identified.
- Necessary access controls of radiological areas are established.
- Appropriate postings (radiation, airborne, contamination, etc.) are in place.
- Exposure monitoring of personnel working within a radiological area is performed, as necessary.

2.2 Field Services Manager –

- Support the RSO, ARSO, AUs, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.

2.3 Radiation Safety Technician (RST)(RSO Designee) –

- The RST in licensing documents is referred to as the RSO Designee. References to the RST include references to the RSO designee.
- Report to the RSO and PM on all radiological matters and the onsite management and implementation of the ALARA program.
- Establish and maintain necessary access controls and posting of radiological areas.
- Monitor for exposure, as necessary, or as directed by RSO or ARSO.

2.4 Authorized Users (AU) –

- Attend training and briefings on radiation protection.

- Comply with all radiological restricted area access controls (barricades, barriers, and gates) and postings.
- Not enter radiological areas unless trained properly to do so.

3. PROCEDURE

NOTE: Access control prevention measures shall NOT be installed at radiological restricted area exits that would prevent rapid evacuation of personnel under emergency conditions.

3.1 General Access Controls – Personnel entry shall be controlled at project sites and to specific radiologically controlled or restricted areas.

- The degree of access control shall be commensurate with the existing and potential radiological hazards within the area. One or more of the following methods shall be used to ensure entry control at access points to licensed radiological areas:
 - Signs and barricades.
 - Control devices on entrances.
 - Conspicuous visual and/or audible alarms.
 - Locked entrance.
 - Additional controls, as approved by the RSO, ARSO, or AU and specified in a radiological work permit (RWP) or other existing approved technical work document.
- Personnel dosimetry may be required for entry.
- When posting is required, a sign shall be placed on each entrance door or fenced area. If the area to be posted is not a room or fenced area, the area containing the licensed material shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable devices and signs shall be displayed in all accessible directions.
- RWP's shall be implemented, as needed, to specify radiological protection and monitoring measures commensurate with existing and potential hazards.

3.2 Controlled Areas – A Controlled Area is an area outside of a restricted area but within the site boundary, to which the licensee can limit access for any reason.

- Controlled Areas shall have signs conspicuously posted at each access point.

- Entry into these areas is limited to those personnel who have met the site training requirements; who have had site-specific training; who have met any special requirements as specified by license designated RSO; and who have a need to enter.
- Access shall be documented using the SOP-04-A - *Controlled Area Access Log Form*, or similar.
- Visitors may be escorted into a Controlled Area by someone who meets all Controlled Area access requirements.

3.3 Restricted Areas – A restricted area is an area where radioactive materials are used, handled, or stored. Restricted areas will encompass all equipment that will be used to perform the licensed activities and will be large enough to prevent unnecessary doses to members of the public. Restricted areas are created to keep doses to workers outside the restricted to at or below 2 mrem/hr.

- Any area or room in which there is used or stored an amount of licensed material exceeding 10 times of the quantity of such material specified in Appendix B to 10 CFR Part 20 shall be identified and posted with a sign that indicates “CAUTION RADIOACTIVE MATERIALS AREA” or “DANGER, RADIOACTIVE MATERIALS”.
- Entry into a restricted area is limited to those personnel who:
 - Have met the training requirements,
 - Have met any special requirements as specified by the RSO,
 - Have a need to enter.
- Entry into a specifically posted restricted area (e.g., Radiation/High Radiation/Very High Radiation Area, Contamination/High Contamination Area and/or Airborne Radiation Area) is limited to those personnel who have read and signed an approved RWP for the area.
- Restricted areas will have designated access/egress locations. All access/egress locations will be equipped with alpha radiation meters to be used for personal contamination surveys.

3.4 Radiation, High Radiation, and Very High Radiation Areas

- RADIATION AREA (RA) is any area with radiation levels greater than 5 millirem (0.05 millisievert) in one hour at 30 centimeters from the source or from any surface through

which the radiation penetrates. *NOTE: A calibrated dose/exposure rate meter may be used to identify the boundary location of the 5 mrem/hr dose rate.*

- Any area accessible to personnel in which there exists ionizing radiation at dose rate levels such that an individual could receive a deep dose equivalent in excess of 5 mrem in 1 hour at 30 cm from the source or from any surface that the radiation penetrates shall be identified and posted with a sign that indicates “CAUTION RADIATION AREA”.
- If an entire room or most of the room is at or above the 5 mrem/hr level, a sign should be placed on each entrance door to the room.
- If the area to be posted is not a room, the area at or above the 5 mrem/hr level shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable device and signs shall be displayed in all accessible directions.
- An exemption to this posting requirement is allowed in areas or rooms containing radioactive materials for periods less than 8 hours, if both the materials are constantly attended to during these periods by an individual who takes the precautions necessary to prevent the exposure to radiation or radioactive materials in excess of the limits specified in the Radiation Protection Program, and the area or room is subject to the licensee’s control.
- Radiation areas will have designated access/egress locations. All access/egress locations will be equipped with alpha radiation meters to be used for personal contamination surveys.
- HIGH RADIATION AREA (HRA) is any area with dose rates greater than 100 millirems (1 millisievert) in one hour at 30 centimeters from the source or from any surface through which the ionizing radiation penetrates. A Very High Radiation Area (VHRA) is an area accessible to individuals, in which radiation levels exceed 500 rad (5 gray) in one hour at one meter from the source or from any surface that the radiation penetrates.

NOTE: It is not anticipated that Disa will ever work in an HRA or VHRA, it is important that Disa personnel be familiar with the HRA and VHRA designation.

- High and very high radiation areas shall be identified and posted with a sign that indicates “CAUTION, HIGH RADIATION AREA” or “DANGER, HIGH RADIATION AREA” for HRA, and “GRAVE DANGER, VERY HIGH RADIATION AREA” for VHRA.
- One or more of the following features shall be used for each entrance or access point to a HRA where radiation levels exist such that an individual could exceed a deep dose equivalent to the whole body of 1 rem (0.01 Sievert) in any 1 hour at 30 cm from the source or from any surface that the radiation penetrates:
 - Entryways that are locked except during periods when access to the area is required, positive control over each entry is maintained.
 - Continuous direct or electronic surveillance that is capable of preventing unauthorized entry.
 - A control device that prevents entry to the area when high radiation levels exist or, that upon entry causes the radiation level to be reduced below the level that defines a high radiation area.
 - A control device that energizes a conspicuous visual or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry.
 - A control device that will automatically generate audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or to permit activation of a secondary control device capable of preventing use or operation of the source.
 - A device that functions automatically to prevent use of or operation of the radiation source or field while personnel are in the area.
 - In addition to the above controls, other physical controls may be used for entry control to an HRA, and additional measures shall be implemented to ensure that individuals are not able to gain unauthorized or inadvertent access to a VHRA.
- Entry into RA/HRA/VHRA are limited to those personnel who have met the training requirements; who have read and signed an approved RWP, if applicable; and who are wearing the appropriate personnel dosimetry.
- Work in HRA and VHRA requires the licensed designated RSO has been provided a dose history for an individual to work in these areas.
- Continuous RST coverage shall be provided while work occurs.

3.5 Contamination, High Contamination, and Airborne Contamination Areas

- CONTAMINATION AREA (CA) – A Contamination Area is an area that has fixed and removable radioactive materials in the form of dusts, particulates or absorbed contaminants which are above the limits specified in the Radiation Protection Program Manual. Contamination may be airborne or deposited in (or on the surface of) structures, objects, soil, water, or living organisms in a concentration that makes the medium unfit for its next intended use.
 - A CA shall be identified and posted with a sign that indicates “CAUTION, CONTAMINATION AREA”.
- HIGH CONTAMINATION AREA (HCA) – A High Contamination Area is a CA that is 100 times above the limits specified in the Radiation Protection Program Manual.
 - A HCA shall be identified and posted with a sign that indicates “CAUTION, HIGH CONTAMINATION AREA”
- AIRBORNE RADIOACTIVITY AREA (ARA) – An Airborne Radioactivity Area is a CA that is a room, enclosure, or other area in which airborne radioactive materials in concentrations that:
 - exceed the derived air concentration limits (DACs), OR
 - would result in an individual present in the area, without respiratory protection, exceeding (during the hours an individual is present in a week) 0.6% of the annual limit on intake (ALI) or 12 DAC-hours, as specified in Appendix B to 10 CFR Part 20.
- A room, enclosure or area shall be posted with a sign that indicates “CAUTION, AIRBORNE RADIOACTIVITY AREA” or “DANGER, AIRBORNE RADIOACTIVITY AREA” if radioactive material is dispersed in the form of fumes, dusts, mists, vapors, or gases and the contamination of the dispersed radioactive materials is in excess of limits above.
- Entry into CA/HCA/ARA are limited to those personnel who have met the training requirements; who have read and signed an approved RWP, if applicable; and who are wearing the appropriate personnel protective equipment (PPE) and dosimetry.
- Personnel exiting a CA, HCA or ARA shall remove PPE and respiratory protection (if respiratory protection is required) and shall perform a whole-body contamination survey (frisk). If background radiation levels or other conditions at the exit point preclude performance of personnel frisking, the exit point should be relocated to an area of lower

background levels. If relocation of the exit point is not practicable, individuals should proceed directly from the exit point to an appropriate area to perform a whole-body frisk.

4. REFERENCES

- 4.1** Radiation Protection Program (RPP) Manual

5. ATTACHMENTS

- 5.1** SOP-05A Controlled Area Access Log Form



Disa Technologies, Inc.

SOP-06 Rev. 0

**Radiation Contamination Surveys and Decontamination
Standard Operating Procedure**

Approvals

_____ *Chief Operating Officer* _____ *Date*

_____ *Radiation Safety Officer* _____ *Date*

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

This procedure describes the methods for conducting radiological contamination surveys for personnel and equipment at Disa, Inc. project sites. This procedure covers multiple types of radiological contamination surveys that may be required under the Radiation Protection Program (RPP) or a Radiation Work Permit (RWP), including fixed or removable contamination involving alpha, beta and/or gamma radiation(s) on personnel or equipment (or some combination thereof). The type(s) of survey(s) specified in the RPP or RWP may vary depending on the nature of the work, potential for contamination, and survey objectives.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent) –

- Appropriate types of radiological surveys or monitoring are selected.
- Appropriate instrumentation to perform these surveys are specified.

2.2 Field Services Manager (FSM) –

- Support the RSO, ARSO, AU, and the Radiation Protection Program.
- Provide necessary resources to implement provisions in RPP and RWPs.

2.3 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is referred to as the RSO Designee in license documents. References to the RST will include the RSO designee.
- Be responsible for onsite management and implementation of RPP and RWPs that include radiological contamination surveys.
- Perform daily instrument QC checks, radiological surveys, and maintain documentation, as necessary.

2.4 Authorized Users (AU) –

- Comply with the Radiation Protection Plan (RPP) and Radiation Work Permit (RWP) requirements regarding all radiological contamination surveys.

3. PROCEDURE

3.1 Equipment and Materials

- Radiation survey instruments, as specified in RPP and/or RWPs.

- Materials and equipment as needed for instrument function checks and efficiency determinations (per SOP-02 and SOP-03) including calibrated check sources and standard geometry devices (i.e., calibration jig)
- Suggested: Camera (e.g., cell phone camera) to document equipment being released, and to identify the locations surveyed on a photo diagram as indicated on Form SOP-3A.

3.2 Preliminary Measurements

- Before a contamination survey is conducted, preliminary measurements are required to verify and document proper instrument response performance (function checks), and to determine instrument counting efficiency (number of counts detected per radioactive decay), where applicable. These measurements and calculations will be performed in accordance with applicable specifications of SOP-02 and SOP-03, depending on the equipment type.

3.3 Equipment Release Surveys

- Equipment release surveys consist of scans, static measurements, and removable swipe measurements to identify and quantify radiological contamination from alpha, beta, and gamma radiations.

3.3.1 Release Criteria

- Generally speaking, equipment that meets the release limits for total and removable alpha activity on surfaces will meet U.S. Nuclear Regulatory Commission (NRC) criteria for unrestricted release from a uranium recovery facility as indicated in U.S. NRC Regulatory Guide 8.30 (NRC, 2002). Corresponding regulatory limits, along with administrative limits and limits for UN2910 excepted packages¹, are given in Table 3-1.

¹ For shipping small quantities of radioactive material (e.g., samples for laboratory analysis).

Table 3-1: Regulatory and Administrative Contamination limits.

Category	Parameter	Regulatory Limit ⁽¹⁾	Administrative Limit ⁽¹⁾
Contamination Limits	Personnel	1,000 dpm/100 cm ² ⁽⁴⁾	Background
	Equipment Release	5,000 dpm/100 cm ² ⁽²⁾ 15,000 dpm/100 cm ² ⁽³⁾ 1,000 dpm/100 cm ² ⁽⁴⁾	200 dpm/100 cm ² , 25 µR/hr
	UN2910 Excepted Packages	24 dpm/cm ² ⁽⁵⁾ 240 dpm/cm ² ⁽⁶⁾ 500 µR/hr ⁽⁷⁾	N/A

⁽¹⁾ Note that limits for personnel and equipment apply only to licensed radioactive materials, but broader application to all radioactive materials is an ALARA goal for Site operations. All limits are net (above background) values.

⁽²⁾ Average total (fixed plus removable) alpha (or beta) activity across any 1-m² area (NRC Reg Guide 8.30).

⁽³⁾ Maximum total alpha (or beta) activity across any 100-cm² area (NRC Reg Guide 8.30).

⁽⁴⁾ Removable gross alpha (or beta) surface activity above background (NRC Reg Guide 8.30).

⁽⁵⁾ Removable alpha activity on package surface (average across 300 cm² area).

⁽⁶⁾ Removable beta/gamma activity on package surface (average across 300 cm² area).

⁽⁷⁾ Gamma exposure rate on contact with package.

3.3.2 Calculation of Surface Activity for Alpha or Beta Radiation

Once measurements of the count rate (CPM) for total (fixed + removable) contamination or removable contamination (swipe samples) have been taken, the measured count rate must be converted to units of surface activity for comparison against the limits given in Table 3-1. The formula for calculation of surface activity is given by Equation 3-1.

Equation 3-1
$$C = \frac{R_S - R_B}{\epsilon_t \left(\frac{A}{100} \right)}$$

Where:

- C = surface activity concentration (DPM/100 cm²).
- R_S = detector count rate for the surface or sampling media (CPM).
- R_B = background count rate for “clean” surface or unused sampling media (CPM).
- ε_t = total detection efficiency (counts/decay), as determined in SOP-03.
- A = areal dimensions (cm²) of active probe area (for static surface counts), or of the area swipe tested (for removable). Note that replacing the ratio A/100 in the above formula with the value of “A” alone will give the activity in units of DPM/cm².

3.3.3 Gamma Scans

Equipment that has the potential to contain residual radioactive materials in interior void spaces (sample packaging, piping, tanks, machinery, etc.) requires a gamma exposure rate scan. All accessible surfaces should be scanned with the detector on, or in close contact

with, surfaces of any item to be released for unrestricted use, or for UN2910 shipping. Investigate any areas with clearly elevated readings, including with subsequent alpha/beta measurements. Results must be documented on the Form SOP-06A *Equipment Release Survey Form*.

If the measured net exposure rate across accessible surfaces is less than 25 $\mu\text{R/hr}$ above background, the item is a candidate for unrestricted release providing that it meets the alpha and beta surface contamination limits given in Table 3-1.

For samples of radioactive material that will be shipped to a commercial laboratory under UN2910 excepted package protocols, the net exposure rate must be less than 500 $\mu\text{R/hr}$ at any point of contact on the exterior of the outer shipping container. For more detailed instructions on UN2910 shipping, see SOP-10.

3.3.4 Alpha/Beta Scans for Surface Activity

Surveys for radioactive surface contamination shall be performed and results evaluated against applicable release criteria specified in Table 3-1 for all equipment, vehicles, or materials that could potentially become radiologically contaminated. Consistent with specifications found in NRC Regulatory Guide 8.30 (NRC, 2002), surveys for alpha activity alone are normally sufficient to demonstrate compliance with release limits.

However, items with the potential for penetration of contamination below the surface, should also be surveyed for beta activity. Examples include items comprised of wood or other porous material. If in doubt, also perform a beta contamination survey. Note that instruments prescribed by the RSO may allow simultaneous alpha/beta surveys (e.g., Ludlum 2360 dual-channel scaler with Ludlum 43-93 alpha/beta probe). Contact the RSO if questions regarding instrument selection and/or use arise when performing contamination surveys required.

General Considerations for Equipment Release Surveys:

- If equipment has been washed prior to surveying, make sure equipment is dry. Alpha particles will not penetrate a layer of water on the equipment.

- Using Form SOP-06A *Equipment Release Survey Form*, document:
 - Location where the equipment was used,
 - Description of the equipment,
 - Name of the individual conducting the release survey,
 - Release survey date, and
 - Specific components of the equipment and/or location(s) surveyed. A photo diagram on the second page of the form, with annotated location ID numbers corresponding to the locations listed on page 1, is suggested but not mandatory.
- In addition, document the information regarding each radiological survey instrument used including:
 - Serial number,
 - Calibration date,
 - Instrument background measurement (at the survey location), and
 - Total detection efficiency (E_t), as determined under SOP-03.

Total (Fixed + Removable) Surface Contamination Survey:

- Scan for total alpha activity (and total beta activity, if appropriate) on accessible surfaces of potentially contaminated items by placing the detector approximately 0.5 cm from the surface and moving the detector over the surface at about 2 cm per second.
- If elevated counts are detected in an area while scanning (relative to background levels), take a static 1-minute scaler count where highest elevated counts were observed. If no elevated counts observed while scanning, then select location(s) based on potential likelihood for contamination and make a 1-minute scaler count at each location.
- The number of measurement locations must be sufficient to adequately represent the entire item being surveyed. For each measurement, record the location and resulting scaler count rate (in CPM) on Form SOP-06A *Equipment Release Survey Form*.
- For each static measurement location, convert the net survey count rate (in cpm) to units of total surface activity (DPM/100 cm²) using Equation 3-1. Record the result

on Form SOP-6A *Equipment Release Survey Form* in the column labeled Total Alpha Activity (and Total Beta Activity, if appropriate).

Removable Surface Contamination Survey:

- If the total (which includes fixed & removable fractions) surface activity for alpha radiation (as measured in the above step) is less than the removable limit (1,000 dpm/100 cm²) across all scanned surfaces, a swipe test for removable alpha contamination is technically unnecessary. Note that this consideration does not apply to removable swipe testing of packages used to ship samples containing radioactive materials under UN2910 excepted package protocols (i.e., swipe testing is always required for shipment of radioactive materials).
- If the total measured surface activity exceeds the removable limit anywhere on the equipment being surveyed, swipe testing shall be performed in areas with the highest scan readings, along with several other locations as needed to provide representative coverage of accessible surfaces. At each location, swipe test an area of 100 cm² (approximately 4 x 4 inches) and subsequently count the sample to determine the alpha activity that is removable. Note that for UN2910 shipping container surveys, the area to be swipe tested is 300 cm².
- Ideally, swipe samples are counted with an instrument that has an attached or built-in sample counting tray (e.g., Ludlum Model 2929 scaler with Model 43-10-1 detector or a combined Model 3030 sample counting instrument), but a portable alpha/beta survey detector may also be used, provided the meter includes appropriate dual channel scaler counting capability (e.g., Ludlum Model 2360 scaler with 43-93 alpha/beta detector). In the latter case, a simple makeshift counting jig can be used to provide a consistent measurement geometry for sample counting, instrument efficiency determinations, and daily function checks. Such a counting jig, where the plastic detector cover is used to maintain a consistent distance of about 0.5 cm between the detector and the sample or check source, is shown in Figure 3-1.
- Once the swipe sample has been counted, convert the net count rate (in cpm) to units of removable gross alpha surface activity (DPM/100 cm²) using Equation 3-1.
- Record the result in the column labeled Removable Alpha Activity on Form SOP-06A *Equipment Release Survey Form*.



Figure 3-1: Example fixed-geometry measurement jig using a Ludlum 43-93 survey probe to count swipe samples, determine instrument efficiency, and to perform daily QC function checks.

Swipe Testing for UN2910 Shipping Packages:

The procedure for swipe testing UN2910 shipping packages is the same as indicated above for equipment release surveys except for the following:

- The areal basis for swipe testing is 300 cm².
- A swipe removal efficiency value of 0.1 must also be applied, in addition to the applicable total efficiency (E_t) value given in SOP-03.
- Applicable limits differ.
- Results of the surveys should be recorded on Form SOP-10A *UN2910 Shipping Package Survey Form*.

See SOP-10 for more details regarding UN2910 shipping of radioactive materials.

3.4 Personnel Exit Surveys

Personnel working in a restricted area are required to scan their clothing, exposed skin, and shoes upon leaving the area. All workers will be instructed in the use of the survey instruments and performing a proper personal exit survey and documenting results on the Form SOP-06 *Personnel Exit Survey Form*. Basic steps for personnel exit surveys are as follows:

- While holding an alpha detector approximately 0.5 cm from the surface to be scanned, survey at a rate of approximately 2 inches per second, paying attention to the audible output (clicks) and/or analog dial response or digital display readings.
- If audibly or visually elevated counts (relative to background) are observed while scanning, pause at that location to confirm whether the counts are at background levels or consistently above.
- If count rate is at background levels, continue with the survey.
- If count rate exceeds the background level, carefully scan around the location to determine the extent of the elevated readings. Note the area for subsequent decontamination and continue scanning until the survey is completed.
- If above-background contamination is identified, the decontamination procedures in Section 4 of this SOP will be followed as applicable.
- If radioactivity above background persists after decontamination, and the applicable regulatory limits in Table 3-1 cannot be met with standard decontamination procedures, consult the RSO for further advising.

An administrative release limit will be determined each day by the RST for each survey instrument to be used based on the maximum ambient “background” count rate observed at the personnel exit survey location. This release limit will be labeled at the top of the Form SOP-06B *Personnel Exit Survey Form* provided for the day. Personnel must acknowledge and document that they have performed a personnel exit survey by providing the date, name, company, any special notes regarding the survey, and to confirm that the release limit was met by initialing the Personnel Exit Survey Form in the indicated column.

3.5 Documentation and Records Retention

The RSO and RST will record/document results of all instrument QC measurements and survey or monitoring results and will maintain all documentation indefinitely until disposition is authorized by NRC. The RSO, ARSO, and RST will retain all completed Survey Forms (Forms SOP-06A, SOP-06B, and SOP-10A) and associated QC data (from SOP-02 and SOP-03) and will maintain these records along with all documentation as indicated above.

4. DECONTAMINATION

4.1 Overview

The surfaces of equipment, vehicles, personal protective equipment (PPE), clothing or skin could potentially become contaminated in excess of administrative action levels or regulatory release limits. In such cases, decontamination is required before releasing the person and/or equipment from the Site. This procedure describes the methods for decontamination.

4.2 Decontamination Facilities and Equipment

Once a decontamination area is selected, the same location should be used for this purpose until project completion and associated procedures are no longer required. A source of clean water and common tools for washing or other means of removing contaminated residues from the surfaces of equipment or personnel will be provided as needed to attain compliance with applicable release limits. The following is a list of decontamination equipment and materials:

- Personal protective equipment, including Level D work clothing, Tyvek coveralls, rubber boots, nitrile gloves, face shields, etc. as required.
- Decontamination equipment and materials, as required (e.g., clean water supply, biodegradable detergent, pressure washer, brushes, double-sided sticky tape, etc.).
- Container(s) for waste materials generated due to decontamination activities, as required.

4.3 Decontamination Methods

- Use of scrapers or brushes can be effective for removing gross accumulations of dirt or mud on equipment, vehicles, and PPE. Stiff-bristled brushes or other abrasive removal methods should not be used for skin to avoid damaging the skin and creating a potential pathway for absorption of contamination into the bloodstream.
- Decontamination with water (e.g., washing skin, pressure washing dirt/mud from equipment, etc.) is effective for most contamination likely to be present. Mild, biodegradable soap or detergent can increase the effectiveness of water as a decontamination agent.
- Disposable wet-wipes or double-sided sticky tape can be effective for removing small amounts of removable contamination or short-lived radon decay products from skin or clothing.

4.4 Personnel Decontamination

If radioactive surface contamination exceeding the administrative limit (above background) is identified on skin, clothing or PPE for personnel working in a Restricted Area, the affected area(s) must be decontaminated. Brushing off visible accumulations of dirt or mud may be sufficient for clothing or PPE, but skin should be gently washed with mild soap and water.

In cases where simple decontamination efforts to remove long-lived radiological contamination (as opposed to short-lived radon decay products) prove ineffective, the RSO or RST must be notified for further advising. The RST will assist the contaminated personnel until the decontamination process has been completed or otherwise terminated. The following are general considerations to be observed during personnel decontamination activities:

- Administration of first aid for immediate treatment of serious injuries or illness must take priority over personnel decontamination considerations.
- Decontamination of serious wounds (other than minor cuts or abrasions) shall be performed by professional medical personnel.
- Minor wounds (cuts, abrasions, etc.) can be flushed with lukewarm water or a saline solution.
- Use protective clothing (i.e., gloves, etc.) as necessary when decontaminating personnel to prevent inadvertent secondary spread of contamination.
- The mildest methods of decontamination should be attempted first, progressing to harsher methods when necessary. Cleansing methods, from the least harsh to the most are listed below:
 - Flushing with water
 - Soap and warm water
 - Mildly abrasive soap, soft brush, and water

4.5 Decontamination of Personal Clothing or Articles

- Decontamination of clothing or personal articles may be performed by the individual under the direction of the RST and in accordance with this procedure.
- Personal clothing or items may be released when surveys indicate that surface activity meets the administrative limit provided at the top of the Form SOP-06B *Personnel Exit Survey Form*.

Special Note: Short-lived airborne decay products of radon gas (progeny) can readily adhere to clothing via static charge, particularly fleece and polyester materials. Radon progeny may produce false positive readings on personnel exit surveys. Radon progeny on surfaces are NOT considered contamination or a health concern as within several hours, the associated radioactivity will decay away. Washing skin and use of double-sided sticky tape rollers (lint removal devices) on clothing can help to remove radon progeny and reduce false positive survey readings for long-lived radionuclides, which are the primary concern. If these measures do not reduce survey readings to acceptable levels, the individual may resurvey after 15-30 minutes. If readings have measurably decreased, this is an indication of radon progeny not long-lived contamination, and the person may leave the Site without need for further decontamination. Alternatively, the article(s) of clothing may be placed in a plastic bag, left onsite, and be resurveyed the following morning to verify that short-lived radon progeny has decayed, and readings have returned to background levels.

4.6 Decontamination of Equipment and Vehicles

- Gross accumulations of dirt or mud on equipment and vehicles shall be removed with a flat bladed scraper, brushes or by pressure washing within the decontamination area.
- Personnel performing decontamination shall wear appropriate PPE as needed (e.g., when using a pressure washer).
- Equipment such as drill rigs, auger, drill bits, and shovels should be sprayed with water (high pressure, if required) to remove potentially contaminated accumulations of mud or dirt. Care should be taken to adequately clean hard to reach places on complicated pieces of machinery.
- After cleaning and sufficient drying of equipment has been completed, perform appropriate radiological surveys, as indicated in this SOP, to ensure that the equipment meets applicable criteria for release for unrestricted use as specified in Table 3-1.
- Perform additional decontamination as necessary until applicable limits are met.

5. REFERENCES

5.1 Radiation Protection Program (RPP) Manual

5.2 U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 8.30

6. ATTACHMENTS

- 6.1** Form SOP-06A Equipment Release Survey
- 6.2** Form SOP-06B Personnel Exit Survey
- 6.3** Form SOP-10A UN2910 Shipping Package Survey

Form SOP-06A

Equipment Release Survey Form

Site:		Equipment Use/Location:				Page									
Survey Description:					RWP #		DATE:								
Meter / Detector (radiation survey type):	Detector Area (cm ²)	Serial Number:		Cal. Due Date:		Background (CPM)		Total Efficiency (counts/decay)							
		Meter	Detector	Meter	Detector	Alpha (α)	Beta (β)	Alpha (α) **	Beta (β) **						
Model 2360 / 43-93 (a/⚡)	100														
Model 19 (α)	NA		NA		NA		(μR/hr)	NA	NA						
Model 2929 Swipe Counter (a/⚡)	32														
Contamination Limits: (dpm/100cm ²) *		Removable a: <u>1,000 (200)</u> dpm/100 cm ²			Removable ⚡ <u>1,000 (200)</u> dpm/100 cm ²			Total a: <u>5,000</u> dpm/100 cm ²			Total ⚡ <u>5,000</u> dpm/100 cm ²			Net α: <u>25</u> μR/hr	
Sample No.	Description/ Location	Gross CPM a Removable	Net CPM a Removable	dpm/100cm ² a Removable	Gross CPM ⚡ Removable	Net CPM ⚡ Removable	dpm/100cm ² ⚡ Removable	Gross CPM a Total	Net CPM a Total	dpm/100cm ² a Total	Gross CPM ⚡ Total	Net CPM ⚡ Total	dpm/100cm ² ⚡ Total	Gross Gamma (μR/hr)	Net Gamma (μR/hr)
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
REMARKS:															
TECHNICIAN SIGNATURE/DATE:															
REVIEWER SIGNATURE/DATE:															

*Administrative limit given in parentheses

**Per SOP-03

Form SOP-06A

Equipment Release Survey Form

Site:						Equipment Use/Location:						Page			
Survey Description:						RWP #						DATE:			
Meter / Detector (radiation survey type):	Detector Area (cm ²)	Serial Number:		Cal. Due Date:		Background (CPM)		Total Efficiency (counts/decay)							
		Meter	Detector	Meter	Detector	Alpha (α)	Beta (β)	Alpha (α) **	Beta (β) **						
Model 2360 / 43-93 (α/β)	100														
Model 19 (γ)	NA		NA		NA		(μR/hr)	NA	NA						
Model 2929 Swipe Counter (α/β)	32														
Contamination Limits: (dpm/100cm ²) *		Removable α: <u>1,000 (200)</u> dpm/100 cm ²			Removable β: <u>1,000 (200)</u> dpm/100 cm ²			Total α: <u>5,000</u> dpm/100 cm ²			Total β: <u>5,000</u> dpm/100 cm ²			Net γ: <u>25</u> μR/hr	
Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	dpm/100cm ² α Removable	Gross CPM β Removable	Net CPM β Removable	dpm/100cm ² β Removable	Gross CPM α Total	Net CPM α Total	dpm/100cm ² α Total	Gross CPM β Total	Net CPM β Total	dpm/100cm ² β Total	Gross Gamma (μR/hr)	Net Gamma (μR/hr)
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
REMARKS:															
TECHNICIAN SIGNATURE/DATE:															
REVIEWER SIGNATURE/DATE:															

*Administrative limit given in parentheses

**Per SOP-03



Disa Technologies, Inc.

SOP-07 Rev. 0

**Radiological Emergency Response
Standard Operating Procedure**

Approvals

Chief Operating Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

The purpose of this procedure is to provide instruction on the specific actions to be taken in the event of a radiological emergency at a site or while working with licensed radioactive materials. Emergency actions that fall outside of the scope of the license, or are not explicitly allowed by the license, will be taken only as approved by the RSO. The appropriate regulatory authority will be notified before, or immediately after, emergency actions, using the appropriate reporting procedures specified in 10 CFR Part 40, or as specified in an application document. Occupational safety emergencies will be addressed in a site-specific health and safety plan.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent)–

- Ensuring implementation of this procedure, and that the emergencies and incidents are reported as specified in 10 CFR Part 40.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST in licensing documents is known as the RSO Designee. References to the RST include references to the RSO designee.
- Implementation of this procedure in response to site radiological incidents and emergencies.

3. PROCEDURE

The following procedure identifies the immediate, supplementary, and any follow-up actions for high airborne radioactivity and for spills of radioactive solids or liquids, fires, and loss of radioactive material (RAM) and related notification to appropriate parties. Personnel will conform to reporting and notification requirements in accordance with the requirements 10 CFR Part 40.

- ### 3.1 High Airborne – High airborne conditions are defined as unexpected particulate radioactivity above $9 \text{ E-}09 \text{ } \mu\text{Ci/ml}$ for beta and/or gamma emitter(s) or $2 \text{ E-}11 \text{ } \mu\text{Ci/ml}$ for an alpha emitter(s) in occupied radiological areas at the work location.

NOTE: High airborne contamination is not expected in ground moving and excavation tasks. However, crushing and grinding uranium mine waste material may be performed, thus warranting these precautions.

- IMMEDIATE ACTIONS:
 - Evacuate personnel from affected areas.
 - Notify RSO, ARSO, or RST.
 - Don respiratory equipment for personnel who must return to the affected area.
 - Verify that the high airborne results (e.g., from air sampling or elevated instrument readings) are correct.
 - Determine the extent of the airborne radioactivity by sampling air in the affected area and adjacent areas which might be affected using portable air samplers.

- SUPPLEMENTARY ACTIONS:
 - Attempt to identify the radionuclide causing the airborne radioactivity using process knowledge and/or by promptly measuring the sample to determine activity characteristics (alpha vs beta vs gamma) and the half-life.
 - Measure and control surface contamination in areas affected by high airborne radioactivity.
 - When resuming operations, take a portable air sample to verify that the cause of high airborne radioactivity is corrected.
 - Check personnel exposed to high particulate radioactivity for internal radioactivity (swipes of inside of respirators, contamination on face, etc. followed by appropriate bioassay sampling if found contaminated).
 - A report of any incident involving high airborne radioactivity other than natural background in areas occupied by personnel not wearing or wearing inappropriate respiratory equipment, will be prepared. The report will include results of internal monitoring and will be submitted to the RSO within ten working days.

3.2 Radioactive Spills

The following steps will be followed in the event of a radioactive spill of liquids or solids. Ensure that proper personal protective equipment (PPE) is donned prior to addressing any spills. PPE could include chemical resistant gloves, protective coveralls, and chemical resistant boots.

- IMMEDIATE ACTIONS:
 - If the spill is minor (e.g., a few liters of water with low radioactivity spilled on a smooth surface), immediately cover the spill with the most convenient absorbent paper or rags to soak up the liquid. Experience has indicated in most cases that for minor spills involving small amounts of radioactivity, wiping up the spill even though gloves are not available, will not result in additional contamination of the individual.
 - After the spill is covered, follow portions of steps 1 through 5 and supplementary actions below, as necessary, to keep the incident under control. These immediate actions may take place simultaneously.
 - The individual at the scene will take charge of the spill until relieved by a radiation safety representative (e.g., RSO, ARSO, or RST). This individual organizes the personnel available and initiates action to control and correct the spill. It is important that this individual make known both his/her presence and the fact that he/his is in charge to all others at the scene. On arrival of the designated individual in charge, the status of correction action taken or in progress will be immediately brought to his attention. The person in charge will designate available personnel to perform the following immediate actions (**SWIMS**):
 1. **Stop the Spill.** If the spill is from a system which might have more material (either airborne particulate radioactivity or fluids) to leak out, promptly stop the leak, if possible. If the spill is from an overturned container, try to set it upright if the contents have not all escaped. Wipe up spilled liquid to prevent it from spreading. The time spent stopping a difficult leak depends upon the radiation levels involved, the possibility of inhaling airborne radioactivity from the spill, and the

consequences of not promptly stopping the spill. In some cases, a prompt stoppage is unnecessary.

2. **Warn Other Personnel**. Immediately warn other personnel in the area who might become contaminated by the spill or who are able to help control it. Notify radiological control personnel.
3. **Isolate the Spill Area**. Keep unnecessary personnel out of the area affected by the spill to minimize the spread of contamination.
4. **Minimize Personnel Exposure to Contamination and Radiation**. Personnel in the spill area will remain at the edge of the area until radiological control personnel advise otherwise. Personnel will keep at the edge of the affected area, taking care to minimize spread of contamination. In some circumstances, stepping outside the room where a spill occurred and closing the access is necessary. Contaminated personnel will be decontaminated without delay.

- **SUPPLEMENTARY ACTIONS:**

- Measure Radioactivity Levels. Measure contamination on personnel who could have been affected, make contamination surveys in the area adjacent to the spill outside the area isolated, determine the magnitude and extent of surface contamination in the spill area, and measure airborne radioactivity near the spill area. If it is suspected that radionuclides have been taken into the body or if skin contamination is detected, internal monitoring (bioassay sampling appropriate for the radionuclides of concern) may be performed.
- Take subsequent radiological control and cleanup actions per radiological control personnel instructions.
- Do not resume operations without the RSO or ARSO approval.

3.3 Loss of Radioactive Material

If licensed radioactive material is lost, the following procedures will be followed.

- The RSO will be immediately notified, and a search conducted. The primary reason for this is to ascertain that no persons will receive inadvertent internal or external exposure from the material.

- If the material cannot be located, the RSO, ARSO, or RST will prepare an incident report in compliance with 10 CFR Part 40.
 - The most likely scenario is loss of a licensed Th-230 check source. A telephone call to NRC will be required within 30 days stating the loss of licensed material and a written report will be submitted within 30 days after the telephone notification.
 - Loss of dispersible source material will require immediate notification to NRC.

3.4 Fire in Controlled Area

- Areas will be evacuated by all non-emergency personnel when a fire, heavy smoke, or similar fumes occur in a controlled area. Radiological controls, operational and/or fire response personnel will be immediately notified.
- When possible, the fire will be extinguished by personnel, using a fire extinguisher or water (whichever is appropriate) in the immediate vicinity (if safe) rather than allowing it to grow larger while designated personnel are on their way.
- If a fire cannot be rapidly extinguished using a fire extinguisher or water, await help from emergency personnel (i.e., firefighters) and evacuate the area as necessary. Inform emergency personnel about the radioactive nature of the material.
- Fire extinguishing agents, such as CO₂, foam, chemicals, are preferred, as this minimizes the volume of potentially contaminated liquids.
- All firefighting personnel will be surveyed prior to exiting the event area, except those in need of immediate medical assistance outside the controlled area. Minimization of the spread of contamination will always be kept in mind.

3.5 Emergency Notification

- In the event of a radiological emergency, notification of the event can be made by calling the RSO or ARSO at phone numbers provided prior to start of onsite work.
- In addition, an emergency call list will be posted in the office area. This call list will provide the name and phone numbers of radiation safety staff, regulatory authority representatives, and fire/first-aid emergency response personnel.
- The chain of contact will proceed as follows, after a radiological emergency:
 - Immediate help from the RSO, ARSO, or RST and field services manager if onsite.

- Immediate help from fire/first-aid emergency response personnel, if deemed necessary.
- Call to RSO and field services manager if offsite.
- Notification to the client of the emergency.
- Notification to regulators, if required, and as specified for a given emergency.
- Notification and reporting of emergencies/incidents will be carried out in accordance with the requirements of 10 CFR Part 40.

4. REFERENCES

4.1 Radiation Protection Program (RPP)

1. PURPOSE

The purpose of this procedure is to discuss the requirements in the performance of general area air sampling and personnel breathing zone air monitoring while working with licensed radioactive materials that are under the authority of the NMED RCB, US NRC or Agreement State regulatory authority.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO or RSO Equivalent) –

- Ensuring that air sampling provides representative samples of the work area and personnel breathing air, potential intakes (inhalation) of radioactive materials by workers, and/or airborne releases to the environment. Representative sampling allows for the identification and evaluation of potential radiological hazards which may then be controlled.
- Authorizing the sampling methods and the instrumentation to be used for analysis of samples.

2.2 Radiation Safety Technician (RST or RSO designee) –

- The RST is referred to as the RSO designee in licensing documents. References to the RST include the RSO designee.
- Informing the RSO or AU when airborne radioactivity levels have increased unexpectedly.
- Collection of air samples in accordance with this procedure, and preparation and analysis of samples to be counted on-site.
- Ensuring air samplers and counting instrumentation have been properly tested prior to use.
- Submittal of environmental samples to off-site laboratories, as needed.

3. PROCEDURE

3.1 Equipment –

- Air sampling pump(s) appropriate to the sampling effort needs.
 - *Low-volume (Low-vol) and High-volume (High-vol) Air Sampler* – This type of air sampler is typically used for area and perimeter air sampling and have flow rates

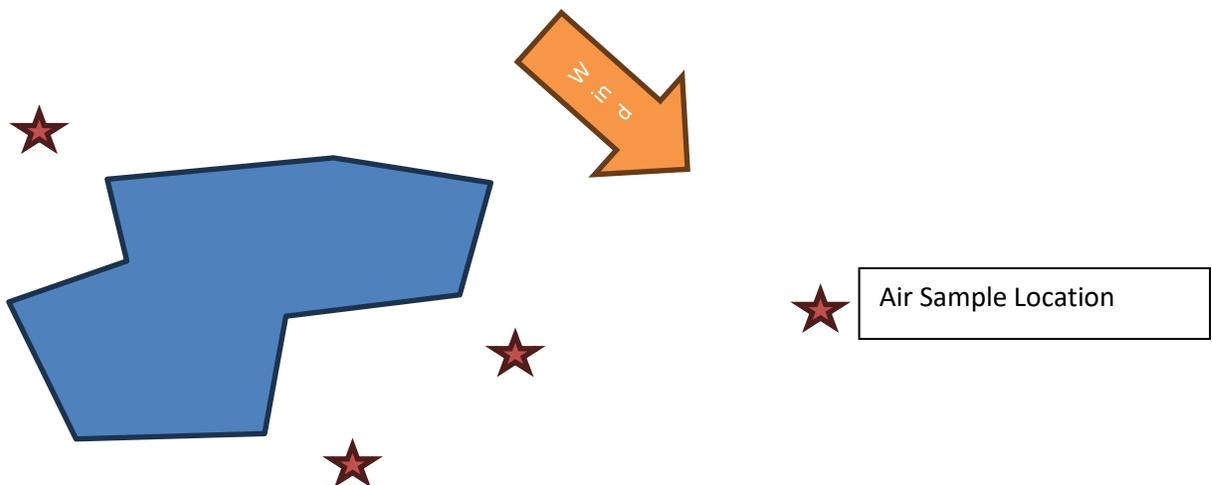
much higher than breathing zone air samplers. These samplers are most often used when it is necessary to obtain large volumes of air. Flow rates range from 10-100 L/min or greater, depending on model and project needs.

- *Breathing Zone Air Sampler* – This type of air sampler is often called by other names, such as “BZ” (short for breathing zone), “personal air sampler”, or “lapel air sampler”. A breathing zone air sampler typically has a flow rate of 0 to 5 liters per minute (LPM) but may range higher.
- Appropriate air sampling filter media (size and material).
- Sample counting instrumentation; typically, a tray counter. *NOTE: Tray counter should be properly calibrated, and function checked prior to use.*
- Materials/Forms for documenting air sampling activities and results (See SOP-12 Swipe and Air Sample Counting).

3.2 Sample Locations

Air sample locations will generally consist of the following:

1. Perimeter Air Sampling – A wind rose from the closest location will be consulted to identify the upwind and two downwind locations. Low-vol or High-vol air particulate samplers will be used at these locations. The following figure demonstrates this type of air sampling.



In addition to the air particulate samplers, DISA will deploy radon cups or continuous radon samplers and environmental gamma optically stimulated luminescence detectors collocated with air particulate samplers.

2. General Air Sampling – General air sampling locations will be established in the restricted area and in the controlled at locations near the excavation of uranium mine waste, which is where the most likely source of dose due to air particulates would occur.
3. Breathing Zone (BZ) Sampling – Instead of General air sampling, DISA may deploy BZ samplers for specific workers to measure the potential dose due to air particulates.

Note that the RSO maintains discretion on the sample locations, sample types, and durations for sampling that occurs at the site.

3.3 Sample Collection Summary – The following table summarizes the air sampling program:

Location	Routine or Special Sampling	Grab or Continuous Sampling	Measurements Gamma / Radon / Both	Filter Exchanges ²	Action Levels	Actions
Perimeter	Routine	Continuous: Lo- or Hi-vol	Both	Weekly, reporting quarterly or at the end of the project whichever comes first	<ul style="list-style-type: none"> 10 CFR 20, App B, Table 2 Air Effluent Limits 	<ol style="list-style-type: none"> More dust suppression. Slower excavation rate. Expand Controlled Area boundary to increase distance to the public
Restricted Area	Routine	Continuous: Lo- or Hi-vol	Gamma exposure measurements daily by meter. No dosimeters on equipment. Personnel will be badged	Weekly, reporting quarterly or at the end of the project whichever comes first	<ul style="list-style-type: none"> 10% of DAC 10% of weekly uranium uptake limit (1 mg/week) 3 mrem/hr (radiation area action) 	<ol style="list-style-type: none"> Increase to daily sampling until conditions return to normal. Monitor gamma for posting as radiation area, where appropriate. Adjust work tasks to reduce time in radiation area.
					<ul style="list-style-type: none"> 30% of DAC 30% of uranium uptake limit 	<ol style="list-style-type: none"> Evaluate the need for respiratory protection
					<ul style="list-style-type: none"> 50% of DAC 50% of uranium uptake limit <p>These limits would indicate routinely exposed</p>	<ol style="list-style-type: none"> Mandate the need for respiratory protection. RSO evaluate the need for a bioassay program.¹
Controlled Area, waste excavation – highest dust generation	Routine	Grab, Breathing Zone	Gamma dosimeters and measurements by meter	Daily, Reporting Daily/	<ul style="list-style-type: none"> 10% of DAC 10% of weekly uranium uptake limit 3 mrem/hr (radiation area action) 	<ol style="list-style-type: none"> More dust suppression. Slower excavation rate. For gamma, monitor for posting as radiation area, where appropriate
					<ul style="list-style-type: none"> 30% of DAC 30% of uranium uptake limit 	<ol style="list-style-type: none"> Evaluate the need for respiratory protection
					<ul style="list-style-type: none"> 50% of DAC 50% of uranium uptake limit 	<ol style="list-style-type: none"> Mandate the need for respiratory protection. RSO evaluate the need for a bioassay program.¹
Notes: ¹ . Regulatory Guide 8.22 will be used to determine corrective actions after bioassays are performed						

3.4 Perimeter Air Sampling - Perimeter air samples are collected to determine airborne concentrations where members of the public may be present and to calculate doses to members of the public. Procedures for perimeter air sampling are as follows:

- Collect the samples using low-vol or high-vol air samplers.
- Position the sampler head with filter approximately 4 to 6 feet above the ground and orient sampler head horizontally or downwards and 90-degrees to primary wind direction, as practical.
- Load the filter media, start the sample pump, and record the location, start date/time, beginning flow rate, and totalizer value, as appropriate for air sampler.

NOTE: The sampler flow rate and sample collection duration should allow for a minimum quantity of air sampled for general area and breathing zone samples should allow the Lower Limit of Detection (LLD) to be less than approximately 10% of the DAC, as applicable.

- To collect filter samples, stop the sample pump, record the stop date/time, ending flow rate, and totalizer value, as appropriate for air sampler.
- Remove the filter media and place in the appropriate container/envelope. *NOTE: Use caution not to cross-contaminate the filter(s).*
- For 47-mm sample filters, DISA personnel will count the filters for gross alpha and will compare the results to DACs for Ra-226, natural uranium, and Th-230. A weighted average will be used to calculate a composite DAC. If the gross alpha count exceeds the composite DAC, then DISA will send the filter samples to an accredited laboratory for analysis of Ra-226, natural uranium, and Th-230. For larger sample filters, DISA will send the filters to an accredited laboratory for analysis. For field counting, radon may cause interference; therefore, DISA may recount the samples after 24 hours to determine if DISA determines that radon is interfering with gross alpha results. Recounting will continue for a maximum of 72 hours after sample collection.

3.5 Perimeter Radon and Environmental Gamma – Radon track-etch or continuous monitors along with dosimeters (TLDs or OSLs) will be collocated with the perimeter air samplers. Track-etch detectors and environmental gamma dosimeters will be collected quarterly or at the end of the project whichever comes first. If continuous radon meters are used instead of the track-etch detectors, the meters will be downloaded weekly.

3.6 General Area Air Sampling – General area air samples are collected to determine airborne concentrations where workers may be present in the restricted area and controlled area. Gamma exposures will be measured daily so no environmental dosimeters will be installed. Routine air sampling may occur within a controlled area near areas of uranium mine waste excavation at the discretion of the RSO. However, sampling in this area will likely be breathing zone sampling discussed below. If controlled area breathing zone sampling occurs, then an environmental gamma dosimeter will be installed near the uranium mine waste excavation area and/or on the excavation equipment. Procedures for General air sampling are as follows:

- Collect the sample using low-vol or high-vol air sampler.
- Position the sampler head with filter approximately 4 to 6 feet above the floor or ground and orient sampler head horizontally or downwards and 90-degrees to any significant air flow direction, as practical.
- Load the filter media, start the sample pump, and record the location, start date/time, beginning flow rate, and totalizer value, as appropriate for air sampler.

NOTE: The sampler flow rate and sample collection duration should allow for a minimum quantity of air sampled for general area and breathing zone samples should allow the Lower Limit of Detection (LLD) to be less than approximately 10% of the DAC, as applicable.

- To collect filter samples, stop the sample pump, record the stop date/time, ending flow rate, and totalizer value, as appropriate for air sampler.
- Remove the filter media and place in the appropriate container/envelope. *NOTE: Use caution not to cross-contaminate the filter(s).*
- For 47-mm sample filters, DISA personnel will count the filters for gross alpha and will compare the results to DACs for Ra-226, natural uranium, and Th-230. A weighted average will be used to calculate a composite DAC. If the gross alpha count exceeds the composite

DAC, then DISA will send the filter samples to an accredited laboratory for analysis of Ra-226, natural uranium, and Th-230. For larger sample filters, DISA will send the filters to an accredited laboratory for analysis. For field counting, radon may cause interference; therefore, DISA may recount the samples after 24 hours to determine if DISA determines that radon is interfering with gross alpha results. Recounting will continue for a maximum of 72 hours after sample collection.

3.7 Breathing Zone Air Sampling – The breathing zone of a worker is taken to mean the air that is representative of the worker’s inhaled air, that is, the area around the nose and mouth. Breathing zone air samples will primarily may be collected using a BZ or lapel air sampler provided they are representative of the breathing zone and sufficient air volume collection is feasible. Low-vol or high-vol air samplers may also be used. These samples will be collected from the restricted area and/or the controlled area and will be grab (8-hr) samples. Breathing zone air samples are collected for the purpose of estimating personnel exposures to airborne activity associated with specific tasks.

- Attach the sample head to the worker’s collar or chest area with the filter head facing horizontally. Instruct the worker to use care not to touch the filter during work. Secure the pump in a manner that does not interfere with the worker’s movement.
- Start the pump within a few minutes prior to worker entering the area and record the start date/time, beginning flow rate, and totalizer/run time, as appropriate for the air sampler.
- Stop the pump within a few minutes of the worker exiting the area and record the end date/time, flow rate, and totalizer/run time, as appropriate for the air sampler.
- Remove the sample filter from the filter cassette, and place filter in the appropriate container/envelope.

NOTE: Use caution not to cross-contaminate the filter.

- DISA personnel will count the filters within 48 hours for gross alpha and compare the results to DACs for Ra-226, natural uranium, and Th-230. A weighted average will be used to calculate a composite DAC. If the gross alpha count exceeds the composite DAC, then DISA will send the filter samples to an accredited laboratory for analysis of Ra-226, natural uranium, and Th-230. For field counting, radon may cause interference; therefore, DISA may recount the samples after 24 hours to determine if DISA determines that radon is

interfering with gross alpha results. Recounting will continue for a maximum of 72 hours after sample collection.

- 3.6 Discontinuation of Air Sampling** – The Radiation Safety Officer may decide to discontinue all or part of the air sampling program at any site or permanently if air sampling results indicates that the breathing or direct gamma pathways (from environmental monitors only) are not contributing substantially to occupational or public dose. This determination will be made after 12 months of measurements are made at multiple HPSA® treatment sites. If DISA is treating one site for a long duration, DISA may discontinue air monitoring after 12 months of data collection at the one site. Before this determination becomes effective DISA’s Safety and Environmental Review Panel (SERP) will review the data and make this determination, which will also be approved by the Radiation Safety Officer. The SERP report will be forwarded for review and approval to the NRC.

4. REFERENCES

- 4.1** Radiation Protection Program (RPP) Manual
- 4.2** U.S. NRC Regulatory Guide 8.25, “Air Sampling in the Workplace”
- 4.3** U.S. NRC Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills”

1. PURPOSE

The purpose of this procedure is to provide instruction for the routine issuing and use of radiation dosimetry devices (dosimeter), establishing and maintaining associated dose records, routine primary dosimetry exchange, and termination of dosimetry while working with licensed radioactive materials that are under the authority of the US NRC or Agreement State regulatory authority. Additionally, this procedure defines regulatory and administrative exposure limits applicable to workers in accordance with the Radiation Protection Plan.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO or RSO Equivalent) –

- Oversight of the Radiation Protection Program with respect to ensuring compliance to dose limits.
- Ensuring appropriate use of dosimetry.
- Providing the methodology for performing dose calculations including calculation of a “missed dose” when a dosimeter is lost or damaged.
- Review and approval of radiation exposure and dose data.
- Investigating if regulatory and/or administrative limits are exceeded, including documentation of such results.
- Required notifications and reports to workers and regulatory agencies.
- Maintaining dosimetry records.
- Ensuring that workers are restricted from activities that could result in additional exposure when administrative limits are exceeded.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is referred to as the RSO designee in License documents. Any reference to RST also includes a reference to the RSO designee
- Issue and change out of dosimeter.
- Reporting and replacing lost dosimeter.
- Maintaining an appropriate inventory of dosimeters from the vendor.

2.3 Authorized Users (AUs) –

- Responsible for notifying the RSO when their physician has prescribed radionuclides for treatment or diagnostic purposes.
- Responsible for wearing assigned dosimeter in proper locations as required.
- Responsible for storing assigned dosimeter in designated storage areas when not in use.
- Responsible for reporting lost, damaged dosimetry, or unusual dosimetry readings (based on typical reading for self-reading dosimeter) to the RSO, ARSO, or AU.
- *DECLARED PREGNANT WORKER* – Voluntarily declare pregnancy and the estimated date of conception to the RSO in writing IF they desire to be considered a “Declared Pregnant Worker” for the purpose of application of radiation protection related limits and/or work restrictions.

3. PROCEDURE

3.1 Equipment –

- Dosimeter(s) – typically Optically Stimulated Luminescence (OSL) badge, Electronic Personal Dosimeter (EPD), or similar.

NOTE: The RSO or ARSO will make arrangements through an approved and accredited dosimeter service (e.g., by NVLAP) to establish a standing order of dosimeters assigned by name to all full-time project employees including extra unassigned dosimeters for new employees (until added to dosimetry roster) and visitors, etc.

- CDPHE Form OR-RH-17

3.2 General Requirements for External Dosimetry Issuance – Requirements for personnel dosimetry will be determined on a project specific basis. At a minimum, any individual who may receive a dose greater than 10% of the 10 CFR Part 20 limits shall be subject to personal dosimetry.

- The personal dosimetry badge shall be capable of measuring the Deep Dose Equivalent (DDE) at a tissue depth of one centimeter, Lens Dose Equivalent (LDE) at a tissue depth of 0.3 centimeter, and Shallow Dose Equivalent (SDE) at a tissue depth of 0.007 centimeter.
- The purpose of the dosimeter is to determine the accumulated dose of the individual over a period of time for official dose records. Typically, the badges will be processed on

quarterly intervals. Dosimeters may be exchanged more often at the discretion of the RSO.

- The dosimeter should be placed on the location of the body expected to be representative of whole-body exposure, typically on the upper torso.

3.3 Initial Badge Issue –

- Ensure that the individual has received radiation safety training and instructions.
- If not already done so by the vendor, label the dosimeter with the individual's name or identification number.
- Record dosimeter number and issuance date on a dosimeter issue form or spreadsheet for record linking specific dosimeters and individual.
- Instruct individual on how/where on body to wear dosimeter (typically the torso) and where to store dosimeter when not wearing it (low background area).

3.4 Dosimeter Exchange –

- Collect all previously issued dosimeters and inventory them against the report of current dosimeter assignments and prepare a list of missing dosimeters. Attempt to recover any missing dosimeters by contacting users.
- Issue new dosimeter to all returning users. If not already done so by the vendor, label the dosimeter with the individual's name or identification number, and record dosimeter number and issuance date on a dosimeter issue form or spreadsheet for record linking specific dosimeters and individual. *NOTE: If dosimeter is damaged remove from service and issue another dosimeter.*
- Return exchanged dosimeters to vendor for analysis with the upcoming quarter (just received) Transit Control dosimeter and the previous quarter Deployment Control dosimeter with the exchanged dosimeters.

NOTE: Return Transit Controls immediately and keep Deployment Controls for the full quarter.

- Employee Termination – The RSO should be informed of an employee or contractor termination from the project so that the dosimeter may be collected. Record the termination date on the dosimeter issue form or spreadsheet.

NOTE: The termination date is the actual last date the occupational radiation exposure monitoring is needed; typically, the last day on site.

3.5 Employee Dose Results – When a dosimeter is returned to the vendor an exposure report for each badge will be made available to the RSO. This record of results shall be maintained for the duration of the license and updated at least annually.

- *Privacy* – Records will be protected from public disclosure due to personal privacy concerns and laws.
- *Lost Dosimeter* – In the event that a dosimeter is lost after it has been used, the dose received shall be estimated by the RSO. Acceptable methods of estimating the dose include using exposures from dosimeters worn by coworkers performing similar duties in the same work areas, and by multiplying average exposure rates for work areas by the time the worker was in these areas.
- *Pregnant Worker* – Exposure records of dose to an embryo/fetus with the records of dose to the declared pregnant woman shall be maintained. The declaration of pregnancy shall also be kept on file but may be maintained separately from the dose records.
- *Reporting* – An individual’s exposure may be made available to that individual upon request. If an individual’s total occupational dose exceeds 100 millirem (1 millisievert) TEDE or to any individual organ or tissue, then a report will be provided without request.

NOTE: This report must be furnished within 30 days from the time the request is made or within 30 days after the exposure of the individual has been determined, whichever is later.

4. REFERENCES

- 4.1** Radiation Protection Program (RPP)
- 4.2** U.S. NRC Regulatory Guide 8.25, “Air Sampling in the Workplace”
- 4.3** U.S. NRC Regulatory Guide 4.14, “Radiological Effluent and Environmental Monitoring at Uranium Mills”

5. ATTACHMENTS

- 5.1** Blank CDPHE Form OR-RH-17



OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD				Page ____ of ____		
1. NAME (LAST, FIRST, MIDDLE INITIAL)		2. IDENTIFICATION NUMBER		3. ID TYPE	4. SEX <input type="checkbox"/> MALE <input type="checkbox"/> FEMALE	5. DATE OF BIRTH
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER(S)	9A. <input type="checkbox"/> RECORD <input type="checkbox"/> ESTIMATE	9B. <input type="checkbox"/> ROUTINE <input type="checkbox"/> PSE
INTAKES				DOSES IN <input type="checkbox"/> Sv or <input type="checkbox"/> Rem		
10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN <input type="checkbox"/> Bq or <input type="checkbox"/> µCi (Check one)	(Check one)		
				DEEP DOSE EQUIVALENT (DDE)	11.	
				EYE DOSE EQUIVALENT (LDE)	12.	
				SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE, WB)	13.	
				SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE, ME)	14.	
				COMMITTED EFFECTIVE DOSE EQUIVALENT (CEDE)	15.	
				COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN (CDE)	16.	
				(BLOCKS 11 + 15) (TEDE)	17.	
				MAX ORGAN (BLOCKS 11 + 16) (TODE)	18.	
				19. COMMENTS		
20. SIGNATURE – LICENSEE OR REGISTRANT					21. DATE PREPARED	

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF DEPARTMENT FORM OR-RH-17 All doses should be stated in rems or sieverts (See RH 4.40.1)																
1. Type or print the full name of the monitored individual in the order of last name (include "Jr.," "Sr.," "III," etc), first name, middle initial (if applicable)	FOR ITEMS 10D-18 INDICATE IF THE UNITS ARE SI OR SPECIAL. (SEE RH 4.40.3)	19. Signature of the person designated to represent the licensee or registrant.														
1. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.	10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-#x," for instance, Cs-137 or Tc-99m.	20. Enter the date this form was prepared.														
2. Enter the code for the type of identification used as shown below: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;">CODE</th> <th style="text-align: left; border-bottom: 1px solid black;">ID TYPE</th> </tr> </thead> <tbody> <tr> <td>SSN</td> <td>U.S. Social Security Number</td> </tr> <tr> <td>PPN</td> <td>Passport Number</td> </tr> <tr> <td>CSI</td> <td>Canadian Social Insurance Number</td> </tr> <tr> <td>WPN</td> <td>Work Permit Number</td> </tr> <tr> <td>IND</td> <td>INDEX Identification Number</td> </tr> <tr> <td>OTH</td> <td>Other</td> </tr> </tbody> </table>	CODE	ID TYPE	SSN	U.S. Social Security Number	PPN	Passport Number	CSI	Canadian Social Insurance Number	WPN	Work Permit Number	IND	INDEX Identification Number	OTH	Other	10B. Enter the lung clearance class as listed in Appendix B to Part D (D, W, Y, V, or O for other) for all intakes by inhalation.	21. COMMENTS. In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Department in reference to the exposure report.
CODE	ID TYPE															
SSN	U.S. Social Security Number															
PPN	Passport Number															
CSI	Canadian Social Insurance Number															
WPN	Work Permit Number															
IND	INDEX Identification Number															
OTH	Other															
3. Check the box that denotes the sex of the individual being monitored.	10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."															
4. Enter the date of birth of the individual being monitored in the format MM/DD/YY.	10D. Enter the intake of each radionuclide in Bq or μ Ci.															
5. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY. – MM/DD/YY.	11. Enter the deep dose equivalent (DDE) to the whole body.															
6. Enter the name of the licensee or registrant.	12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.															
7. Enter the Department license or registration number or numbers.	13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).															
9A. Place an "x" in Record or Estimate. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.	14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).															
9B. Place an "x" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring Period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs	15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".															
	16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated".															
	17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.															
	18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.															

1. PURPOSE

The purpose of this procedure is to provide standard instruction on how to ship a container of soil samples having unknown radionuclide concentrations or activities as UN2910, Radioactive Materials, Excepted Package – Limited Quantity of Material.

NOTE: HAZMAT Shipper Training must be completed every two years. Only personnel trained on HAZMAT shipping may perform UN2910 shipping procedures.

2. RESPONSIBILITIES

Personnel responsible for the proper shipment of UN2910 materials would include the RSO/ARSO and the RST. The RST is known as the RSO-designee in License documents.

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent –

- Ensuring that gamma scans and contamination surveys were performed appropriately for the container to be shipped.
- Ensuring that shipping papers are properly completed and that the proper labels are applied to the containers.
- Ensuring that exposure rates and contamination levels are within prescribed limits.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is known as the RSO designee in licensing documents. Any reference to RST will include a reference to the RSO designee
- Collect gamma exposure rates and contamination samples.
- Count the contamination samples properly
- Record the data and provide the data to the RSO/ARSO
- Complete shipping papers and apply shipping labels as appropriate.
- Perform release surveys on trucks that are leaving the restricted area and transporting source material.

3. DISCUSSION

This procedure is to ensure proper packaging, labeling and shipment of samples when offered as UN2910 Radioactive Materials, Excepted Package – Limited Quantity of Material.

49 CFR 173.403 defines “*Limited quantity of Class 7 (radioactive) material*” as a quantity of Class 7 (radioactive) material not exceeding the material's package limits specified in Section 173.425 and conforming with requirements specified in Section 173.421.

Section 173.425 Table 4 Activity Limits for Limited Quantities shows the limited quantity package limits for *Solids: Normal form* are 1×10^{-3} the A^2 values found in Section 173.435 Table of A^1 and A^2 values for radionuclides. The radionuclides in soil most often shipped by DISA personnel are natural uranium (U-nat) and progeny, and natural thorium (Th-nat) and progeny. The A^2 values for both radionuclides are unlimited and include contributions from progeny with half-lives less than 10 days. The U-nat and Th-nat progeny (with associated A^2 values in curies [Ci]) that must be included in a sum of fractions calculation, for confirmation that limited quantity package activity limits are not exceeded, are shown in below Table 1. The sum of fraction values for both U-nat and Th-nat, assuming a 40-pound consignment, parent radionuclide concentrations in soil of 1,000 pCi/g, and progeny in secular equilibrium are located in Equation 1 and Equation 2 below. The sum of fraction calculated result in values of less than 1.0 for both U-nat and Th-nat. Therefore, assuming a sample container with no more than 40 pounds of soil containing either U-nat or Th-nat in concentrations of 1,000 pCi/g or less, the container would fall below the activity limits required allowing it to be shipped as UN2910 Radioactive Materials, Excepted Package – Limited Quantity of Material.

Symbol of radionuclide	A^2 (Ci)	Limited Quantity Package Limit (Ci)
U (nat)	Unlimited	Unlimited
Th-230	2.7×10^{-2}	2.7×10^{-5}
Ra-226	8.1×10^{-2}	8.1×10^{-5}
Pb-210	1.4	1.4×10^{-3}
Po-210	5.4×10^{-1}	5.4×10^{-4}
Th (nat)	Unlimited	Unlimited
Ra-228	5.4×10^{-1}	5.4×10^{-4}
Th-228	2.7×10^{-2}	2.7×10^{-5}

Table 1. Table of A² Values and Limited Quantity Package Limits

NOTE: A 40-pound container (18,144 grams) of soil samples with U-238 or Th-232 in soil at a concentration of 1000 pCi/g equates to an activity of 1.815 × 10⁻⁵ Ci of U-238/Th-232. Progeny of U-238 in secular equilibrium would have an activity of approximately 50% of this (a conservatively safe assumption), or 0.907 × 10⁻⁵ Ci.

$$SOF_{U-nat} = \frac{1.815 E-5}{Unlimited} + \frac{0.907 E-5}{2.7 E-5} + \frac{0.907 E-5}{8.1 E-5} + \frac{0.907 E-5}{1.4 E-3} + \frac{0.907 E-5}{5.4 E-4} = 0.45 \quad (\text{Equation 1})$$

$$SOF_{Th-nat} = \frac{1.815 E-5}{Unlimited} + \frac{1.815 E-5}{5.4 E-4} + \frac{1.815 E-5}{2.7 E-5} = 0.68 \quad (\text{Equation 2})$$

The Section 173.421 requirements for excepted package for limited quantities of Class 7 (radioactive materials) are such that a Class 7 (radioactive) material with an activity per package which does not exceed the limited quantity package limits specified in Table 4 in Section 173.425 (discussed in previous bullet), and its packaging are excepted from requirements in this subchapter for marking (except for UN identification number), and if not a hazardous substance or hazardous waste, shipping papers, and the requirements of this subpart if:

- Shipped in an appropriate container.
- The radiation level at any point on the external surface of the package does not exceed 0.5 mrem/h (500 μR/h).
- The removable contamination on the external surface of the package does not exceed limits specified in Section 173.443 (a); which are 240 dpm/cm² for beta, gamma and low-toxicity alpha emitters, or 24 dpm/cm² for all other alpha emitters, from a 300-cm² area; with removable activity calculated using a wipe efficiency of 0.10.

NOTE: Low toxicity alpha emitters means natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; and alpha emitters with a half-life of less than 10 days. If there is any question regarding which alpha contaminant limit to use communicate directly with the Project Health Physicist.

- The outside of the inner packaging or, if there is no inner packaging, the outside of the packaging itself bears the marking “Radioactive”.
- The package does not contain fissile material.

- The material is otherwise prepared for shipment as specified in accordance with Section 173.422.

Shipping potentially radioactive samples requires the individual preparing the shipment to have completed Hazardous Materials Transportation – General Awareness/Familiarization, Safety, and Security Awareness Training and the appropriate function specific training for the particular shipping task. The task of shipping potentially radioactive samples requires the ‘Function Specific Training – DOT, IATA, & NRC Requirements for Shipping Limited Quantity Radioactive Materials’.

NOTE: Personnel who have not completed the required training or are no longer current on their training are not permitted to ship UN2910 under any circumstances. Under the provisions of Title 49, U.S. Code 5123 (a)(1), persons (as defined in Title 49 CFR 171.8) in violation of the HMR are subject to a civil penalty of up to \$50,000 for each violation, and in some instance’s criminal penalties.

4. PROCEDURE

3.1 Supplies -

- **Shipping Container** – Ship samples in a container that is durable enough to reasonably assume when loaded it will arrive at its destination intact. Select a container of appropriate size to minimize unnecessary void space, and fill remaining void space, as necessary to minimize sample bag movement and resulting leakage. If the container has a drain plug it must be secured in closed position. Shipping containers may be requested from/provided by the analytical laboratory to be used for sample analysis.
- **Sample Bags and/or Sample Containers** – Sample bags or sample containers should not leak or break during shipment. Ziploc type bags can be used for soils and other dry materials, as long as the bag is sealed tight. Consider double-bagging samples to minimize potential spillage. Avoid glass containers, if possible, as they have a higher potential to break during shipment.
- **Laboratory Chain-of-Custody Form** – A completed chain-of-custody (COC) form should always accompany samples sent to a laboratory. *NOTE: Each lab has its own COC form. Use the appropriate lab-specific COC for the lab being shipped to.* Each shipping container should have its own COC placed on top of the samples prior container closure so that it is readily available upon receipt by the lab.

- **Custody Seal** – When the shipping container is loaded and ready to ship, place a custody seal on the shipping container in such a manner that the container cannot be opened without breaking the seal. Custody seals may be requested from/provided by the analytical laboratory to be used for sample analysis.
- **Tape** – Clear packing or strapping tape that will ensure the shipping container remains closed until delivery and intentional opening.
- **Radiological Survey Instruments** – An exposure rate meter such as a Ludlum Model 19, or similar; and a surface activity detector and meter, such as a Ludlum Model 43-93 with Ludlum Model 2360, or similar.

3.2 **Load Samples into Container** – Place the soil samples into the shipping container and limit each shipping container's total loaded weight to no more than 40 pounds. Use more than one container, when necessary. Load samples in a manner that evenly distributes samples throughout the container and attempt to minimize void space. Fill excess void space with packing materials, as necessary.

3.3 **Close Shipping Container** – Fill out a custody seal with signature and date of person securing closure of the shipping container. Place the custody seal in position on the shipping container which will break when the container is opened. Use packing or strapping tape to secure the shipping container lid in a closed position.

3.4 **Survey Shipping Container and Document** – Survey and document in logbook or Form SOP-06B *UN2910 Shipping Package Survey* that the shipping container meets radiological limits for UN2910 Limited Quantity, Excepted Package, which are:

- **Exposure Rate Limit** –

The maximum allowable exposure rate on any external surface of a “Limited Quantity” package shall not exceed 500 $\mu\text{R/hr}$.

NOTE: Alternatively, if 500 $\mu\text{R/hr}$ on the outside of the package is exceeded, try using a larger package, or limit the number of samples inside the package.

Use the exposure rate meter to measure the shipping containers external surfaces. Record instrument information (make/model/serial number calibration due date) and the maximum exposure rate measured in a project logbook or on Form SOP-06B *UN2910 Shipping Package Survey*.

- **Removable Contamination Limit –**

The maximum allowable removable contamination limit for “all other alpha emitters is 24-dpm/cm² over a 300-cm² area, or 7,200 dpm/300-cm².

NOTE: If total contamination levels measured with a handheld instrument are less than 7,200 dpm/300-cm² (2,400 dpm/100-cm² over a 300-cm² area) then removable contamination levels may also be expected to be less than 7,200 dpm/300-cm², and therefore meet the Removable Contamination Limit.

The maximum allowable removable contamination limit for beta, gamma and low toxicity alpha emitters is 240 dpm/cm² over a 300-cm² area, or 72,000 dpm/300-cm².

NOTE: For calculating removable contamination activity a removal efficiency of 0.10 is acceptable.

Use the surface activity detector and meter to measure the shipping containers external surface total contamination levels. If there is any measurable contamination decontaminate the shipping container or use another shipping container. Record instrument information (make/model/serial numbers calibration due date) and the maximum surface activity rate measured in a project logbook or on Form 06B Shipping Container Survey Log.

NOTE: If using a Model 2360 with Model 43-93 detector to measure total surface activity then a typical alpha efficiency of 10-percent and beta efficiency of 15-percent may be used in the calculation. This would result in using action levels of 240 cpm/100-cm² above background for “all other alpha emitters” and 3,600 cpm/100-cm² above background for beta-gamma and low toxicity alpha emitters. Contamination levels below these values and the package meets the limits specified in Section 173.443 (a).

3.5 **Labeling** – The outside of the container must be marked with a UN2910 label, and include the language Radioactive Material, Excepted Package – Limited Quantity of Material. An acceptable form of this label is included in this procedure as an attachment. The only marking/labeling requirement for this UN number is having the label placed on top of the box. No Dangerous Goods HAZMAT paperwork is required.

3.6 **Ship the Container** – Ship the container via FedEx or UPS.

NOTE: Indicate on the shipping form or label that Dangerous Goods are included. The FedEx labels and online label have an option under Special Services to identify the shipment as having Dangerous Goods. Indicate that Dangerous Goods are packed as Inaccessible, which is to say they are not required to be accessible.

4. REFERENCES

- 4.1 49 CFR 172 Subpart I
- 4.2 49 CFR Section 172 – Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, And Security Plans
- 4.3 49 CFR Section 173 – Shippers General Requirements for Shipments And Packagings

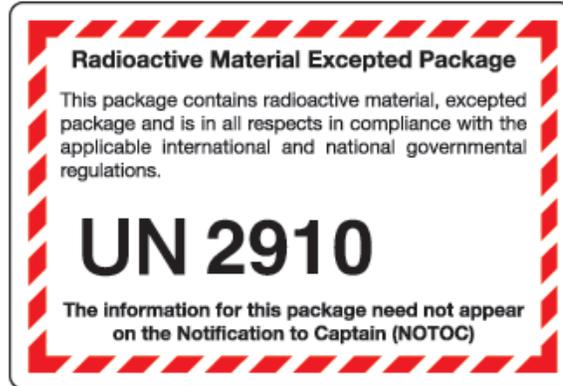
5. ATTACHMENTS

- 5.1 UN 2910 Shipping Label
- 5.2 Form SOP-10A UN2910 Shipping Package Survey



UNCONTROLLED COPY IF PRINTED

ATTACHMENTS



UN2910 Label

Form SOP-10A

UN2910 Shipping Package Survey Form

SITE:		PACKAGE DESCRIPTION:				Page				
SAMPLE TYPE(S):		PACKAGE #			DATE:					
Meter / Detector	Radiation Type	Serial Number:		Cal. Due Date:		Background (CPM)		Total Efficiency (counts/decay)		
		Meter	Detector	Meter	Detector	Alpha (α)	Beta (β)	Alpha (α)	Beta (β)	
	(α/β)									
	(γ)		NA		NA		(μR/hr)	NA	NA	
Contamination Limits:		Removable α: 24 DPM/cm ² or 7,200 DPM/300 cm ²			Removable β/γ and α _{LT} ** 240 DPM/cm ² or 72,000 DPM/300 cm ²			Max Gamma: 500 μR/hr	Package Diagram with Annotated Survey Locations:	
Sample No.	Description/ Location	Gross CPM α Removable	Net CPM α Removable	dpm/cm ² α Removable*	Gross CPM β Removable	Net CPM β Removable	dpm/cm ² β Removable*	Exposure Rate (μR/hr) on Contact		
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
REMARKS:										
TECHNICIAN SIGNATURE/DATE:										
REVIEWER SIGNATURE/DATE:										

* Including addition of a swipe removal efficiency factor of 0.1 (i.e., ε_t × 0.1; see SOP-03)

** α_{LT} = Low toxicity alpha emitters

1. PURPOSE

This Standard Operating Procedure (SOP) describes the steps for conducting radiological dose rate and contamination surveys of haul trucks transporting uranium source material as LSA-1. This SOP covers the steps necessary to ensure a haul truck carrying uranium source material meets the DOT requirements to transport material as LSA-1. Requirements include personnel training, radiological dose rate and removable contamination surveys, vehicle placarding and marking, and making sure all paperwork associated with the shipment is correct and complete.

Anyone associated with the loading/unloading, transport of, and radiological survey of the trailer must have all appropriate hazardous materials (HAZMAT) shipper training; including knowledge of emergency response information, self-protection measures, accident prevention methods and procedures, and modal-specific training requirements for the shipment of LSA-1 materials.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent) –

- Development and approval of SOPs and oversight of procedure implementation.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is known as the RSO designee in License documents. References to the RST will also mean the RSO designee, as well.
- Onsite management and implementation of this SOP, including daily instrument QC checks, radiological surveys, documentation, etc.

3. PROCEDURE

3.1 Equipment –

- Ludlum Model 19 Micro-R Meter (Model 19), or similar.
- Ludlum Model 2929 with Ludlum Model 43-10-1 Dual-Channel Tray Counter (Model 2929), or similar.
- Radiological check source and materials as needed for instrument function checks and efficiency determinations.
- Removable surface contamination swipe (smear) sampling pads.
- SOP-11A LSA-1 Shipment Survey Form to document survey results.

3.2 Contamination Survey Procedure –

3.2.1 Preliminary Radiological Survey Measurements

Function-check radiological survey instruments in accordance with SOP-02 (*Operational Checkout of Single-Channel Detector with Meter*) and SOP-03 (*Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter*), as applicable.

3.2.2 Shipping Manifest Confirmation

Receive the shipping manifest, as prepared by the haul truck driver. Determine the total amount of radioactivity contained in the source materials shipment (expressed as percent uranium oxide (% U₃O₈)) and provide this information along with the measured Transport Index to the driver to complete the shipping manifest. Both values will be determined by the Radiation Safety Technician (RST) and included on Form SOP-11A following radiological release surveys. Confirm that the manifest is complete and correct.

- Must include the Consignor’s address.
- Must include the Consignee’s address.
- The words “Exclusive Use Shipment” must be included on the paperwork.
- Must include the DOT proper shipping name and description, including:
 - Shipping Name: Radioactive material, low specific activity (LSA-I)
 - Hazard Class: Class 7
 - Identification Number: UN2912
 - Packaging: Bulk-Unpackaged
 - Quantity: Total amount of radioactivity being shipped in terabecquerels (TBq) and in curies (Ci).

NOTE: This value is calculated on Form SOP-11A based on the source materials grade and measured net weight of source materials in the shipment.

- Radionuclide(s): U-Nat, Pb-210, Po-210, Ra-226, Rn-222, Th-230.
- Form: Solid (Uranium Ore Concentrate)
- Transport Index: The Transport Index (T.I.) will be calculated below.
- The emergency contact and phone number need to be included.
- The Facility Service Manager must certify the shipment by signing and dating the manifest.
- Keep a copy of the shipping manifest with the contamination survey log form for the shipment.

3.2.3 Visual Vehicle Inspection

Walk around the trailer and visually confirm and document of Form SOP-11A the following:

- The tarp cover assembly and gates must be closed and secured.
- There should be no loose or leaking material observed on the trailer. If loose material is identified, then it should be removed.
- The words “RADIOACTIVE – LSA” and “FOR RADIOACTIVE MATERIALS USE ONLY” are stenciled or marked in a visible and conspicuous place on both sides of the trailer on the in 3-inch letters.
- If the shipping manifest indicates a quantity greater than 0.053 Ci then the letters “RQ” must also be stenciled or marked in a visible and conspicuous place on both sides of the trailer in 3-inch letters.
- Each side and end of the trailer shall have a “RADIOACTIVE” placard.

3.3 Radiological Survey

3.3.1 Release Dose ate Measurements

The Ludlum Model 19 instrument measures external gamma exposure rate [in units of micro-roentgen per hour ($\mu\text{R/hr}$)]. For the purposes of this procedure, the measured exposure rate value will be considered equivalent to the tissue-equivalent dose rate [in units of microrem per hour ($\mu\text{rem/hr}$)], and this dose rate will be divided by 1,000 to obtain the dose rate in units of millirem per hour (mrem/hr) as required by DOT regulations.

- Walk around the trailer making periodic measurements with the Ludlum Model 19 on the side, top and underneath surfaces. No point on the external surfaces should exceed 200,000 $\mu\text{R/hr}$. Enter the measurement results and locations on Form SOP-11A. Use the calculator spreadsheet to assist with calculations.

NOTE: The maximum reading a Ludlum Model 19 can display is 5,000 $\mu\text{R/hr}$. If this rate is exceeded, then contact the site Radiation Safety Officer (RSO) for further guidance.

- Walk around the trailer making periodic measurements 2-meters from the trailer side. No point on the external surfaces should exceed 10,000 $\mu\text{R/hr}$. Confirm on Form SOP-11A that no readings exceed 10,000 $\mu\text{R/hr}$.

- **Transport Index** – At the location exhibiting the highest gamma rates make a measurement 1-meter from the trailer side. The Transport Index is equivalent to the millirem measurement.

EXAMPLE: 2 millirem (2,000 μ R/hr) at 1-meter away results in a T.I. of 2.0.

Record on Form SOP-11A the Transport Index. Provide this value to the driver to complete the shipping manifest.

- Make a measurement in the haul truck driver’s cab (occupied space) with the Ludlum Model 19. No point in the cab should exceed 2,000 μ R/hr. Confirm on Form SOP-11A that no readings exceed 2,000 μ R/hr.

3.3.2 Removable Contamination Measurements

Make enough removable contamination measurements to ensure the trailer has been adequately surveyed.

- Select locations on the trailer to make removable contamination measurements. Swipe locations should be selected to identify areas of possible contamination; tires, visible dust, gates, etc.
- Using a removable contamination swipe and pressing downward on the surface, cover an area of 300-cm², approximately 2-inches wide by 24-inches long.
- Count the swipes on the Ludlum Model 2929 with Ludlum Model 43-10-1 tray counter (or equivalent) and enter the results on Form SOP-11A. No removable contamination measurement may exceed 24 dpm/cm² for alpha or 240 dpm/cm² for beta-gamma. The removable activity calculations must account for the 0.10 removable efficiency. This factor is built into Form SOP-11A calculator spreadsheet already.

3.4 Survey Documentation

- If using the digital form (calculator spreadsheet), print Form SOP-11A from the Form SOP-11A Calculator spreadsheet. Otherwise, perform and check calculations and fill out Form SOP-11A completely and accurately.
- Review and confirm all criteria result in a “PASS” result, and there are no failures. If results are acceptable, sign and date the form. If results are not acceptable then identify what additional information is necessary and/or contact the site RSO for additional guidance.
- Make a copy of final documentation and provide to the haul truck driver for their records.

- Attach the shipping manifest copy provided by the haul truck driver to the completed Form SOP-11A and file.

4. REFERENCES

- 4.1** Radiation Protection Program (RPP) Manual

5. ATTACHMENTS

- 5.1** Form SOP-11A LSA-I Shipment Survey Form

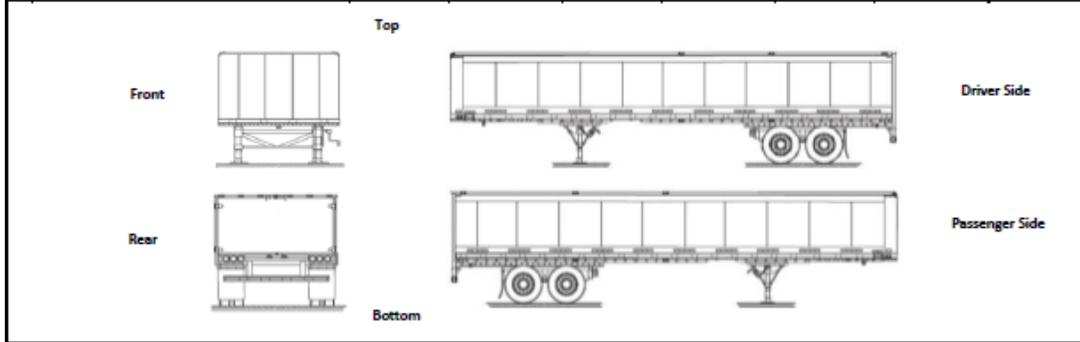
Form SOP-11A LSA-I Shipment Survey Form

Facility: _____	Transport Vehicle ID: _____	Date/Time: _____
Shipping Container Contents Description: _____		U308 Grade: _____ %

Has a complete and correct Shipping Manifest been provided?	Yes or No	
Is the tarp cover assembly and tailgate fully closed and secured?	Yes or No	
Is there loose or leaking material observed on vehicle?	Yes or No	
Is the vehicle properly marked and placarded?	Yes or No	
Maximum exposure rate 2-meters from vehicle outer lateral surfaces (µR/hr):	Consignment Limit: 10,000 µR/hr	
Maximum exposure rate vehicle cab-interior (µR/hr):	Limit: 2,000 µR/hr	
Transport Index (T.I.):	T.I. Limit: 10.0	

Instrument Make/Model:			
Instrument Serial No.:			
Calibration Due Date:			
Total Efficiency (cpm/dpm): ⁽²⁾	n/a		
Background (counts):	Cs-137 Button Source	alpha:	beta:
MDA (dpm/100-cm ²): ⁽⁴⁾	n/a		

#	Package/Description	Contact Exposure Rate Limit: 200,000 µR/hr		Remov. Alpha Activity ⁽³⁾ Limit: 24 dpm/cm²		Remov. Beta Activity ⁽³⁾ Limit: 240 dpm/cm²		Meets DOT Limits For Shipping
		Gross (µR/hr)	Net (µR/hr)	Gross Counts	Activity (dpm/100 cm ²)	Gross Counts	Activity (dpm/100 cm ²)	
1								
2								
3								
4								
5								
6								
7								
8								



Comments: _____

Technician Signature/Date: _____

Reviewer Signature/Date: _____

Notes:

- (1) Radiological check sources used:
If instrument function check is within acceptable range then total efficiency number used is based on initial instrument QC counts. The instrument total efficiency is calculated per NUREG 1575; Total Efficiency =
- (2) Instrument Efficiency X Source Efficiency. Alpha source efficiency and beta source efficiency (for < 400 keV) = 0.25.
- (3) Smear removal efficiency of 0.10 used in removable activity calculation.
- (4) Calculations rely on user set count times:

ALPHA: Th-230 (s/m:)		2π dpm
BETA: Tc-99 (s/m:)		2π dpm
Remov. SOURCE Count Time:		minute(s)
Remov. BKG Count Time:		minute(s)
Remov. SAMPLE Count Time:		minute(s)

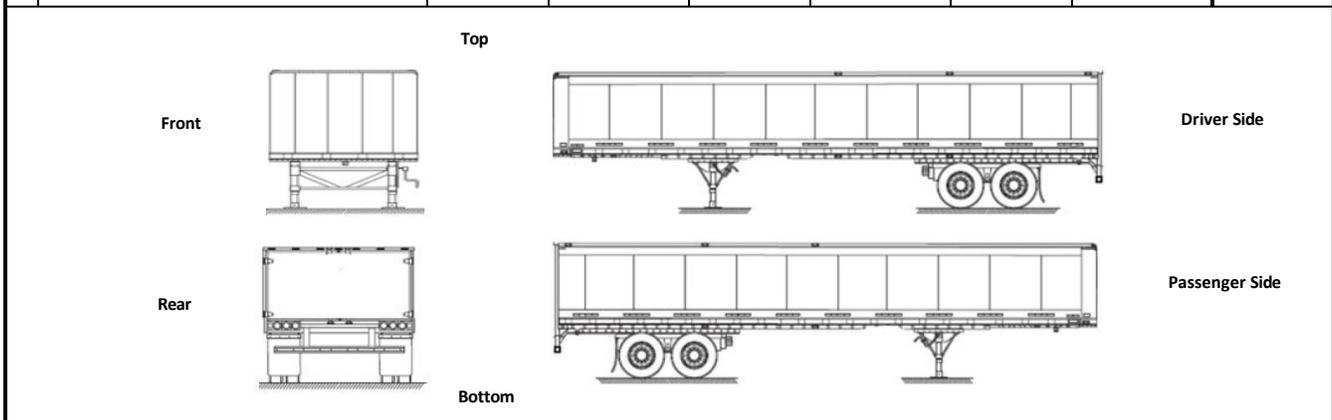
SOP-3A - LSA-I Shipment Survey Form

Facility: _____ Transport Vehicle ID: _____ Date/Time: _____
 Shipping Container Contents Description: _____ U3O8 Grade: _____%

Has a complete and correct Shipping Manifest been provided?	Yes or No
Is the tarp cover assembly and tailgate fully closed and secured?	Yes or No
Is there loose or leaking material observed on vehicle?	Yes or No
Is the vehicle properly marked and placarded?	Yes or No
Maximum exposure rate 2-meters from vehicle outer lateral surfaces (µR/hr):	Consignment Limit: 10,000 µR/hr
Maximum exposure rate vehicle cab-interior (µR/hr):	Limit: 2,000 µR/hr
Transport Index (T.I.)	T.I. Limit: 10.0

Instrument Make/Model:	
Instrument Serial No.:	
Calibration Due Date:	
Total Efficiency (cpm/dpm): ⁽²⁾	<i>n/a</i>
Background (counts):	<i>n/a</i>
MDA (dpm/100-cm ²): ⁽⁴⁾	<i>n/a</i>

#	Package/Description	Contact Exposure Rate Limit: 200,000 µR/hr		Remov. Alpha Activity ⁽³⁾ Limit: 24 dpm/cm ²		Remov. Beta Activity ⁽³⁾ Limit: 240 dpm/cm ²		Meets DOT Limits For Shipping
		Gross (µR/hr)	Net (µR/hr)	Gross Counts	Activity (dpm/100 cm ²)	Gross Counts	Activity (dpm/100 cm ²)	
1								
2								
3								
4								
5								
6								
7								
8								



Comments: _____
 Technician Signature/Date: _____
 Reviewer Signature/Date: _____

Notes:

(1) Radiological check sources used:

If instrument function check is within acceptable range then total efficiency number used is based on initial instrument QC counts. The instrument total efficiency is calculated per NUREG 1579; Total Efficiency = Instrument Efficiency × Source Efficiency. Alpha source efficiency and beta source efficiency (for < 400 keV) = 0.25.

ALPHA: Th-230 (s/n: _____)	_____	2TT dpm
BETA: Tc-99 (s/n: _____)	_____	2TT dpm
Remov. SOURCE Count Time: _____	_____	minute(s)
Remov. BKG Count Time: _____	_____	minute(s)
Remov. SAMPLE Count Time: _____	_____	minute(s)

SOP-3A - LSA-I Shipment Survey Form

- (3) Smear removal efficiency of 0.10 used in removable activity calculation.
- (4) Calculations rely on user set count times:

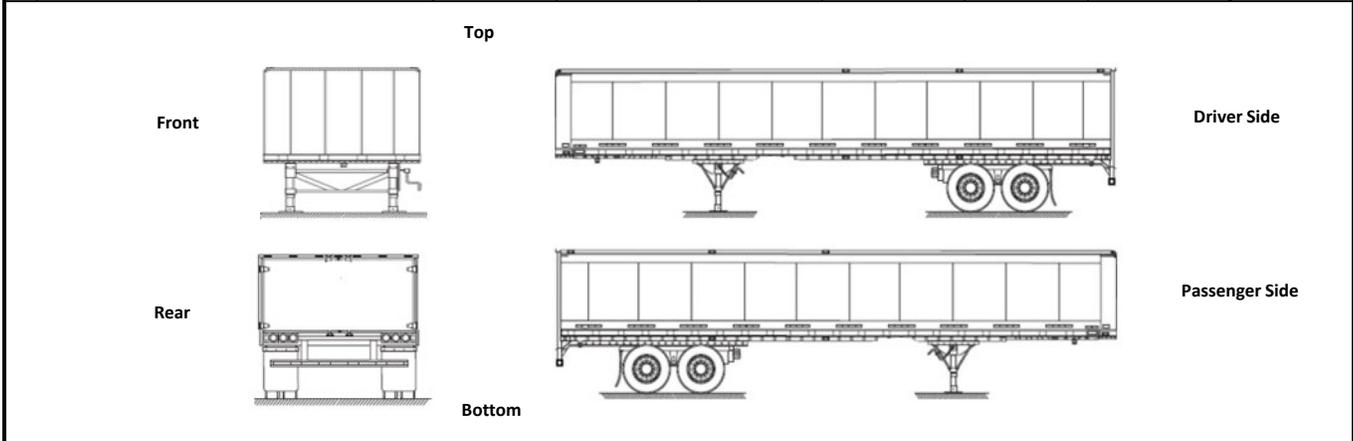
SOP-3A - LSA-I Shipment Survey Form

Facility: _____ Transport Vehicle ID: _____ Date/Time: _____
 Shipping Container Contents Description: _____ U308 Grade: _____%

Has a complete and correct Shipping Manifest been provided?	Yes or No
Is the tarp cover assembly and tailgate fully closed and secured?	Yes or No
Is there loose or leaking material observed on vehicle?	Yes or No
Is the vehicle properly marked and placarded?	Yes or No
Maximum exposure rate 2-meters from vehicle outer lateral surfaces (µR/hr):	Consignment Limit: 10,000 µR/hr
Maximum exposure rate vehicle cab-interior (µR/hr):	Limit: 2,000 µR/hr
Transport Index (T.I.)	T.I. Limit: 10.0

Instrument Make/Model:	
Instrument Serial No.:	
Calibration Due Date:	
Total Efficiency (cpm/dpm): ⁽²⁾	n/a
Background (counts):	alpha: _____ beta: _____
MDA (dpm/100-cm ²): ⁽⁴⁾	n/a

#	Package/Description	Contact Exposure Rate Limit: 200,000 µR/hr		Remov. Alpha Activity ⁽³⁾ Limit: 24 dpm/cm ²		Remov. Beta Activity ⁽³⁾ Limit: 240 dpm/cm ²		Meets DOT Limits For Shipping
		Gross (µR/hr)	Net (µR/hr)	Gross Counts	Activity (dpm/100 cm ²)	Gross Counts	Activity (dpm/100 cm ²)	
1								
2								
3								
4								
5								
6								
7								
8								



Comments:
 Technician Signature/Date:
 Reviewer Signature/Date:

SOP-3A - LSA-I Shipment Survey Form

(1) Radiological check sources used:

- If instrument function check is within acceptable range then total efficiency number used is based on initial instrument QC counts. The instrument total efficiency is calculated per NUREG 1579; Total Efficiency = Instrument Efficiency × Source Efficiency. Alpha source efficiency and beta source efficiency (for < 400 keV) = 0.25.
- (2)
 - (3) Smear removal efficiency of 0.10 used in removable activity calculation.
 - (4) Calculations rely on user set count times:

BETA: Tc-99 (s/n:)		2π dpm
Remov. SOURCE Count Time:		minute(s)
Remov. BKG Count Time:		minute(s)
Remov. SAMPLE Count Time:		minute(s)

1. PURPOSE

The purpose of this procedure is to provide guidance and identify requirements for conducting contamination surveys, counting of removable contamination swipes (smears), and air sample filters (filters) by personnel working under the Disa Service Providers Radioactive Materials License.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (RSO Equivalent) –

- The requirements of this procedure are properly implemented.
- All staff, including project employees and contractors at a site, are properly trained to perform activities identified in this procedure.
- Swipe and filter counting records are properly reviewed.

2.2 Radiation Safety Technician (RST) (RSO Designee) –

- The RST is known as the RSO designee in License documents. Any reference to RST includes a reference to RSO designee.
- Use calibrated counting instruments.
- Generate and maintain records in accordance with this procedure.
- Perform counting instrument function checks, and notify the RSO, ARSO, or AU when operational checks fall outside acceptable ranges.
- Notify the RSO, ARSO, or AU when sample activity is detected above established limits and/or criteria.

3. PROCEDURE

3.1 Equipment and Materials –

- Calibrated scalar meter with tray-counter detector (tray counter), e.g., Ludlum 2929 with 43-10-1, or equivalent.
- Ludlum Model 2360 with a Ludlum 43-93 or equivalent for alpha/beta contamination/release surveys
- Ludlum Model 3000 with a 44-10 detector, or equivalent for gamma radiation
- Radioactive check sources, e.g., Th-230 (alpha) and Tc-99 (beta), or equivalent.
- Planchet(s)

3.2 Function Check – The tray counter shall be function checked prior to use in counting

swipes or filters using the most current revision of SOP-03 *Operational Checkout of Dual- Channel Alpha/Beta Detector with Meter.*

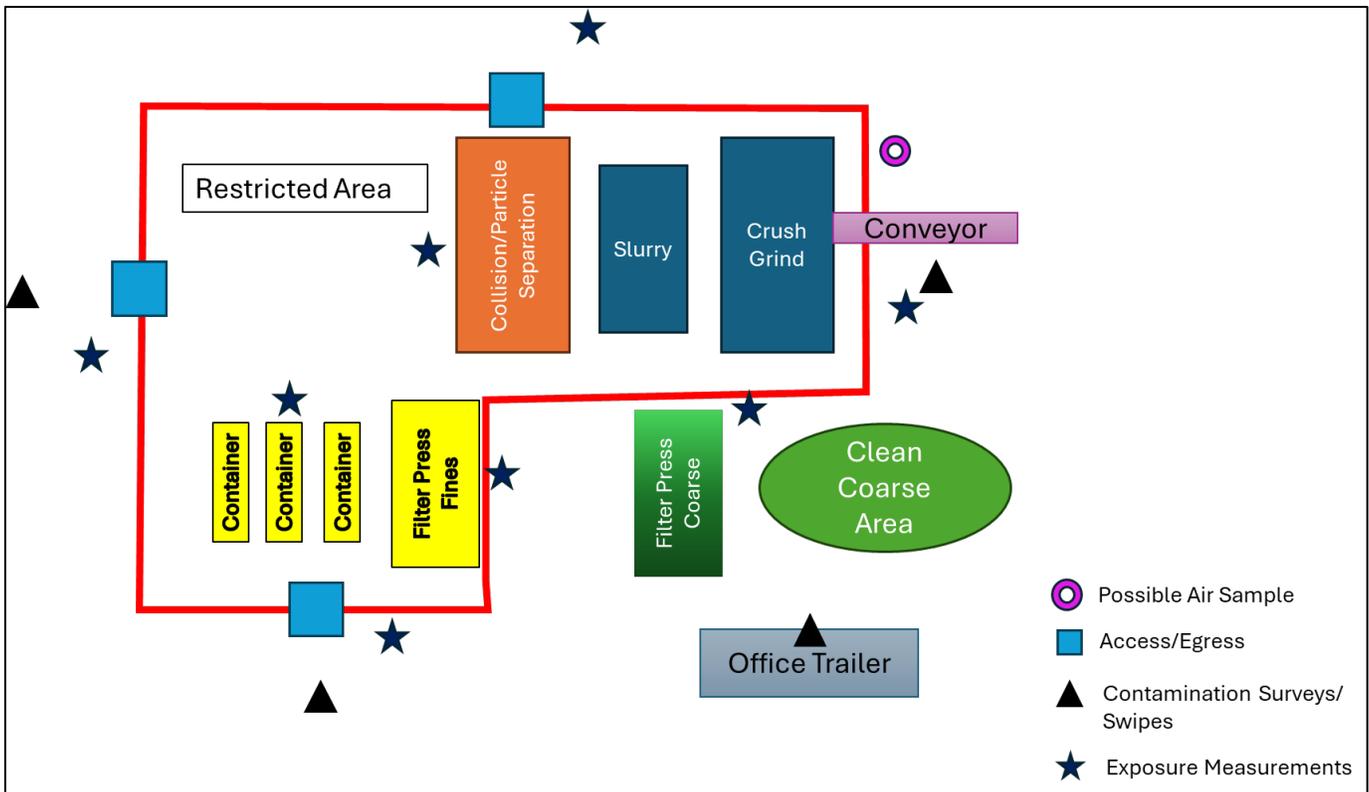
3.3 Exposure and Contamination Survey Procedure

3.3.1 Restricted Areas

Restricted areas will be established around the HPSA equipment including crushing and grinding, slurry, collision, and particle separation equipment. Also included in the restricted area will be the fines concentrates filter press and storage containers. The restricted area will be designated by a physical barrier such as posts and ropes, temporary chain link, or other types of barriers. Access and egress to the restricted area will occur only at certain point designated at the time the area is established and will be located in a manner to promote safe work flow. No unauthorized people are allowed in the restricted including members or the public or workers who are not trained to be there.

3.3.2 Exposure Surveys

Exposure surveys are to be performed daily at areas within the work area where uranium is being concentrated or stored. The figure below shows examples of where to conduct exposure surveys.



The purpose of the exposure measurements is to ensure that workers are not receiving unnecessarily high doses and that areas within the restricted area are properly marked and signed. DISA expects that certain areas may be considered radiation areas based on dose, for example, the fines concentrates container storage area. Radiation areas means an area, accessible to individuals,

in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates

Exposure measurements are also necessary to ensure that the restricted area is sufficiently large to prevent members of the public from receiving a dose greater than 2 mrem/hour. If exposures to members of the public exceed this rate at the restricted area boundary, the boundary will be moved until the 2 mrem/hour limit is met.

3.3.3 Contamination Surveys

Contamination surveys will be designed to detect the spread of contamination outside the restricted area. Contamination surveys will include, at a minimum, soil surveys in areas immediately outside restricted area access/egress points, on equipment and personnel leaving the restricted area, and in office/eating areas outside the restricted area. Surveys will consist of either swipes or measurements with a meter. Measurements with a meter (alpha/beta) will occur by holding the detector approximately 0.5 inch from the surface to be surveyed and moving the detector at a speed of approximately on detector dimension per second.

Swipes will occur by first measuring alpha, as discussed above, to identify any potential hotspots on the surface and then using a swipe to rub an area of 100 cm². If a hotspot is not identified then use a swipe to collect a sample on a surface that is the most accessible to workers. Swipes are then counted to obtain the alpha contamination level.

3.3.4 Survey Frequencies

1. Exposure Surveys will be conducted daily to ensure that gamma exposures are within limits to workers and members of the public.
2. Site contamination surveys (land outside restricted area access points and office trailers) will be performed weekly.
3. Personnel and equipment contamination surveys will be conducted as needed when personnel must be released from the restricted area. This includes surveys required to release containers for transportation.

3.4 Sample Counting – For counting swipes or filters:

- Obtain tray counter background; place a blank swipe or filter on a planchet and count for one-minute, or sufficient time to achieve the necessary counting minimum detectable activity (MDA).

NOTE: The MDA should be approximately 10% of, but no greater than 50% of, the applicable contamination limit or DAC. The MDA and detector efficiency may be calculated on a results calculator spreadsheet form or noted on the instrument function check form and calculated using the instrument's initial QC counts, per SOP-03.

- Record the background counts onto Form SOP-12A – *Removable Contamination Survey Results Form* for swipes or Form SOP-12B – *Air Sample Filter Results*, or equivalent calculator spreadsheet form, as appropriate.

- **For Swipes** – Place the sample swipe on a planchet and count for the one-minute, or sufficient time to achieve the necessary counting MDA, and record the results on SOP- 12A or equivalent calculator spreadsheet.
- **For Air Filters** – Place the sample filter on a planchet and count for the sufficient time to achieve the necessary counting MDA.
 - Enter the air sample start time, end time and flow rate onto Form SOP-12B – *Air Sample Filter Results*, or form calculator spreadsheet to calculate the volume of air sampled.
 - Record the sample counts onto Form SOP-12B – *Air Sample Filter Results*, or form calculator spreadsheet.

NOTE: Air Sample Filter Results Form calculator spreadsheet will calculate all appropriate DAC values.

- Compare counting results to project or site contamination or air concentration limits. Notify RSO of any failures.

4. REFERENCES

- 4.1 Radiation Protection Program (RPP) Manual
- 4.2 SOP-03 Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter

5. ATTACHMENTS

- 5.1 Form SOP-12A Removable Contamination Survey Results Form
- 5.2 Form SOP-12B Air Sample Filter Results

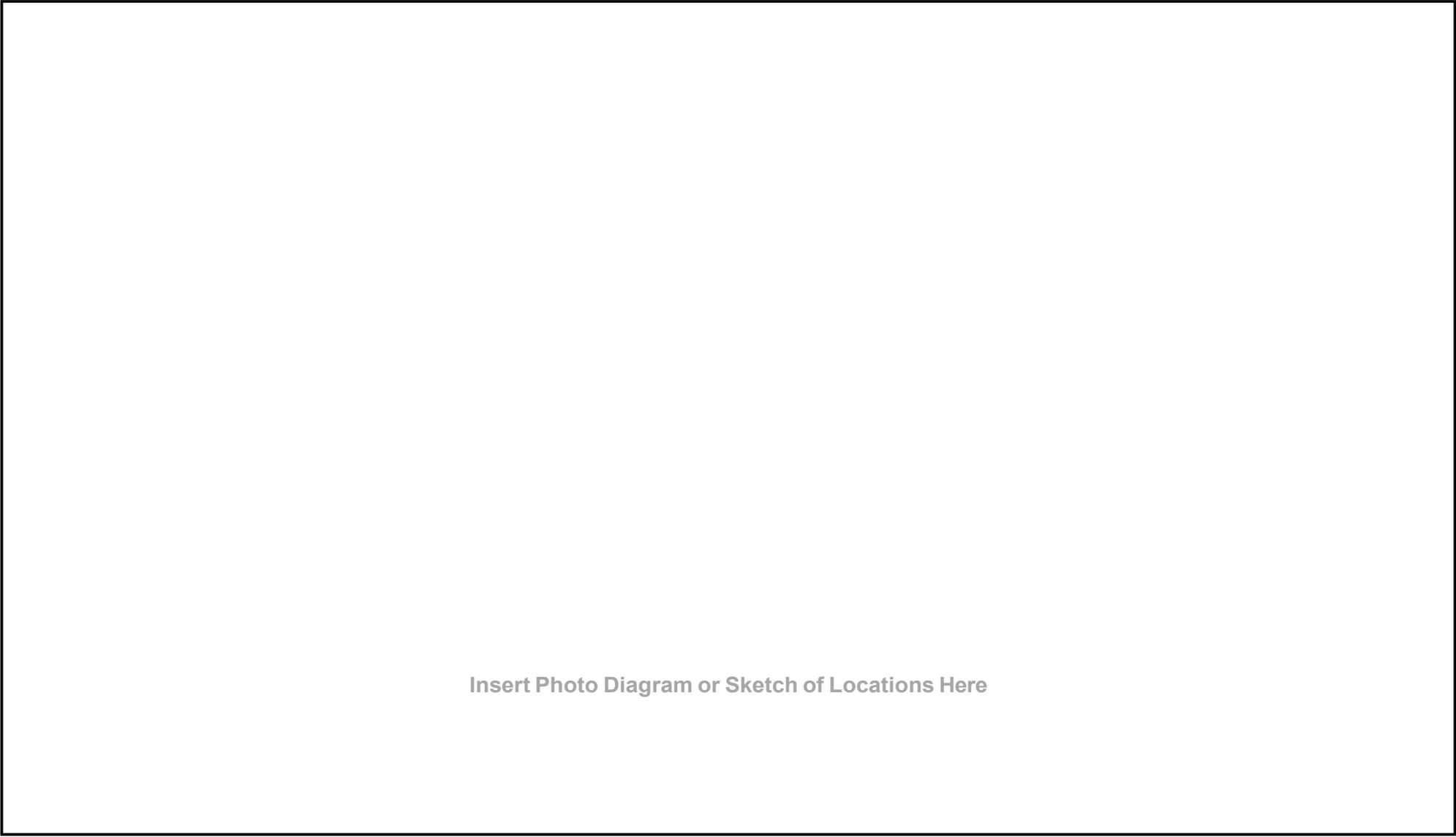
Form SOP-12A Contamination Survey Form

Site:		Equipment Use/Location:							Page						
Survey Description:								RWP #					DATE:		
Meter / Detector (radiation survey type):	Detector Area (cm²):	Serial Number:		Cal. Due Date:		Background (CPM)		Total Efficiency (counts/decay)							
		Meter	Detector	Meter	Detector	Alpha (α)	Beta (β)	Alpha (α) **	Beta (β) **						
Model 2360 / 43-93 (a/⚡)	100														
Model 19 (ε)	NA		NA		NA			(μR/hr)	NA			NA	NA		
Model 2929 Swipe Counter (a/⚡)	32														
Contamination Limits: (dpm/100cm²) *		Removable α: 1,000 (200) dpm/100 cm²			Removable β: 1,000 (200) dpm/100 cm²			Total α: 5,000 dpm/100 cm²			Total β: 5,000 dpm/100 cm²			Net γ: 25 μR/hr	
Sample No.	Description/ Location	Gross CPM a Removable	Net CPM a Removable	dpm/100cm ² a Removable	Gross CPM ⚡ Removable	Net CPM ⚡ Removable	dpm/100cm ² ⚡ Removable	Gross CPM a Total	Net CPM a Total	dpm/100cm ² a Total	Gross CPM ⚡ Total	Net CPM ⚡ Total	dpm/100cm ² ⚡ Total	Gross Gamma (μR/hr)	Net Gamma (μR/hr)
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
REMARKS:															
TECHNICIAN SIGNATURE/DATE:															
REVIEWER SIGNATURE/DATE:															

*Administrative limit given in parentheses

**Per SOP-03

Site:		Survey Locations Diagram	Page
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Air Sample Collection and Analysis Log

Air Sample Collection:

Sample Number:

		Technician:		Date:	
Air Sampler Make/Model:		Air Sampler Serial Number:		Air Sampler Calibration Due:	
1	Collection Start Time (24:00):		Collection Stop Time (24:00):		Elapsed Time (min.):
	Flow Rate Start (LPM):		Flow Rate Stop (LPM):		Flow Rate Average (LPM):
	Volume (ml)				
2	Collection Start Time (24:00):		Collection Stop Time (24:00):		Elapsed Time (min.):
	Flow Rate Start (LPM):		Flow Rate Stop (LPM):		Flow Rate Average (LPM):
	Volume (ml)				
Total Air Sample Volume (ml):					0.00E+00

Air Sample Analysis:

Tray Counter Make/Model:		Tray Counter Serial Number:	Tray Counter Calibration Due:	
Alpha-Channel Efficiency ⁽¹⁾ :		Radionuclide Of Concern:		DAC Limit ⁽²⁾ (µCi/ml):
1	Analysis Date:			Analysis Time (24:00):
	Total Alpha Background Counts:	Background Count Duration (min.):		Alpha Background Count Rate (cpm):
	Gross Alpha Sample Counts:	Sample Count Duration (min.):		Sample Count Rate (cpm):
MDA (µCi/ml):		Gross Alpha Conc (µCi/ml):		Percent of DAC:
2	Analysis Date:			Analysis Time (24:00):
	Total Alpha Background Counts:	Background Count Duration (min.):		Alpha Background Count Rate (cpm):
	Gross Alpha Sample Counts:	Sample Count Duration (min.):		Sample Count Rate (cpm):
MDA (µCi/ml):		Gross Alpha Conc (µCi/ml):		Percent of DAC:

Notes:

1. Alpha Efficiency calculated as (net source counts (cpm)/4-pi source activity (dpm)) × 0.85 (filter self-absorbtion factor).
2. DAC Limits provided in 10 CFR 20, Appendix B, Table 1.

Comments:

Completed By: _____

Date: _____

Reviewed By: _____

Date: _____

Form SOP-12B

Site:

Survey Locations Diagram

Page

Insert Photo Diagram or Sketch of Locations Here



Air Sample Collection and Analysis Log

Air Sample Collection:

Sample Number:

Technician: 		Date: 	
Air Sampler Make/Model: 	Air Sampler Serial Number: 	Air Sampler Calibration Due: 	
1	Collection Start Time (24:00): 	Collection Stop Time (24:00): 	Elapsed Time (min.):
	Flow Rate Start (LPM): 	Flow Rate Stop (LPM): 	Flow Rate Average (LPM):
	Volume (ml)		
2	Collection Start Time (24:00): 	Collection Stop Time (24:00): 	Elapsed Time (min.):
	Flow Rate Start (LPM): 	Flow Rate Stop (LPM): 	Flow Rate Average (LPM):
	Volume (ml)		
Total Air Sample Volume (ml):			0.00E+00

Air Sample Analysis:

Tray Counter Make/Model: 		Tray Counter Serial Number: 		Tray Counter Calibration Due: 	
Alpha-Channel Efficiency ⁽¹⁾ : 		Radionuclide Of Concern: 		DAC Limit ⁽²⁾ (µCi/ml): 	
1	Analysis Date: 		Analysis Time (24:00): 		
	Total Alpha Background Counts: 	Background Count Duration (min.): 	Alpha Background Count Rate (cpm): 		
	Gross Alpha Sample Counts: 	Sample Count Duration (min.): 	Sample Count Rate (cpm): 		
MDA (µCi/ml):		Gross Alpha Conc. (µCi/ml):		Percent of DAC:	
2	Analysis Date: 		Analysis Time (24:00): 		
	Total Alpha Background Counts: 	Background Count Duration (min.): 	Alpha Background Count Rate (cpm): 		
	Gross Alpha Sample Counts: 	Sample Count Duration (min.): 	Sample Count Rate (cpm): 		
MDA (µCi/ml):		Gross Alpha Conc. (µCi/ml):		Percent of DAC:	

Notes:

1. Alpha Efficiency calculated as (net source counts (cpm)/4-pi source activity (dpm)) × 0.85 (filter self-absorbtion factor).
2. DAC Limits provided in 10 CFR 20, Appendix B, Table 1.

Comments:

Completed By: _____ **Date:** _____

Reviewed By: _____ **Date:** _____

1. PURPOSE

The purpose of this procedure is to provide guidance and identify requirements for radioactive materials and waste storage and disposal/recycling at sites and where Disa has responsibility for managing these materials for its projects.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent)–

- Ensuring radioactive materials (source material) are transported to a licensed processing or licensed disposal facility, prior to demobilization from a site.
- Ensuring waste storage does not occur beyond the completion of each individual project and before demobilization.
- Posting of radioactive materials and waste storage areas.
- Ensuring security to radioactive materials and waste storage areas and access by only trained and authorized personnel.
- Ensuring radiation surveys (exposure rate and contamination, as applicable) are conducted in radioactive materials and waste storage areas.
- Ensuring that radioactive materials and waste storage containers are properly labeled.
- Development of procedures for specific waste types, as necessary, beyond the basic descriptions in this SOP.
- Supplying radiation work permits, as necessary, for activities where no developed procedure applies.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is known as the RSO designee in License documents. References to the RST will also include the RSO designee.
- Proper posting of radioactive materials and waste storage areas.
- Compliance with posting and procedures.
- Preventing unauthorized access to radioactive materials and waste storage areas.
- Performing routine equipment function checks, and for notifying the RSO, ARSO, or AU when equipment function checks fall outside acceptable ranges.

- Conducting radiation surveys (exposure and contamination, as applicable) of radioactive materials and waste storage areas.
- Labeling, as applicable, radioactive materials and waste storage containers.

2.3 Field Services Manager (FSM) –

- Enforce and comply with recommendations and requirements as specified by the RSO, ARSO, or RST.
- Supply adequate resources to ensure compliance with this procedure.

3. PROCEDURE

3.1 Equipment and Materials –

- Appropriate radiation survey equipment to perform exposure rate (e.g., Ludlum Model 19 or equivalent) and contamination surveys (Ludlum 2360 with 43-93 and Ludlum 2929 with 43-10-1, or equivalents).
- Labels for posting areas and containers.
- Posts and rope/tape to cordon off the restricted area or any other are as deemed necessary by the RSO/ARSO.

3.2 Function Check – Equipment will be function checked prior to use, using appropriate standard operating procedures.

3.3 Packaging and Repackaging of Radioactive Materials or Waste –

- Users shall wear appropriate PPE, as identified by the RSO.
- Dosimetry shall be worn, as determined necessary by RSO.
- Establish a restricted area.
- Material and waste containers shall meet the necessary requirements for transportation or will be repackaged into appropriate containers (e.g., IP-1, IP-2, IP-3, Type A) prior to transport.
- Dry waste shall be packaged separately from liquid waste (no scintillation vials or other liquid waste with dry waste).
- Drums, if used, shall have a plastic liner to receive the waste, if liquids are being stored.
- Liquid waste shall be double contained to prevent leakage.
- Containers shall be sealed when full and sufficient head space allowed for expansion.

- Remove any lead or other shielding prior to conducting radiological monitoring of the container.
- The area and container shall be monitored for contamination and radiation levels (radiation levels shall be taken in low background area, 0.05 mR/hr or less). All surfaces of the container shall be monitored to find the highest radiation level.

3.4 Storage and Segregation of Radioactive Materials and Waste –

- Material and waste shall be stored in authorized locations only.
- Material and waste storage areas shall be appropriately posted using Caution or Danger Radioactive Material language.
- Material and waste storage containers shall be labeled using Caution or Danger Radioactive Material language.
- A physical inventory will be conducted at least every 6 months and documented. The documentation will include radionuclides, radioactivity, location, date of the inventory and person conducting the inventory.
- The material and waste inventory will be kept current.
- Collection containers for material and waste may be kept within restricted areas and will be transferred to storage container(s) when the collection container approaches being full.
- Radiological surveys (exposure rate and contamination surveys) will be taken at least monthly while waste is being handled.
- Segregate radioactive material in storage areas.
- Keep or remove non-radioactive waste out of radioactive material and waste areas.
- Keep mixed Low-Level Radioactive Waste (LLRW) in separate containers from non-mixed LLRW.
- Separate radioactive material and waste from explosives.
- Separate potentially contaminated areas from clean areas by barriers or other controls.
- Ensure waste acceptance criteria (WAC) of potential disposal facilities allow for disposal of specific nuclides. Nuclides that are not allowed shall be packaged separately. This shall be accomplished at the point of generation.

- Higher activity waste (if operations could result in a dose greater than 100 mrem/yr) shall not be segregated or handled without a Radiation Work Permit (RWP) approved by the RSO.
- Material and waste may be consolidated if WAC and container volume allow. Consolidation of material and waste will be conducted by procedure SOP-04 – Guidelines for Handling Radioactive Material or a radioactive work permit (RWP) if dose levels could exceed 100 mrem/yr.

3.5 Transfer or Disposal of Waste –

- Radioactive material for disposal or recycling may be transferred to another licensed recipient who is licensed specifically for the category of material to be disposed.
- All material and waste will be transported offsite prior to demobilization of the High-Pressure Slurry Ablation equipment.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual

1. PURPOSE

The purpose of this procedure is to outline the radiation safety training requirements for all employees and contractors working under the Disa Radioactive Materials License performing work that is under the jurisdiction of the NRC or Agreement State regulatory authority. This SOP provides guidance in preparing and implementing the radiation safety training (training) program for employees and contractors. The Radiation Safety Officer (RSO) is responsible for review and approval of training materials for all staff designated as an Authorized User (AU), RSO Designee, or Radiation Safety Technician (RST), or for those staff working with radioactive materials or in a restricted area.

Note: An AU may oversee and direct the use of or handling of licensed radioactive material.

Training will be commensurate with assigned duties and responsibilities. All AUs and RSTs will receive additional training on the use of radiation detection instruments and radiation protection monitoring.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO) or Assistant Radiation Safety Officer (ARSO)(RSO Equivalent) –

- Review and approve of all training materials for staff designated as an AU, RST, or for those staff working with radioactive materials or working in or frequenting a restricted area; ensuring training materials are consistent with the requirements of the RPP and this SOP, and that training reflects work methods that are consistent with Disa ALARA policy.
- Work with project or site management to ensure all staff, including contractors at a site working with licensed radioactive materials or working in or frequenting a restricted area, receive prior training commensurate with their duties.
- Provide training, exam, and grading of exam.
- Provide remedial training for deficiencies, as warranted.
- Ensuring refresher training is provided, as warranted.
- Properly maintain training records.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is known as the RSO designee in License documents. References to the RST in this document will also include the RSO designee.
- Work with project or site management to ensure all staff, including contractors at a site working with licensed radioactive materials, or working in or frequenting a restricted area, receive prior training commensurate with their duties.
- Properly maintain training records.
- Oversee the use of, or handling of, licensed radioactive material.
- An RST will report directly to the RSO for radiation safety purposes.

2.3 Field Services Manager (FSM) –

- Ensure all employees comply with training and site access requirements.
- Coordinate with the RSO, ARSO, and RST for new employee training prior to working with radioactive materials or working in, or frequenting, a restricted area.
- Work with the RSO or ARSO to ensure all workers receive training commensurate with their duties prior to work in a restricted area.

2.4 Authorized Users (AUs) –

- Attend training and briefings on radiation safety.
- Comply with training and site access requirements; do not work with licensed radioactive materials or in a restricted area without appropriate training and/or access permission.

3. PROCEDURE

Radiation safety training will be designed to inform employees of the inherent risks of exposure to radiation as well as the fundamentals of protection against exposure. The radiation safety training program will be administered following guidance provided in NRC NUREGs 1556 Vol. 11 and 18, NRC Regulatory Guide 8.13, NRC Regulatory Guide 8.29 and other national and industry wide radiation safety training guidance. All employees will be provided access to and made familiar with instructions outlining radiation safety and emergency procedures. Additionally, all workers who enter restricted areas will be provided instructions in accordance with 6 CCR 1007-1 Part 10.

Radiation Safety Training –

Prior to using licensed radioactive materials or working in or frequenting a restricted area, all employees will receive, at minimum, basic radiation training. A qualified instructor will be used for this training. The instructor will have the following qualifications:

- Meets the qualifications for RSO, ARSO, or RST on the license and is familiar with the RPP. Qualifications for these roles are as follows:
 - **RSO/ARSO**
 - Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in source material facility radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study.
 - 2. Health Physics Experience: At least 1 year of work experience relevant to source material operations in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
 - 3. Specialized Training: At least 1 week of specialized classroom training in health physics specifically applicable to source material. In addition, the RSO should attend refresher training on source material or general health physics every 2 years.
 - 4. Specialized Knowledge: A thorough knowledge of the proper application and use of all health physics equipment used in the source material facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the source material process and equipment used in the facility and how the hazards are generated and controlled during the Disa's treatment process.
 - **RST** – An RST is an RSO designee who has been designated to administer the RPP onsite. At least one Disa employee will serve as the Site Radiation Safety Technician (RST) during any site operation. Qualifications for the RST are

equivalent to those of a Health Physics Technician in RG 8.31. Requirements presented below are the equivalent to RG 8.31 except that the experience should occur at a source material or operation. This person shall have one of the following combinations of qualifications:

- Education: An associate degree or 2 or more years of study in the physical sciences, engineering, or a health-related field;
- Training: At least a total of 4 weeks of generalized training (up to 2 weeks may be on-the-job training) in radiation health protection applicable to source material facilities. A mock HPSA may be established for the purpose of training RSTs and other DISA personnel and contractors;
- Experience: One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a source material facility;

or

- Education: A high school diploma;
- Training: A total of at least 3 months of specialized training (up to 1 month may be on-the-job training) in radiation health protection relevant to source material facilities; Experience: Two years of relevant work experience in applied radiation protection. The RST should demonstrate a working knowledge of the proper operation of health physics instruments used in the source material facility, surveying and sampling techniques, and personnel dosimetry requirements.

The radiation safety training may be administered by classroom lecture, video, internet-based class, self-study, or a combination of these and will be commensurate with the expected hazards encountered during routine and emergency conditions. Disa will also provide site-specific training to address the hazards of each individual work site. Additional training will be given whenever a significant change in regulations or the terms and conditions of the service providers license (SPL) occurs.

The radiation safety training will include, at a minimum, the following topics:

- Fundamentals of Radiation Safety:
 - Characteristics of radiation
 - Units of radiation dose and quantity of radioactivity

- Hazards of exposure to radiation
- Levels of radiation from licensed material
- Methods of controlling radiation dose (time, distance, and shielding)
- As low as is reasonably achievable (ALARA) concept.
- Radiation Detection Instruments:
 - Operation
 - Calibration
 - Limitations of radiation survey instruments
 - Radiation survey techniques for measuring radiation field
 - Radiation survey techniques for measuring removable/fixed contamination.
 - Handling and proper use of personnel monitoring equipment
- Emergency Procedures
- Radiation Protection Equipment and Use:
 - Proper use of protective equipment
 - Decontamination of contaminated equipment
- Applicable NRC regulations (10 CFR Parts 20 and 40)
- USDOT Training for Transporting Radioactive Materials. DOT Training for Radioactive Materials – Due to the unique requirement of shipping radioactive Class 7 material, any HAZMAT employee who ships or influences a shipment under the Radioactive Materials License will have DOT training specific to Class 7 material. This training may be given by the RSO, ARSO, or others who have a formal approved training program.

A written test with questions directly related to the radiation safety training will be administered to each employee. The instructor will review the test with each employee and discuss any incorrect answers so that the employee understands the error. Workers who do not pass the test with 70% of the answers correct will be retested after receiving additional training. This exam will serve as documentation of completed radiation safety training.

Refresher training is required annually. Employees who do not complete the refresher training within 12 months of the last training will be removed from duties involving licensed radioactive materials until the refresher training is completed. The refresher training will include a brief review of topics covered in the initial training as well as relevant radiation safety issues that have arisen, changes in requirements, and experience (“lessons learned”).

AU and RST Training –

- Authorized Users shall also receive specific training on what license requirement they are going to perform. This may include site-specific training for temporary job sites and/or trainings required under client’s licenses.
- All RSTs will take additional radiation safety training or an RSO training class. RSTs will be assessed by the RSO to ensure that each proposed RST is qualified to work independently and that each individual is knowledgeable of the radiation safety aspects of licensed activities. This may be demonstrated by observing the proposed RST perform licensed activities. Because RSTs will perform certain RSO functions, RSTs will receive the following training. This training will be both lecture and on-the-job. On-the-job training will include setting up a mock HPSA treatment project and implementing the radiation protection program on that mock setup. The RSO will also be onsite to get RSTs trained on an actual project.
 - Air monitoring systems: establishing, collecting filters
 - Contamination surveys
 - Equipment function checks
 - Daily tailgate meetings
 - Exposure surveys
 - Isolating and signing radiation areas
 - Release surveys
 - Daily and weekly inspections
 - Sample collection and shipment

4. REFERENCES

- Radiation Protection Program (RPP) Manual
- USNRC NUREG-1556 Volume 18 Revision 1, Program-Specific Guidance about Service Provider Licenses, 2017
- USNRC, Regulatory Guide 8.13 “Instruction Concerning Prenatal Radiation Exposure” 1999
- USNRC, Regulatory Guide 8.29 “Instruction Concerning Risks from Occupational Radiation Exposure” 1996

1. PURPOSE

The purpose of this procedure is to provide instruction on receiving licensed radioactive materials in excess of Type A quantity (as defined in 6 CCR 1007-1, Section 17.2.2 and Appendix 17A to Part 17) and are under the authority of the US NRC or Agreement State regulatory authority. Packages in excess of Type A quantity should be labeled with Radioactive White II, Yellow II or Yellow III labels or placards, examples of which are provided in Attachments.

NOTE: Typical environmental samples or radiological check sources would not fall under this classification. For shipping environmental samples (soil samples, water samples, etc.) refer to the current version of SOP-10 Shipping UN2910 Radioactive Material.

A radiation and contamination survey must be conducted upon receipt of licensed radioactive materials, with survey records retained for most labeled packages (e.g., special form not required) to comply with NRC regulation 10 CFR Part 20. This procedure establishes specific requirements for conducting receipt surveys, opening of packages, and reporting of unusual observations.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO) or Assistant Radiation Safety Officer (ARSO)(RSO Equivalent) –

- Ensuring implementation of this procedure, including DOT Hazardous Materials Shipper training required of any RST who receives licensed radioactive materials.
- If possible, obtaining shipping information from consignor (party who is shipping) prior to the shipment.
- If possible, reviewing transfer records prior to receipt of radioactive materials to ensure total activity of is within license limits.
- Maintain current licensed radioactive material inventory, and update inventory immediately upon receipt of licensed radioactive material.
- Ensuring for the proper storage, and security for received packages.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is known as the RSO designee in License documents. References to the RST in this document also include the RSO designee.

- Implementation of this procedure when receiving licensed radioactive materials, including notification of the RSO upon receipt of licensed radioactive materials.
- Performing visual inspection, exposure, and removable contamination survey, as appropriate.

2.3 Authorized Users (AU) –

- Notify the RSO or RST upon receipt of radioactive materials.

NOTE: Common carrier deliveries of radioactive material, not exceeding Type A quantities, are normally received at the client's Shipping/Receiving areas during normal working hours. Immediately upon arrival, receiving personnel shall notify the RSO or RST.

3. PROCEDURE

3.1 Equipment –

- Exposure rate meter; typically, a Ludlum Model 19 or similar.
- Removable surface activity tray counter; typically, a Ludlum Model 2929 scaler and Ludlum Model 43-10-1 dual-channel (alpha/beta) tray counter, or similar.
- Removable surface contamination swipes.
- Materials/Forms for documenting survey activities and results.

NOTE: Radiological survey instruments should be properly calibrated, and function checked prior to use.

3.2 Receiving –

- Review the bill-of-lading and any other documentation provided by the consignor (originator) to verify the radioactivity is within the limits of the license. Verify with the RSO that shipment of Class 7 material from the originator has been authorized.
- A package visual inspection, radiation survey (exposure rate), and removable contamination survey must be conducted on a received package labeled radioactive materials within 3 hours after receipt during normal working hours or within 3 hours after the start of the next working day if received after working hours. NOTE: Unlabeled licensed radioactive material (exempt from DOT regulations or “Limited Quantity, Excepted Package”) do not have to meet the 3-hour receipt survey requirements.

- **VISUAL INSPECTION** – Visually inspect the package for signs of damage or leakage. If damage or leakage is noted, take appropriate precautions to minimize potential radiation exposure and spread of contamination and notify the RSO if assistance is needed.
- **EXPOSURE SURVEY** – Measure the external radiation level (mrem/hr) at the package surface and at 1 meter from the surface. If radiation levels are greater than 200 mrem/hr at the package surface, or greater than 10 mrem/hr at 1 meter from the package, immediately notify the RSO. In turn, the RSO may need to notify the shipping carrier, the US Department of Transportation, and the appropriate regulatory authority (e.g., NRC Operations Center at 301-816-5100).
- **REMOVABLE CONTAMINATION SURVEY** – Swipe at least 300-cm² of the external surface of the package with moderate pressure and count the swipes for contamination prior to opening the package. Removable contamination on swipes will be expressed as dpm/100 cm². NOTE: Use a swipe efficiency of 10-percent in removable activity calculation. If the removable contamination exceeds 240 dpm/cm² beta/gamma and low-toxicity alpha emitters or 24 dpm/cm² for “all other alpha emitters” immediately notify the RSO.

NOTE: License specific contamination limits may be lower than this.

- Record the receipt survey results on the Radioactive Materials Receipt Survey Form.
- Locate package to a proper and secure storage area.
- **Opening Packages** – Opening and unpacking packages containing licensed radioactive materials will be carried out in an area appropriately controlled and equipped to limit radiation exposure and the spread of contamination.
 - Carefully open the package while being alert for any signs of damage to the inner packing and source container. Monitor radiation exposure levels while opening package. If damage is evident or suspected, swipe the surface of the source container, and request RSO assistance as needed.
 - Remove or deface radiation labels on empty packages. Survey the packing material and the empty package(s) as necessary to assure the absence of contamination. If contaminated, treat as radioactive waste and notify the RSO.

- Record any elevated survey results or comments on the Shipping Survey Form and provide completed form to the RSO for review and filing.

4. REFERENCES

- 4.1** ERG Radiation Protection Program (RPP) Manual
- 4.2** 10 CFR 71 – Packaging and Transportation of Radioactive Material.
- 4.3** 49 CFR 171 - 178 – Transportation

5. ATTACHMENTS

- 5.1** Form SOP-15A – Radioactive Materials Receipt Survey Form

Attachments

Type A Packages

Labels are 4" x 4" and are displayed on the outside of packages. The three radioactive labels are shown below in increasing hazard (White I, Yellow II, and Yellow III).



Form SOP-15A Radioactive Materials Receipt Survey Form

This statement must be completed by an individual authorized to directly accept shipment of radioactive materials. Record the following information, one form per package.

Order/Shipping Number:	
Vendor:	
Nuclide:	
Activity Received:	
Recipient:	
Exposure Rate, Contact:	
Exposure Rate, 3 feet:	
Wipe Test:	
Receipt Date:	
Receipt Time:	
Person Receiving:	
Signature:	

Exposure is measured with an exposure rate survey meter (e.g. Ludlum Model 19) in a low background area. Record the highest exposure at the package surface and at 3 feet.

Swipe at least 300-cm² of the external surface of the package with moderate pressure. If the removable contamination exceeds 240 dpm/cm² beta/gamma and low-toxicity alpha emitters or 24 dpm/cm² for "all other alpha emitters" immediately notify the RSO.



Form SOP-15A Radioactive Materials Receipt Survey Form

This statement must be completed by an individual authorized to directly accept shipment of radioactive materials. Record the following information, one form per package.

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Exposure Rate, Contact:	
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Wipe Test:	
Receipt Date:	
Receipt Time:	
Person Receiving:	
Signature:	

Exposure is measured with an exposure rate survey meter (e.g. Ludlum Model 19) in a low background area. Record the highest exposure at the package surface and at 3 feet.

Swipe at least 300-cm² of the external surface of the package with moderate pressure. If the removable contamination exceeds 240 dpm/cm² beta/gamma and low-toxicity alpha emitters or 24 dpm/cm² for "all other alpha emitters" immediately notify the RSO.



Disa Technologies, Inc.

SOP-16 Rev. 0

**High-Pressure Slurry Ablation
Mobilization and Demobilization
Standard Operating Procedure**

Approvals

_____	_____
<i>Chief Operating Officer</i>	<i>Date</i>
_____	_____
<i>Radiation Safety Officer</i>	<i>Date</i>

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

The purpose of this procedure is to define the manner in which the High-Pressure Slurry Ablation (HPSA) equipment will be mobilized, utilized, and then demobilized from a site. This procedure will discuss pre-mobilization activities, establishment of the restricted area and scanning stations, and post-operation equipment releases and site release.

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO)(RSO Equivalent)

- All appropriate project/site personnel are properly trained on ALARA principles.
- Radiological surveys are performed to provide current information on the radiological environment(s) to which personnel are potentially exposed, as needed.
- Areas that contain licensed material are properly posted.
- Restricted areas are properly established.
- Appropriate personnel protective equipment (PPE), dosimetry and radiological instrumentation, are prescribed, as needed.
- Radiation Work Permits (RWPs) are used for non-routine operations that has the potential to result in a significant radiological dose based on the radionuclide quantity, form, and work to be performed.
- Stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.2 Field Services Manager (FSM) –

- Support the RSO, ARSO, AU, and ALARA program.
- Inform the RSO of any changes to site procedures or schedule that could affect radiation protection.
- Ensure personnel, resources, and support equipment necessary to ensure ALARA are available for project personnel by working with RSO and AU.
- Ensure that stop work authority is maintained and encouraged, as necessary, to ensure ALARA.

2.3 Radiation Safety Technician (RST) (RSO Designee) –

- The RST is known as the RSO designee in License documents. References to the RST in this document also include the RSO designee.
- Report to the RSO on all radiological matters. Where appropriate, report to the onsite management for support on implementation of the ALARA program.
- Perform radiological surveys to provide current information on the radiological environments(s) to which personnel are potentially exposed, as needed.
- Manage onsite personnel protective equipment (PPE), dosimetry, and radiological instrumentation, as needed.
- Ensure proper recordkeeping, instrument calibrations, and maintenance.
- Post areas that contain licensed material.
- Ensure that stop work authority is maintained and encourage as necessary to ensure ALARA.

2.4 Authorized Users (AU) –

- Comply with the Radiation Protection Plan (RPP) and the Standard Operating Procedures (SOP).
- Attend training and briefings on radiation protection and RWPs.
- Comply with all notices, postings, procedures, and instructions from radiation safety staff.
- Properly use and wear all required PPE.
- Follow basic ALARA principles including time, distance, shielding, and contamination control.
- Obey "stop work" and "evacuate" instructions issued by RSO, ARSO, another AU, or FSM.
- Wear and use monitoring devices as required by site procedures and instructions, postings, or the RSO, ARSO, or RST.
- Plan work ahead of performing work. Attempt to minimize exposures, as necessary.
- Leave Radiation Areas or Airborne Radioactivity Areas when not actively working. Use staging or "wait areas", when designated.

- DO NOT eat, drink, or smoke in restricted areas. One-time use water bottles may be used to stay hydrated.
- Perform a personnel scan for contamination when leaving any Restricted Area.
- Report known/potential radiologically unsafe or noncompliance situations to the RSO or ARSO.
- Report prior or concurrent occupational radiation exposures to the RSO.
- Maintain good housekeeping practices to minimize the spread of radiological contamination.
- Exercise stop-work authority and discuss immediately with RSO, ARSO, or RST any circumstance or condition that you believe is contrary the principles of ALARA.

3. PROCEDURE

3.1 Pre-Mobilization Notification

Prior to mobilizing to any treatment site, Disa is required to submit a pre-mobilization notification (PMN) to the NRC staff. The NRC staff requests 90 days to review the notifications and provide its approval, and its approval is required in 90 days. These notifications are not trivial and require diligence to complete and include information that is vital to support the decommissioning of treatment sites. The full scope of the notification is as follows:

1. Estimate the quantity of gravel and resulting number of truck shipments that would be needed per 10 miles of road.
2. Schedule for NRC touchpoints.
3. Dose assessment scenario that applies residential farmer, resident garden, rancher, or recreational.
4. The no. of samples/40,000 tons of clean coarse material post-HPSA treatment will be presented in the pre-mobilization notification along with the ProUCL output. DISA is to assume that 5 samples of clean coarse material will be collected at sites where the total uranium mine waste mass is less than 40,000 tons
5. Appendix A of EA assumptions.
6. Specific location for that project site.
7. A description of the site to include anticipated land disturbance activities (i.e., constructing temporary roadways, grading of soil for equipment placement, approximate volume of soils/waste rock to be processed, and whether large volumes of soil/waste rock will be moved at the project site to facilitate treatment.

8. Preliminary data developed by the applicant for each project site to include concentrations of U and Th in the waste rock and the surface soils prior to mobilization, waste rock volumes expected to be processed and the anticipated number of treatment units, and survey data used to establish background radiation levels that will be used in subsequent public dose calculations.
9. Information developed by the licensee regarding consultations with property owners, resource experts, and local or state government representatives concerning any native or endangered species at the project site as well as cultural or historical information of interest and existing and proposed future land use.
10. Approximate mass of source material that the applicant will possess (this can later be refined for inventory and material accountability).
11. Anticipated date(s) of mobilization and start of operations as well as the anticipated duration of operations.
12. Methodology used to determine that the project site will meet release criteria including the extent of residual radioactivity remaining at the site from operations and justifications based on land use in the vicinity of the site and other site characteristics for scenarios and parameters used to calculate dose to demonstrate 10 CFR 20 Subpart E release criterion are met.
13. An updated site-specific decommissioning cost estimate, as applicable.
14. A certification that financial assurance for decommissioning has been provided in an amount that is at least that of the updated decommissioning cost estimate.

3.2 Pre-Mobilization Activities

- Prior to mobilizing any equipment to a site, the FSM and RST shall perform a site reconnaissance to determine the site layout. The site layout will include the placement of HPSA equipment, the alignment of the restricted area, and the location of restricted area access/egress points.
- The FSM will stake the locations of all the equipment to be used onsite and the alignment of the restricted area.
- The boundary of the restricted area, must be large enough to include the following equipment, at a minimum:
 - Material Hopper
 - All Conveyors
 - Screen and Crusher
 - HPSA Processing Unit

- HPSA Containment Berm
- Product Dewatering System
- Product Dewatering Hopper
- Loader
- Product Roll-off Container or Trailer
- Process Water Tank
- Process Water Treatment Unit
- The restricted area boundary will also include a 5-m minimum buffer around all the equipment. However, this buffer may be expanded if public dose rates exceed 2 mrem/hr.
- All equipment positions and surveyed by GPS.

3.2 Site Security

- As part of the Pre-Mobilization phase, the type of security for the site will be determined.
- Options for site security may include the following:
 - Existing site locking gate
 - Installation of a temporary locking gate
 - Off-hours security guard
 - Company personnel will stay onsite in a mobile trailer

3.3 Mobilization

- After collecting the data for the equipment positions and the restricted area, the GPS data will be downloaded, and a site layout map will be created.
- Using this map, HPSA units and support equipment will be mobilized to the site and placed according to the site layout map.
- Once all the equipment is installed, the restricted area boundary will be erected. The restricted area boundary will be a physical boundary constructed of temporary posts and a physical barrier, such as rope or temporary fences.
- A physical access/egress point will be established with a scanning station for personnel to survey themselves or equipment out of the restricted area.
- A log of all personnel entering/exiting the restricted area will be maintained along that will include personnel survey results, date and time of surveys, and any pertinent information regarding the meters used.
- The RSO, ARSO, RST, FSM, and AUs are the only personnel that may enter the restricted area.

3.4 Demobilization

- Once operations are finished, all processed material and waste will be removed from the equipment.
- Processed material will be added to the trailer or container for transport to a licensed recycling facility or other licensed disposal facility.
- Any waste contaminated with radioactive materials will be containerized and transported offsite to a licensed uranium recycling or disposal facility.
- Uncontaminated waste will be containerized and disposed at a sanitary or construction landfill.
- Equipment being removed from the restricted area will be decontaminated, as necessary, and subjected to release surveys prior to removal.
- After all materials and equipment have been removed from the restricted area, the RST will perform a GPS-gamma survey of the restricted area using the same transects as the baseline survey.
- A t-test will be performed to compare the means of the restricted area baseline and the post-operation GPS-gamma surveys.
- If the test indicates the means are statistically different, then the higher concentration materials will be excavated and disposed at a licensed uranium recycling or disposal facility.
- Once the restricted area soils passes the t-test (baseline and post-operation GPS-gamma surveys are statistically the same) the site is considered acceptable for free release. All equipment may be demobilized at this point in time.
- In addition, doses from the clean coarse material will be assessed pursuant to the following:
 - The RST will collect samples of clean coarse material as stated in the PMN. Analytical results will be compared to the screening criteria presented in the PMN. If the 95% upper confidence limit (UCL) is at or below the screening criteria, then the site may be released for unrestricted use.
 - If the results exceed the screening criteria, then dose modeling will be required using the scenarios presented in the PMN. Soil mixing may be used as a means of reducing doses to meet the unrestricted release criterion. Soil mixing will be performed pursuant to NRC guidance in NUREG-1757, Volume 1, Revision 2
- Once the analysis of the clean coarse material is completed, then DISA may demobilize from the site.

3.5 Demobilization Notification

Within 30 days of demobilizing from a treatment site, DISA must submit a Demobilization Notification. This notification must include the following information:

1. Dose assessment results and radionuclide concentration results for clean coarse material, fines concentrates, and process water.
2. Results of the Synthetic Precipitation Leaching Procedure (SPLP) analysis for the clean coarse material
3. Presentation of release criterion, screening criteria, and applicable effluent standards.
4. Comparisons of doses and concentrations to the criteria and standards presented in Item 3 above.
5. Determination that process water may be discharged onsite or decision to take the process water offsite.
6. Description of how process water was discharged onsite, if applicable.
7. Facility-specific site number to be created by Disa.
8. Name, location, geographic coordinates of the site.
9. Owner and owner’s contact information.
10. Actual volume of abandoned mine waste treated.
11. Name of the actual licensed recycling, disposal, or storage facility receiving fine concentrates.
12. Mass of mineral-rich material transported to the recycling facility.
13. Description of how coarse material was handled following processing.
14. Final determination on clean coarse material. Did concentrations meet the screening criteria for the scenario specified in the PMN. If not, describe the final survey data and methodology used to determine that the project site meets release criteria, including the extent of residual radioactivity remaining at the site from operations and justifications based on land use in the vicinity of the site and other site characteristics for scenarios and parameters used to calculate dose to demonstrate 10 CFR 20 Subpart E release criterion are met.

3.6 Limits

3.6.1 Radionuclide screening concentrations for the various scenarios are presented in the following table:

Scenario	Ra-226, pCi/g	U-238, mg/kg ¹	Natural Uranium, mg/kg ³	Th-230, pCi/g
Resident Farmer	1.7	556 ²	1,151 ²	12
Resident Gardener	4.1	866	1,792	30
Rural Resident	5.3	970	2,008	42
Rancher	12	2,360	5,445	86
Recreationalist	63	8,000	16,562	295

¹Uranium-238 specific activity to calculate limit is 3.36E-7 Ci/g.

²Uranium concentrations are presented here for the sole purpose of completing the sum of fractions calculations described in Section 2.2 for unrestricted release doses. The total mass concentration of uranium and/or thorium that will be allowed to remain on a treatment site must be below 500 mg/kg.

³ Note: U-238 activity is approximately half of U-nat activity (48.3%).

3.6.2 The unrestricted release criterion is 25 mrem/year pursuant to 10 CFR 20.1402. The source material mass limit is below 500 mg/kg uranium and/or thorium

3.6.3 Process water effluent and agreed upon Synthetic Precipitation Leaching Procedure limits are as follows:

- Radium-226 = 60 pCi/L
- Th-230 = 100 pCi/L
- Natural Uranium = 0.43 mg/L based on 300 pCi/L limit

3.6.4 Toxic Characteristic Leaching Procedure limits for the 8 RCRA metals will be as follows:

- Arsenic = 5.0 mg/L
- Barium = 100.0 mg/L
- Cadmium = 1.0 mg/L
- Chromium = 5.0 mg/L
- Lead = 5.0 mg/L
- Mercury = 0.2 mg/L
- Selenium = 1.0 mg/L
- Silver = 5.0 mg/L

4. REFERENCES

4.1 Radiation Protection Program (RPP)

1. PURPOSE

- 1.1 This procedure presents the method to be utilized by Disa Technologies, Inc. (Disa) to evaluate changes, tests, or experiments to its High-Pressure Slurry Ablation (HPSA) process that have not been directly authorized by the U.S. Nuclear Regulatory Commission (NRC) staff in its Materials License. The NRC staff approved Disa's ability to conduct these reviews in License Amendment __. Specifically, License Condition ___ states that certain changes, tests, or experiments may be made after an analysis is performed that addresses the criteria in License Condition __. This License Condition states the following:
- a. The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (b) of this condition:
 - i. Make changes in the type of equipment used in HPSA® as described in the license application (as updated);
 - ii. Make changes in the procedures, as described in the license application (as updated); and
 - iii. Conduct tests or experiments not described in the license application (as updated).
 - b. The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would:
 - i. Result in a radiological release scenario that has not been previously addressed in the license application (as updated);
 - ii. Result in more than a minimal increase in the likelihood of a radiological release from structures and equipment evaluated in the license application (as updated);
 - iii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), or environmental assessment (EA) or technical evaluation reports (TERs) or other analyses and evaluations for license amendments;
 - c. Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with NRC's previous conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.
 - d. The licensee's determinations concerning (b) and (c) of this condition shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall have expertise in management and shall be responsible for financial approval for changes; one

member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address operational and technical aspects. Temporary members or permanent members, other than the three above-specified individuals, may be consultants.

- e. The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining that changes comply with (b) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation of each. In addition, the licensee shall annually submit to the NRC changed pages, which shall include both a change indicator for the area changed, e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed, and a page change identification (date of change or change number or both), to the operations plan and reclamation plan of the approved license application (as updated) to reflect changes made under this condition.

1.2 Disa’s implementation involves producing a description of the change, test, or experiment (herein, referred to as a proposed action), and reviewing applicable license conditions and NRC staff decision documents. If the proposed action is directly authorized under the license, Disa documents that decision. If the proposed action is not directly authorized, then Disa addresses the criteria that are presented in License Condition __. After this review, Disa makes a final determination regarding whether or not the proposed action requires a license amendment and documents that decision.

1.3 Officially this review process is known as the “Performance-Based Licensing Action Review”, and these reviews are completed by the Safety and Environmental Review Panel (SERP). Decision documents produced by the SERP are called “SERP Reports.” These reports are maintained at Disa’s Casper, Wyoming, headquarters.

2. APPLICABILITY

2.1 This procedure only applies to proposed actions that directly involve the management of licensed materials or that may have a nexus to radiological health and safety. For example, the following types of proposed actions would be subject to this procedure:

- Proposed action that involves tests with the HPSA process, and
- Modifications to equipment or systems that are used to manage source material.

2.2 However, any activity involving Disa or its use of HPSA that does not involve the management and control of licensed materials and associated engineering controls with a nexus to radiological health and safety will not be subjected to this procedure. Similarly,

potential changes to standard operating procedures (SOPs) that are developed to meet the requirements of license conditions and applicable regulations will not be subject to this procedure since SOPs are not formally approved by NRC staff. Instead, SOPs are routinely inspected for adequacy. Therefore, these activities, along with SOPs, will not be reviewed as part of this procedure.

- 2.3 The term “nexus to radiological health and safety” is a term used in the definition of construction in 10 CFR 40.4. Under this definition, the NRC states that it is not responsible for regulating activities that do not have a nexus to radiological health and safety. By extension, Disa will only review proposed actions involving the SSCs used to manage and control 11e.(2) byproduct material and respective engineering controls that have a nexus to radiological health and safety under this procedure.

3. RESPONSIBILITIES

3.1 Chief Executive Officer

- 3.1.1 The Chief Executive Officer (CEO) (or the CEO’s designee) is responsible for ensuring that the requirements of this procedure are implemented appropriately. In this SOP, any reference to the CEO and his/her duties shall automatically apply to the CEO’s designee.
- 3.1.2 The CEO (or the CEO’s designee) will act as the Chair of the SERP and will be responsible for selecting the additional members of the SERP.
- 3.1.3 The CEO (or the CEO’s designee) will detail the scope of all SERP reviews to ensure that sufficient resources are provided to properly analyze issues before the SERP.

3.2 Radiation Safety Officer

- 3.2.1 The Radiation Safety Officer (RSO) or the Alternate RSO (ARSO) must serve as a member of the SERP. In this SOP, any reference to the RSO and his/her duties shall automatically apply to the ARSO.
- 3.2.2 The RSO’s primary purpose on the SERP is to ensure that a proposed action shall not compromise the public radiological health and safety, and the environment. The RSO will also support efforts to ensure that a proposed action complies with NRC regulations.

3.3 Chief Operating Officer

- 3.3.1 The Chief Operating Officer (COO) (or designee) must serve as a member of the SERP. In this SOP, any reference to the COO and his/her duties shall automatically apply to the COO’s designee.
- 3.3.2 The COO’s (or designee’s) primary purpose on the SERP is to ensure that a proposed action shall not compromise the operations of the HPSA process and of Disa’s overall operations. The COO also ensures that the proposed action is implemented properly.

3.4 Employees/Contractors

- 3.4.1 Proposed actions are often identified by employees or contractors or through use of a new project checklist.
- 3.4.2 Therefore, if an employee or contractor identifies such a necessary change, the employee or contractor should discuss this issue with his or her immediate

supervisor or the COO.

- 3.4.3 Employees or contractors are also responsible for implementing changes per the procedures approved by the SERP and all other safety work rules, established procedures, and Disa’s policies. Employees or contractors are further responsible for reporting the success or failure of a proposed action and, most importantly, any adverse or dangerous conditions produced by the proposed action.

4. SAFETY AND ENVIRONMENTAL REVIEW PANEL

4.1 SERP Function. The function of the SERP is to review proposed actions to determine whether a proposed action is directly authorized, if the SERP may approve the proposed action, or if a license amendment is required for approval. The SERP accomplishes this by performing the following:

- Reviewing proposed actions in the equipment, facility, or process, with respect to the directly authorized operations, as presented in the NRC license, or other relevant documents, approved by the NRC staff.
- Reviewing proposed actions not presented in the NRC license, or other relevant documents, approved by the NRC staff.

4.2 SERP Organization. The SERP shall consist of the following individuals:

- CEO who shall have expertise in management and shall be responsible for managerial and financial approval of all proposed actions.
- The RSO who shall have the responsibility of ensuring that proposed actions conform to radiation safety requirements.
- The COO who has expertise in the HPSA operations and construction and shall have the responsibility of ensuring that proposed actions conform are implemented properly with no impact to the safety of Disa’s operations.
- Other, at large, members who possess certain expertise that may be required for specific proposed actions. At large members will be appointed by the CEO and may either be Disa employees or outside consultants.
- The CEO will act as the Chairperson of the SERP. The Chairperson will appoint a SERP Secretary to act as the facilitator and maintain the records of the SERP. Generally, the RSO will fulfill this role.

5. PERFORMANCE-BASED LICENSE REVIEW PROCESS

5.1 Decisions

When a reviewing a proposed action, the SERP must make one of three decisions. These include:

- Proposed action is directly authorized in License _____;
- Proposed action is not directly authorized; however, the SERP may approve the proposed action based on its review; and,
- Proposed action requires a license amendment.

Each of these decisions must be documented in a report produced by the SERP.

5.2 Proposed Action Description

The first step in the performance-based review process is to develop a proposed action description that is to be reviewed by the SERP. Proposed action descriptions may be produced by any employee of Disa or contractor, at the direction of any upper level manager. These descriptions do not need to be unnecessarily detailed but must provide sufficient information for the SERP to perform its review. Proposed action descriptions should include the following information:

- General summary of the proposed action;
- Need for the proposed action
- Implementation of the proposed action (whichever are applicable):
 - o Process of implementation
 - o Equipment (including materials, reagents, SDSs, etc.);
 - o Health and safety impacts;
 - o Expected wastes (i.e., quantities, activities, concentrations) and waste management;
 - o Criteria used to determine success or failure;
 - o Sampling and analysis;
 - o Quality control;
 - o Drawings, schematics, or plans, if applicable; and,
 - o Method to report results.

Once completed, proposed action descriptions are circulated to the SERP through the CEO for review. The CEO will compile all comments from the SERP and will submit those comments to the author. No further review will occur until all SERP comments are appropriately addressed. (Note: This procedure is still valid even if the author is a SERP member.) Once finalized, these descriptions will become part of the SERP report that documents the SERP decisions.

5.3 Directly Authorized Review

Once the project description is completed, the SERP will conduct a review to determine if the proposed action is directly authorized. This review will include identifying any applicable license conditions in the most recent amendment of Radioactive Materials License No. _____. After identifying the appropriate license condition(s), the SERP will review the appropriate decision documents, which could include the following: Safety Evaluation Reports (SERs), Technical Evaluation Reports (TERs), Environmental Assessments (EAs), or Environmental Impact Statements (EISs).

If the SERP determines that the proposed action is directly authorized in the license and decision

documents, the SERP may end its review and prepare a SERP Report. This report should include the following information:

- Proposed action description;
- License conditions directly authorizing the proposed action;
- Citations from the decision documents that authorize the proposed action;
- Declarative statement that the proposed action is directly authorized; and,
- Signatures of all SERP members, signature date, and report date.

If the SERP determines that the proposed action is not directly authorized, then the SERP proceeds with the performance-based review.

5.4 Reviews of Actions Not Directly Authorized

Reviews of proposed actions that are not directly authorized are performed to determine whether or not the SERP may approve these proposed actions. To accomplish this review, the SERP meets to discuss the proposed action description and the results of the direct authorization review presented in Section 4.3. The SERP then analyzes the proposed action by comparing the action to the criteria found in the August 12, 2020, license amendment request. A license amendment is required for any proposed action if the proposed action affects any of the following:

- i. Result in a radiological release scenario that has not been previously addressed in the license application (as updated);
- ii. Result in more than a minimal increase in the likelihood of a radiological release from structures and equipment evaluated in the license application (as updated);
- iii. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), or environmental assessment (EA) or technical evaluation reports (TERs) or other analyses and evaluations for license amendments.

6. FINANCIAL SURETY

- 6.1 Once the proposed action has been analyzed, the SERP will review the proposed action to determine if any adjustment to the financial surety arrangement or the approved amount is required. If the proposed action will require an increase to the existing surety amount, the financial surety instrument must be increased accordingly and approved by the NRC staff or other appropriate regulatory agencies. Pursuant to License Condition____, adjustments to the financial surety are made during the regularly scheduled update.

7. CONSULTATION WITH NRC STAFF

- 7.1 After the SERP conducts the review process for a proposed change, the CEO and the RSO or personnel and/or consultants, as appropriate, may set up and complete conference calls or meetings with the NRC Project Manager, to brief the NRC staff on the proposed change. The objective of the briefings would be to establish consensus on the approach to the proposed change and consensus regarding the SERP findings.

8. DOCUMENTATION OF SERP REVIEW PROCESS

- 8.1 After the SERP conducts the review process for a proposed action, it will document its findings, recommendations, and conclusions in a written report format. Additional documents, figures, and tables may be attached to the report form at the discretion of the SERP members.
- 8.2 The date of the SERP decision will be added to the end of the report, and all members of the SERP will sign the final report. In lieu of a signature, a SERP member may state an approval by email if that particular SERP member cannot be present for the actual SERP meeting. All approval emails will be attached to the SERP report.
- 8.3 For SERPs consisting of more than six members, a simple majority (i.e., greater than fifty percent) is required to approve a SERP report. However, under no circumstances will a SERP report be approved, if either of the CEO, RSO, or COO does not agree with the conclusion. Furthermore, any disagreement shall be documented in an appendix to the SERP report for future reference.
- 8.4 If the report concludes that the SERP may approve the proposed action without a license amendment, Disa may implement the proposed action. If the report concludes that a license amendment is necessary before implementing the proposed change, the report will document the reasons.

9. RECORDKEEPING

- 9.1 SERP proceedings are considered documents associated with the NRC-issued Radioactive Materials License and will be maintained until license termination. SERP reports may be inspected by the NRC staff, and SERP reports may become public records. Therefore, no material that is confidential and/or proprietary to Disa should be placed in any SERP report. If such material is included in a SERP report and the NRC staff requests a copy for its records, the CEO (or the CEO's designee) shall include a request for withholding information from the public for any such information pursuant to 10 CFR 2.390.



Disa Technologies, Inc.

SOP-18 Rev. 0
Sealed Source Leak Test
Standard Operation Procedure

Approvals

Chief Operating Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

To provide a method for conducting leak tests on sealed sources.

2. DISCUSSION

Pursuant to guidance in NUREG-1556, Volume 18, leak tests are required for sealed sources to ensure that contamination is not being spread to other surfaces or to employees. Sealed sources are used for calibrating and function testing meters used in Disa's operations. Typical sealed sources will include thorium-230, technetium-99, and cesium-137.

3. PROCEDURE

3.1 Equipment

- Radiological survey detector –
Ludlum Model 19, Ludlum Model 43-5, Ludlum Model 44-9, Ludlum Model 44-10 detector, Ludlum Model 44-20 detector, or similar.
- Calibrated meter –
Ludlum Model 12, Ludlum Model 2221, Ludlum Model 2241, or similar.
- Radiological check sources –
 - For typical function check of an alpha detector, use a thorium-230 (Th-230) source.
 - For typical beta detector function check, use a technetium-99 (Tc-99) or strontium/yttrium-90 (Sr/Y-90) source.
 - For typical function check of a high-energy gamma detector, use a cesium-137 (Cs-137) source.

3.2 Documentation – A function check log form (Form SOP-02A) must be created and maintained for each individual detector. The detector should be function checked before each day of use. The function check log form must be retained.

3.3 To ensure achieving the required sensitivity of measurements, analyze leak tests in a low- background area.

3.4 Use a calibrated and operable radiation survey instrument to check leak-test samples for gross contamination before they are analyzed.

- 3.5** Analyze the leak-test sample using an instrument that is appropriate for the type of radiation to be measured [e.g., NaI (TI) well-counter system for gamma emitters, liquid scintillation for beta emitters, and gas-flow proportional counter for alpha emitters].
- 3.6** If the sensitivity of the counting system is unknown, determine the minimum detectable activity (MDA). The MDA may be determined using the following formula:

$$MDA = \frac{2.71 + 3.29 \sqrt{C_{background} \times t_{sample} \times \left(1 + \frac{t_{sample}}{t_{background}}\right)}}{t_{sample} \times E_t}$$

Where:

- MDA = minimum detectable activity with 95% confidence (dpm/100 cm²)
- C_{background} = Counts from background in time, t (counts)
- t_{sample} = Sample counting time (minutes)
- t_{background} = Background counting time (minutes)
- E_t = Total efficiency (cpm/epm)

Note: The MDA equation shown assumes that counting times for the background measurement and for the sample will be equal. MDA equations for non-equal counting times, as well as derivations of equations and discussions of limitations, can be found in “Decommissioning Health Physics—A Handbook for MARSSIM Users,” Eric W. Abelquist, published by Taylor & Francis Group, 2001.

- 3.7** Frequency for Conducting Leak Tests of Sealed Sources. - Leak tests will be conducted at the frequency specified in the respective Sealed Source and Device Registration certificate. If a sealed source is not registered, leak tests should be conducted at 6-month intervals, unless a different interval is established during the licensing process. Leak testing of sealed sources may be required by license condition.

3.8 Procedure for Performing Leak Testing and Analysis

- For each sealed source to be tested, list identifying information such as the sealed source serial number, manufacturer, model number, radionuclide, and activity.
- Use a radiation survey meter to monitor exposure.
- Prepare a separate wipe sample (e.g., cotton swab or filter paper) for each source.
- Number each wipe to correlate with identifying information for each source.
- Wipe the most accessible area where contamination would accumulate if the sealed source were leaking, but do not wipe the surface of a plated or foil source (see manufacturer’s instructions).
- Select instrumentation that is sensitive enough to detect 185 becquerels [0.005 microcurie] of the radionuclide contained in the sealed source.
- Using the selected instrument, count and record background count rate. Check the instrument’s counting efficiency using a standard source of the same radionuclide as the source being tested or one with similar energy characteristics. The calibration source should be in the same configuration as the sample. Accuracy of standards should be within plus or minus 5 percent of the stated value and traceable to primary radiation standards such as those maintained by the National Institute of Standards and Technology.
- Calculate the counting efficiency of the detector.

$$Efficiency\ in\ \frac{cpm}{Bq} = \frac{cpm\ from\ standard - cpm\ from\ background}{activity\ of\ standard\ in\ Bq}$$

Where: cpm = counts per minute
 Bq = becquerel

- Count each wipe sample; determine net count rate.
- For each sample, calculate and record estimated activity in Bq (or millicuries). The activity of the sample in becquerels may be calculated using the following formula:

$$\text{Sample Activity (Bq)} = \frac{\text{cpm wipe sample} - \text{cpm bkg}}{\text{efficiency in cpm/Bq}}$$

- Sign and date the list of sources, data, and calculations. Retain records for 3 years [under Title 10 of the Code of Federal Regulations (10 CFR) 20.2103(a)].
- If the wipe test activity is 185 Bq [0.005 microcurie] or greater, notify the radiation safety officer so that the source can be withdrawn from use and disposed of properly. Also notify the U.S. Nuclear Regulatory Commission.



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LEAK TEST INFORMATION FORM

Source Data

Source Owned by:	
Source Manufactured by:	
Source Model No.:	
Source Serial No.:	
Isotope:	
Activity: Note - Isotope activity expressed in curies, millicuries, or microcuries	
Date of Test:	

Test Data

Background Counts:	
Standard Counts:	
Standard Activity in Bq	
Efficiency of Detector	
Wipe Sample Counts	
Wipe Sample Activity in Bq	

Additional Information:

--

Name of Tester:	
Signature of Tester:	
Date:	



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Name of Reviewer:	
Signature of Reviewer:	
Date:	
Date of Test:	



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REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	All

1. PURPOSE

This procedure addresses emergencies that may occur during characterization and HPSA treatment at various inactive uranium mine sites. A JSA must be attached to this procedure for each individual site. The format and content is adapted from Regulatory Guide 3.67, "Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities.

This emergency plan is required to address licensed activities only. However, all major types of accidents are addressed in this plan. All Disa employees must be familiar with and trained in the corporate Health and Safety Plan. One copy of the Health and Safety Plan and the Radiation Protection Plan must be kept in a vehicle or field office that is onsite. Emergencies that may occur on a High-Pressure Slurry Ablation (HPSA) treatment jobsite may include fires, serious injuries, releases of diesel fuel, releases of radioactive materials, and traffic accidents. Each employee must remember HPSA treatment and the related activities resemble construction sites; therefore, vigilant safety practices are required to ensure the health and safety of all Disa employees and contractors. General activities that occur at HPSA sites include site characterization and waste treatment. These are described below.

This procedure cannot cover all the necessary information required for each jobsite. Therefore, Disa will prepare a Job Safety Analysis (JSA) that will contain all required information for working at a particular site. No Disa personnel may mobilize to a site without a JSA attached to this Emergency Plan. Information that is required on Job Safety Analysis (Attachment 1) includes:

- Location of closest medical facility
- Procedures for contacting emergency services
- Evacuation routes
- Emergency contacts
- Onsite Protective Actions
- Offsite Protection Actions

2. RESPONSIBILITIES

2.1 Radiation Safety Officer (RSO), Assistant Radiation Safety Officer (ARSO) (RSO Equivalent) –

- Serves as the Health and Safety Officer for work performed under the license.
- Responsible for the proper implementation of the DISA Health and Safety Plan and this procedure.
- Responsible for ensuring that a Job Safety Analysis has been performed for each High-Pressure Slurry Ablation (HPSA) jobsite.
- Ensuring that all documentation including training forms, daily tailgate meetings, and injury forms are completed within the prescribed timeframes.

2.2 Radiation Safety Technician (RST)(RSO Designee) –

- The RST is known as the RSO designee in License documents. References to the RST will also mean the RSO designee, as well.
- Serves as the site health and safety officer.
- Responsible for ensuring that DISA employees and contractors follow the DISA health and safety plan.
- Responsible for leading response actions in the event of an emergency.
- Responsible for contacting local emergency services to make them aware of our activities and timeframes for these activities.
- Serves as primary contact in the event of an emergency.

3. PROCEDURE

3.1 Facility Description

Disa's operations do not occur at facilities; they occur at individual inactive

mine sites. These sites occur in relative isolation from population centers on Federal, state, or private land. The sites consist of abandoned uranium mine waste which may appear as barren rock piles or graded areas that are slightly vegetated. In some cases, the abandoned mine waste occurs along steep slopes. The conditions at these sites vary greatly so no one description will suffice.

3.2 Descriptions of Nearby Areas

Areas surrounding abandoned uranium mine waste piles are unoccupied, vacant land. However, these areas contain roads and other evidence of various types of disturbance including excavation and grading.

3.3 Types of Activities

3.3.1 Site Characterization

Site characterization involves performing walkover GPS-gamma scans, collecting surface soil



RadScout with a 44-10

Model 2221

44-10 NaI 2x2 Probe

samples, and operating a drill rig to drill borings. Walkover gamma scans will be completed using a RadScout. Borings will be logged for gamma radiation using a 44-10 gamma probe attached to a Model 2221 or Model 3000 meter. Borings will be drilled using a TMG MB-38, track mounted drill rig.

Drilling will occur using 3-inch solid stem augers to advance borings to a maximum of 50 feet. Once the augers are retracted, Disa staff

will lower the 44-10 probe down hole and obtain the log. Data will be entered into a computer for later processing.



3.3.2 HPSA Treatment

HPSA Treatment involves excavating waste piles, placing the waste onto a conveyor for crushing, grinding, and mixing with water. This slurry is then pumped through the collision chamber, and then separated by centrifuges to produce the Fines Concentrates and the Clean Coarse Material. The Fines Concentrates will be stored in rolloff containers while the Clean Coarse Material will be piled and spread throughout the site. Process water will be sampled and, if release criteria are met, will be discharged to the ground surface. Otherwise, water will be reused at other sites and/or transported to a treatment facility for disposal.

3.4 Types of Accidents

- Fire – Fires may occur in equipment, on grassy areas near HPSA equipment (generators) due to sparks, ignition of diesel fuel, or may start offsite as wild land fires. Fires will be detected by visual observation as Disa staff will always be onsite during treatment. Fires area classified as the following types of accidents:

- Equipment Fire – Alert
- Grass Fire – Site Area Emergency
- Wild Land Fire – Site Area Emergency
- Diesel Fuel Fires – Site Area Emergency
- Medical – Personnel medical issues can occur through accidents or a known or unknown medical condition. Accidents involving licensed materials could be a sudden release of source material from the HPSA equipment or a release of source material from the storage area.
- Severe Weather/Natural Disasters – These could include blizzards, floods, avalanches, landslides, tornadoes, etc. These are all considered Site Area Emergencies.
- Hazardous Material Spills – Diesel fuel would be the only hazardous material onsite. This is considered an alert.

3.5 Notification and Coordination

3.5.1 Alerts

The purpose of declaring an alert is to ensure that (1) emergency personnel are alerted and are prepared to mitigate the consequences of the accident, (2) the emergency is properly assessed, (3) offsite officials are notified, and (4) steps can be taken to escalate the response quickly if necessary. The following is a descriptions of the actions to be taken:

- Decision to declare an alert. Any Authorized User or RST may declare an alert. Alerts are communicated by phone or radio.
- Activation of onsite emergency response organization. The RST or Field Services Manager should lead the emergency response. However, considering time may be of the essence, any Authorized Use may implement an emergency response if the Authorized User is trained (i.e., fire extinguishing).
- If necessary, prompt notification of offsite response authorities to inform them that an alert has been declared (normally within 15

minutes of declaring an alert). The RST or Field Services Manager are responsible for notifying offsite authorities either by cell phone or satellite phone.

- The RSO or ARSO are notified immediately after the offsite authorities by the RST.
- Notification to the NRC Operations Center at 301-816-5100 immediately after notification of offsite authorities and the RSO/ARSO, and in any case within 1 hour of the declaration of an alert. The RSO is responsible for notifying the NRC Operations Center.
- Decision to initiate any onsite protective actions. Decisions to initiate onsite protective activities are made by the Field Services Manager and communicated in-person, or by radio, cellphone, or satellite phone.
- Decision to escalate to a site area emergency, if appropriate. The Field Services Manager is responsible for escalating an alert to a site area emergency. This is communicated in-person, or by radio, cellphone, or satellite phone. However, when immediate evacuation is required, the Field Services Manager should blast an air horn.
- Decision to request support from offsite organizations. These decisions are made by the Field Services Manager.
- Decision to terminate the emergency or enter recovery mode. These decisions are made by the Field Services Manager.

Alerts that do not require offsite services are those that can be addressed by onsite personnel. Examples are spills of process water or source material that do not enter surface water, small fuel spills that do not enter surface water, minor injuries that can be treated with first aid, minor accidents that only result in minor injuries that can be treated with first aid.

3.5.2 Site Area Emergencies

The purpose of declaring a site area emergency is to ensure that offsite officials are informed of potential or actual offsite consequences, that offsite

officials are provided with recommended actions to protect persons offsite, and that the licensee's response organization is supplemented by additional personnel and equipment. The following describes how and by whom the following actions will be taken:

- Decision to declare a site area emergency. The Field Services Manager is authorized to declare a site area emergency using the accident classifications stated in above, observations of the accident and potential consequences, and input from other Authorized Users.
- Activation of onsite emergency response organization. Disa will not have an onsite response organization for site area emergencies.
- Prompt notification of offsite response authorities that a site area emergency has been declared, including the licensee's initial recommendation for offsite protective actions (normally within 15 minutes of declaring a site area emergency). The Field Services Manager will notify the offsite authorities.
- The RSO or ARSO are notified immediately after the offsite authorities by the RST.
- Notification to the NRC Operations Center at 301-816-5100 immediately after notification of the appropriate offsite response organizations and the RSO/ARSO and not later than 1 hour after the licensee has declared a site area emergency. (See 10 CFR Part 20 for additional notification requirements.) The RSO will notify the NRC Operations Center.
- Decision on what onsite protective actions to initiate. The Field Services Manager will ensure that all HPSA equipment and generators are deactivated.
- Decision on what offsite protective actions to recommend. Offsite protective actions will not be made by the Field Services Manager in coordination with offsite authorities.
- Decision to request support from offsite organizations. These

decisions will be made by Field Services Manager.

- Decision to terminate the emergency or enter recovery mode. This decision will be made by Field Services Manager in cooperation with offsite authorities.

3.6 Information to be Communicated

Disa will provide clear, concise information to offsite response organizations. The communication should avoid technical terms and jargon and should be stated to prevent an under- or over- evaluation of the seriousness of the incident. Disa will provide the following information:

- Description of the status of the facility and the nature of any onsite radioactivity release.
- Recommendations for protective actions to be implemented by offsite response organizations.
- Preplanned protective action recommendations the licensee will make to each appropriate offsite organization (including NRC) for each postulated accident.
- Disa will attempt to make protective action recommendations directly to State or local officials responsible for implementing the specific protective actions. The recommendations should specify the size of the area where the actions are to be taken.
- Provide assurance to NRC that the information has been received by offsite response organizations and that it is periodically reaffirmed and updated with these agencies.

3.7 Response Coordination

During an emergency, after emergency services are called, if necessary, Disa personnel must notify the Radiation Safety Officer and the Operations Manager. Phone numbers for these personnel will be presented on the JSA. Prior to HSPA operations in an area, the Field Services Manager will contact location emergency authorities and inform them of the activities that will be occurring. Disa will attempt to organize its treatment operations to work in one area or county before moving to the next. Organizations to be contacted include: police, fire, and hospitals. Disa will contract with an occupational medical group that will provide medical services to Disa personnel and that can address the radiological aspect of the medical emergencies.

3.8 Emergency Response Measures

3.8.1 Activation of the Emergency Response Organization

- Phone – cell or satellite
- Radio
- Air horn – In an emergency evacuation, an air horn should sound and personnel will be responsible for immediately responding.
- Text

Disa will also notify the local emergency response authorities, which will be identified on the JSA.

3.8.2 Fire:

Where appropriate, fire extinguishers will be mounted the vehicles, drill rigs, work trucks, and generators. To the extent possible, avoid drilling and driving in high grass. If a fire starts in grass, Disa personnel should attempt to extinguish the fire. If a fire starts in the rig, generator, or a vehicle, Disa personnel may extinguish the fire if the fire is reasonably small. This is in the judgement of site personnel. If the fire is large, then Disa personnel should move away from the fire. Whether fighting a fire or moving away from a fire, all systems must be deactivated, and the Field Services Manager must call emergency services. Disa personnel will have a satellite communication device to allow for phone calls in isolated locations.

In case of wildland fires that start outside of a Disa worksite, the worksite must be shut down and employees must evacuate. If time allows, the drill rig should be loaded and towed away from the site. If time does not allow, then personnel should immediately evacuate.

3.8.3 Medical

If medical attention is required, only trained first aid and CPR certified individuals should lead the treatment. If possible, the individual should be moved to a safe location if not already situated in a minimized-hazard environment. First-aid kits and AEDs will be located at least one field vehicle. First Aid kits will include blood borne pathogens (BBP) kits. If an emergency occurs, render aid to the victim, then call emergency services. Portable eye wash bottles or stations must be placed every vehicle that is onsite.

All incident-reporting forms must be filled out. If first aid is applied onsite, the nature of the first aid, condition of the individual, and recommendation for further treatment must be recorded.

Additionally, Emergency Medical Services (EMS) should be called immediately if a victim exhibits the following symptoms and cannot be easily and/or safely transported to a medical facility:

- Any injuries to the head, neck, or back;
- Abdominal pain or pressure;
- Broken bones;
- Difficulty breathing/shortness of breath;
- Extreme change in mental status (unusual behavior, confusion);
- Seizure;
- Severe bleeding;
- Severe headache;
- Severe heat stroke;
- Severe hypothermia;
- Slurred Speech;
- Sudden dizziness; and,
- Unconsciousness.

In the event of an emergency, the victim should attempt to reach EMS. If they are unable to do so, any nearby personnel are required to assist the victim immediately.

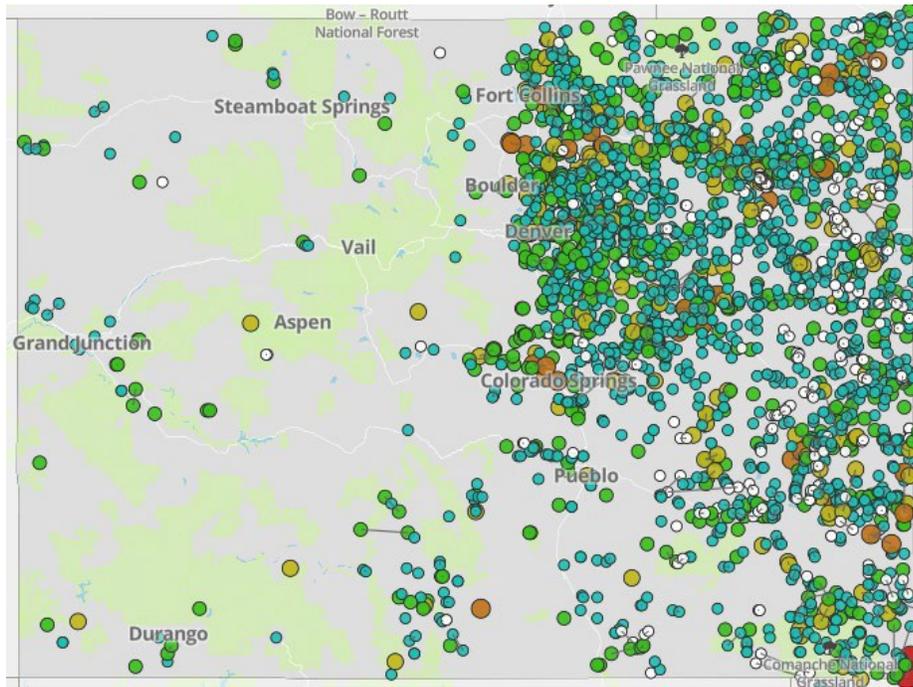
If there is a medical emergency at a contaminated uranium mine site that requires professional medical treatment, first responders should be notified that the injured individuals have been working at contaminated uranium mine sites, but the

contaminants involved are low-level naturally occurring radionuclides that would be present only in trace amounts and do not pose a significant health hazard. In all cases, medical attention takes precedent over any radiological contamination concerns. If the first responders or the hospital are concerned about contamination, simple alcohol swipes can be used to clean off any dirt on the skin.

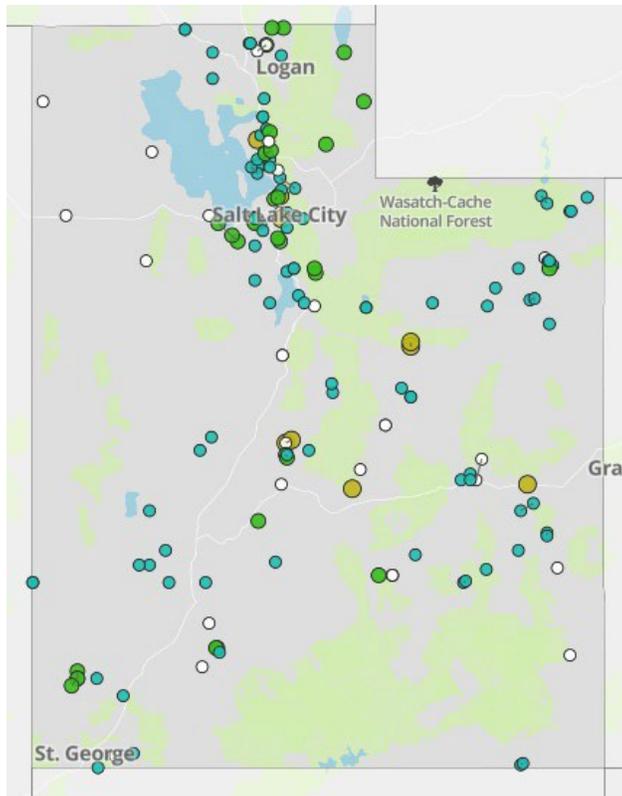
1. Severe Weather and Natural Disasters:

Severe weather that could occur includes thunderstorms, windstorms, and hail. A history of tornadoes in Colorado and Utah is depicted in the following images:

Colorado Tornado History Since 1950s



Utah History of Tornadoes Since 1950s



Based on this information, a tornado occurrence would be a low probability for work in the area that HPSA would be utilized.

In event of severe weather, equipment will be shut down and personnel will evacuate the jobsite. Special attention should be given to large precipitation events especially at jobsites adjacent to water bodies. Sudden flooding could occur during large precipitation events that may affect the ability to leave a site.

2. Hazardous Materials Releases

Diesel fuel will be the only hazardous material located at a HPSA remediation site, which will be used to fuel the generators. One to two, 7,500-gallon diesel trucks will be onsite per week at a HPSA remediation site. Trucks will be parked in an area that is sloped and bermed. In the event of a release, onsite construction equipment will be used to excavate and isolate the fuel and contaminated soil and stockpile it in a safe area. Disa will have a contract with a HAZMAT disposal company that will collect the contaminated soil and dispose of it properly. Disa will also maintain spill cleanup kits onsite for use in diesel releases.

3. Equipment Shutdown:

We do not currently operate any critical equipment that would need special emergency shutdown procedures. If an alert is sounded for an evacuation, leave immediately unless leaving the running equipment would pose an additional hazard, and in this case it should be shut down as quickly as possible before exiting the building or site. If the circumstances come down to anyone's safety or the broken equipment, always prioritize avoiding bodily harm.

4. Evacuation Procedures

An evacuation will be required for fires, some types of extreme weather, and other serious incidents where employees and visitors need to remove themselves from the hazards at hand. Emergency services should be called as soon as safely possible if the circumstances are appropriate to do so. After an audible alert, all employees will vacate the site in a calm and orderly fashion. The meeting point after evacuating will be at the designated muster point, which will be determined for each site and identified on the JSA. At the muster point, the Field Services Manager will note attendance of the group to ensure all employees and visitors are accounted for.

5. Contacting Emergency Services

In the event of an emergency, the victim should attempt to reach EMS. If they are unable to do so, any nearby personnel are required to assist the victim immediately. If there is a medical emergency at a contaminated uranium mine site that requires professional medical treatment, first responders should be notified that the injured individuals have been working at contaminated uranium mine sites, but the contaminants involved are low-level naturally occurring radionuclides that would be present only in trace amounts and do not pose a significant health hazard. In all cases, medical attention takes precedent

over any radiological contamination concerns. If the first responders or the hospital are concerned about contamination, simple alcohol swipes can be used to clean off any dirt on the skin.

Exposure Control in Radiological Emergencies

Releases of source material resulting from Disa's operations will not result in substantial radiation exposure due to the minor concentrations of uranium, albeit above the 500 mg/kg exemption limit. For onsite releases (alerts), Disa personnel will contain the release and excavate contaminated material. Contamination material will be transported offsite with the fines concentrates. In a site area emergency, all source material will be secured in roll-off containers or within the HPSA equipment. If a site area emergency results in the release of source material, Disa personnel will perform surveys and will excavate contaminated material where it is detected.

Incident Reporting

Following an emergency, an Incident Investigation Reporting Form must be filled out within 2 business days for minor accidents, within 24 hours for a serious injury or fatality, or within eight (8) hours of near misses that could have resulted in serious injury or illness.

4. REFERENCES

4.1 Radiation Protection Program (RPP) Manual



SOP-20, REV. 0

**QUALITY ASSURANCE PROJECT PLAN
HIGH-PRESSURE SLURRY ABLATION**

**Site Characterization and Waste Treatment
Operations**



TITLE: Sampling Plan and Quality Assurance Project Plan High-Pressure Slurry Ablation Site Characterization And Waste Treatment Operations

Date: August 2025

Chief Regulatory Affairs Officer
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Date: _____

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DOCUMENT REVISION TRACKING

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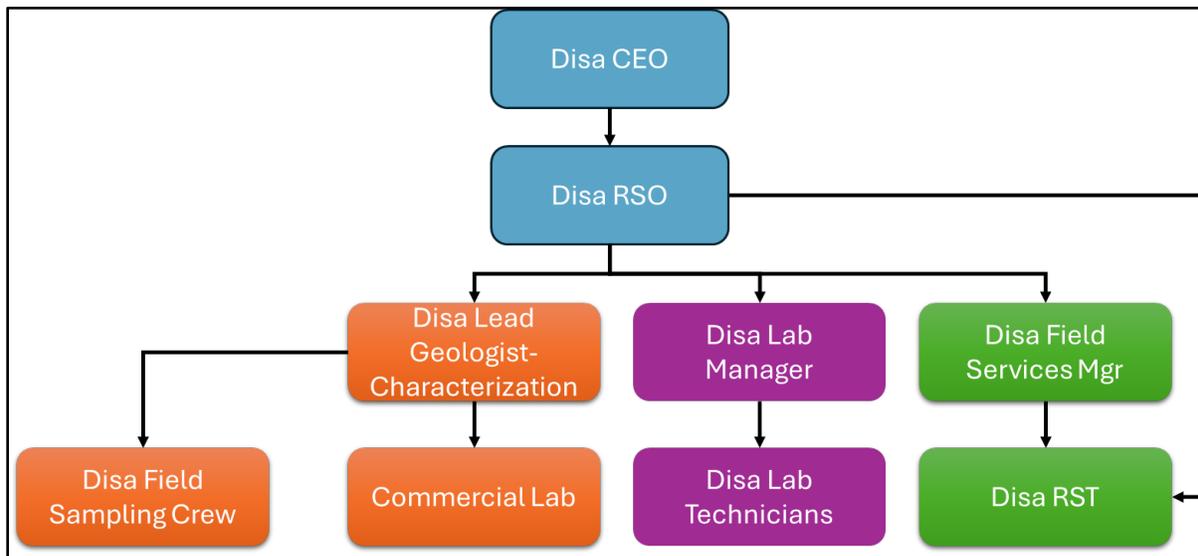
1. INTRODUCTION

DISA Technologies, Inc. (DISA) received a multi-site, service provider’s, source material license from the U.S. Nuclear Regulatory Commission (License No. ____) to utilize High-Pressure Slurry Ablation (HPSA®) to treat uranium mine waste, concentrate uranium (source material) in the fines concentrates, and recycle the uranium at a licensed facility. The license also allows DISA to leave the clean coarse material at the treatment as long as the unrestricted release criteria are met, which are 25 mrem/yr dose to the public and less than 500 mg/kg (exemption limit). DISA has also developed screening criteria for various dose modeling scenarios that will be used to help define when the post-treatment site meets the unrestricted release criteria. DISA’s operations involve site characterization and sampling and analysis (during HPSA® treatment) of the fines concentrates and clean coarse material. This Quality Assurance Project Plan (QAPP) is designed to promote consistency in site characterization and HPSA® product sampling and to ensure that data are of sufficient quality to allow for proper decision making.

1.1 PROJECT MANAGEMENT

Figure 1-1 contains an organization chart for characterization and product sampling activities under DISA’s service provider’s license. The Radiation Safety Officer (RSO) will be responsible for all sampling and QA activities. These sampling and QA activities will be split between characterization and product treatment. Characterization responsibilities fall under DISA’s Lead Geologist and the process for which is found in SOP-21. Waste treatment sampling falls under DISA Field Services Manager (FSM), and the DISA RST works with the FSM to arrange sampling activities. The DISA Lab Manager will be responsible for in-house analyses of samples.

Figure 1-1: Project Organization Chart



1.2 PROBLEM DEFINITION

The fundamental problems to be addressed by this characterization and waste sampling activities are summarized as follows:

- Background gamma radiation and concentrations of radium-226 (Ra-226), natural uranium, and thorium-230 (Th-230).
- Characterization uranium mine waste for gamma radiation and concentrations of Ra-226, natural uranium, and Th-230.
- Estimates of the waste volumes and natural uranium concentrations in the uranium mine waste.
- Concentrations of natural uranium, Ra-226, and Th-230 in the fines concentrates.
- Concentrations of natural uranium, Ra-226, Th-230, gamma radiation in the clean coarse material.
- Leachability of radionuclides and metals in the clean coarse material.
- Concentrations of air particulates and Rn-222 liberated during waste treatment operations.

The regulatory criteria for this license that will determine when DISA may demobilize from a treatment site are as follows:

1. 10 CFR 20.1402 unrestricted release criterion of 25 mrem/year
2. Below the 500 mg/kg source material exemption limit in 10 CFR 40.13
3. Table 1-1 below of screening criteria.

Table 1-1: Dose Screening Criteria

Scenario	Ra-226, pCi/g	U-238, mg/kg ¹	Natural Uranium, mg/kg ³	Th-230, pCi/g
Resident Farmer	1.7	556 ²	1,151 ²	12
Resident Gardener	4.1	866	1,792	30
Rural Resident	5.3	970	2,008	42
Rancher	12	2,360	5,445	86
Recreationalist	63	8,000	16,562	295
¹ Uranium-238 specific activity to calculate limit is 3.36E-7 Ci/g. ² Uranium concentrations are presented here for the sole purpose of completing the sum of fractions calculations described in Section 2.2 for unrestricted release doses. The total mass concentration of uranium and/or thorium that will be allowed to remain on a treatment site must be below 500 mg/kg. ³ Note: U-238 activity is approximately half of natural uranium activity (48.3%).				

1.3 SITE CHARACTERIZATION AND WASTE TREATMENT APPROACH

1.3.1 Site Characterization

This QAPP contains a detailed description of the analytical approach and field work necessary to resolve the problem definition. To summarize, spatially comprehensive gamma radiation surveys and a statistical correlation between Ra-226 concentrations in surface wastes and associated gamma radiation will be used to characterize the horizontal and vertical extents of impacts to soil from historic mining operations. Correlations between gamma and natural uranium or Ra-226 and uranium in surface wastes will be used to quantify the uranium resource that exists in mine waste. Th-230 will be analyzed in surface samples to calculate the total mass of source material in the uranium mine waste.

The vertical extent of mining impacts to subsurface soils will be characterized based on systematic borehole surveys with downhole gamma profile measurements at each borehole location, along with subsurface waste sampling at select borehole locations within each waste pile.

1.3.2 Waste Treatment Sampling

This QAPP contains a detailed description of the analytical and sampling approach for characterizing the HPSA® treatment products, fines concentrates (source material) and clean coarse material, and HPSA® treatment process water. To summarize, DISA will collect periodic samples of treatment products as the products are being produced to obtain ongoing information regarding the treatment effectiveness and compliance with DISA's unrestricted release criteria. Samples of clean coarse material will be analyzed for Ra-226, natural uranium, Th-230, and Synthetic Precipitation Leaching Procedure (SPLP) for radionuclides, and Toxic Characteristic Leaching Procedure (TCLP) for the 8 RCRA metals. Treatment process water will be sampled for Ra-226, natural uranium, natural thorium, and RCRA metals. Fines concentrates will be analyzed for Ra-226, natural uranium, and Th-230.

1.4 DATA OBJECTIVES

Data generated from DISA's Site Characterization and Waste Treatment Sampling efforts will be used to develop estimates of uranium mass in uranium mine waste and also provide data to determine the compliance with the unrestricted release criteria and the 10 CFR 20, Appendix B, Table 2 effluent standards.

1.5 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

1.5.1 Data Quality Objectives Summary

Data Quality Objectives (DQOs) used to develop the study designs and analytical criteria detailed are described below.

1.5.1.1 State the Problem

Project problem statements are provided in Section 1.2 above.

1.5.1.2 Identify the Goals of the Study

Based on the project problem statements (Section 1.2), the primary goals of the study are as follows:

- a. Determine whether the Ra-226/gamma count rate and uranium/gamma count rate produce a regression model that may be used to estimate the uranium mass in a waste pile (coefficient of determination (R^2) >0.85).
- b. Determine whether uranium mine waste sites/piles contain sufficient uranium to warrant treatment.
- c. Estimate the total volume of uranium mine waste and the mass of natural uranium in the waste.
- d. Determine the quantity of uranium in the fines concentrates to allow for proper accounting and to address the Additional Protocol requirements. Also determine the quantity of radionuclides to allow for the proper shipment of the fines concentrates offsite to a licensed facility.
- e. Determine the quantity of Ra-226, natural uranium, Th-230, and the SPLP and TCLP leachability in the clean coarse material to evaluate whether this material meets the unrestricted release criteria for this license and sufficiently stable to prevent future contamination issues.

Based on these study goals, the principal study questions and alternative actions are shown in Table 1-2.

Table 1-1: Principal Study Questions and Alternative Actions

Principal Study Question	Alternative Actions
1. Do the Ra-226/gamma count rate produce a regression coefficient that exceeds 0.85	A. Resulting regression equation may be used in the quantification of uranium mass in soils
	B. Quantification must be accomplished using sampling results and geostatistics.
2. What is the total volume of uranium mine waste in the pile or area?	A. Include all mine-related materials that occur in the mine waste area and that exceed background values.

Principal Study Question	Alternative Actions
	B. Exclude any native soils unless soils exhibit gamma rates that exceed 2 times background.
3. Is the mass of uranium in the mine waste sufficient to perform HPSA® treatment?	A. Yes, the mass of uranium is sufficient to perform HPSA® treatment.
	B. No. Project may not be viable.
4. Does laboratory testing indicate that HPSA® treatment will successfully result in a clean coarse material that will meet the unrestricted release criteria?	A. Conduct dose modeling if the analytical results do not indicate that the radionuclide concentrations will not meet the screening criteria.
	B. Include alternatives such as soil mixing in the modeling to determine if the clean coarse material will meet the unrestricted release criteria.
	C. Unrestricted release criteria cannot be met. Reject the project.
5. Do the concentrations of radionuclides allow for the discharge of process water onsite?	A. Discharge the water onsite.
	B. Transport the water to another treatment site for reuse.
	C. Discharge the water to a permitted water treatment plant.
6. Are air particulate and radon-222 data sufficient to estimate doses to the members of the public and workers?	A. Sample analysis shows that concentrations are large enough to affect public and worker doses.
	B. Sample analysis shows that concentrations are insufficient to affect public and worker doses. Seek to discontinue pursuant to SOPs.
7. Will post-treatment clean coarse material meet unrestricted release criteria/screening criteria	A. Collect post-treatment clean coarse samples to determine compliance
	B. Site-specific dose modeling if clean coarse material will not meet criteria
	C. Incorporate soil mixing into remediation to allow clean coarse material to meet standards
8. What is the concentration of uranium in fines concentrates and what is the proper transportation labeling/placarding/HAZMAT code	A. Analyze samples for Ra-226, natural uranium, and Th-230.

1.5.1.3 Identify Information Inputs

The following inputs are necessary to address the principal study questions:

1. Regression analyses for gamma, Ra-226, and natural uranium: gamma walkover scans, surface samples for Ra-226 and natural uranium for laboratory analysis.
2. Total volume of uranium mine waste: gamma walkover scans, surface samples for Ra-226 and natural uranium for laboratory analysis, borehole drilling and gamma logging of each borehole. Collection of subsurface samples for Ra-226

and natural uranium. Additional sources of data and supporting technical information may include digital topographic, geologic, and soils data in GIS format. This information along with the gamma and radionuclide data will be used to create 3-dimensional models of the uranium mine waste area/pile to estimate the uranium resource

3. Total mass of natural uranium in uranium mine waste: 3D modeling (as described in Item 2.) of the gamma data, use of regression equations to calculate the uranium mass.
4. Will clean coarse material meet the unrestricted release criteria or screening criteria: sampling and analysis of clean coarse material from Mills, WY, lab testing for Ra-226, natural uranium, Th-230, SPLP radionuclides, and TCLP metals.
5. Discharging process water to ground surface: sampling and analysis for radionuclides for comparison to 10 CFR 20, Appendix B, Table 2, Effluent standards.
6. Air particulate and radon-222 data: sampling and analysis of air particulate sampler filters and track-etch detectors.
7. Post-treatment clean coarse material compliance: periodic sampling of clean coarse material and analysis for Ra-226, natural uranium, Th-230, SPLP radionuclides, and TCLP metals.
8. Radionuclide characteristics of the fines concentrates: sampling and analysis for Ra-226, natural uranium, and Th-230.

Analytical methods to support the project DQOs discussed herein are presented in Table 1-3.

Table 1-3: Analytical Parameters and Methods

Parameter	Reporting Limit	Units	Method	Solids or Water
Mine Waste Sampling				
Natural Uranium	1	mg/Kg	EPA 200.8	Solids
Vanadium	5	mg/Kg	EPA 200.8	Solids
Radium-226	0.2	pCi/g	EPA 901.1 Mod.	Solids
Thorium-230	0.2	pCi/g	ACW01	Solids
Toxic Characteristic Leaching Procedure				
Mercury	0.005	mg/L	EPA 7470A	Liquid Extract
Arsenic	0.2	mg/L	EPA 6010C	Liquid Extract
Barium	0.5	mg/L	EPA 6010C	Liquid Extract
Cadmium	0.05	mg/L	EPA 6010C	Liquid Extract
Chromium	0.01	mg/L	EPA 6010C	Liquid Extract
Lead	0.2	mg/L	EPA 6010C	Liquid Extract

Parameter	Reporting Limit	Units	Method	Solids or Water
Selenium	0.2	mg/L	EPA 6010C	Liquid Extract
Silver	0.05	mg/L	EPA 6010C	Liquid Extract
Uranium	0.1	mg/L	EPA 6010C	Liquid Extract
Vanadium	0.2	mg/L	EPA 6010C	Liquid Extract
Synthetic Precipitation Leaching Procedure, EPA Method 1312				
Natural Uranium	0.1	mg/L	EPA 1312	Liquid Extract
Radium-226	0.2	pCi/L	SM 7500 Ra-B	Liquid Extract
Thorium-230	0.2	pCi/L	ACW10	Liquid Extract
Water Samples				
Mercury	0.001	mg/L	EPA 245.1	Water – Total and Dissolved
Arsenic	0.005	mg/L	EPA 200.8	Water – Total and Dissolved
Barium	0.1	mg/L	EPA 200.8	Water – Total and Dissolved
Cadmium	0.001	mg/L	EPA 200.8	Water – Total and Dissolved
Chromium	0.003	mg/L	EPA 200.8	Water – Total and Dissolved
Lead	0.001	mg/L	EPA 200.8	Water – Total and Dissolved
Selenium	0.005	mg/L	EPA 200.8	Water – Total and Dissolved
Silver	0.003	mg/L	EPA 200.8	Water – Total and Dissolved
Natural Uranium	0.0003	mg/L	EPA 200.8	Water – Total and Dissolved
Vanadium	0.02	mg/L	EPA 200.8	Water – Total and Dissolved
Radium-226	0.2	pCi/L	SM 7500 Ra-B	Water – Total and Dissolved
Thorium-230	0.2	pCi/L	ACW10	Water – Total and Dissolved

1.5.1.4 Define Study Boundaries

Spatial boundaries exist for this project. Spatial boundaries are those that are the physical limits of the uranium mine waste.

1.5.1.5 Develop the Analytical Approach

The analytical approaches and methods to be used for site characterization and HPSA® post-treatment sampling are summarized in Section 1.3 and Table 1-2, above.

1.5.1.6 Performance or Acceptance Criteria

Performance criteria for characterization of gamma radiation, radionuclides, and metals in uranium waste piles will include requirements for 1) instrument calibrations (within 1 year prior to use on the project), 2) initial consistency of instrument response between calibrated instruments (within $\pm 10\%$), and 3) daily instrument response checks (within ± 3 standard deviations from the initial mean among all instruments to be used for scanning waste piles). Maps of gamma radiation across the waste piles will be presented in units of count rate (cpm).

For laboratory analysis of soil samples, data acceptance criteria (e.g., for data validation) are provided in this QAPP. Acceptance criteria for statistical regression relationships will include an $R^2 > 0.85$, along with a statistically significant slope ($p\text{-value} \leq 0.05$) for the best fit (linear or non-linear) regression model. Statistical outliers will be reviewed prior to omission to ensure that valid data is not being excluded from the analysis. The statistic used to determine the uranium content of a waste pile will be the upper confidence limit (UCL) using a statistical confidence level of 95%. However, means and standard deviations will also be calculated.

2. QUALITY ASSURANCE OBJECTIVES

2.1 IDENTIFYING OBJECTIVES

For characterization and unrestricted release compliance, Ra-226 concentrations, natural uranium, and Th-230 in soil are expected to be the primary drivers of dose and the source material limit, and, therefore, compliance with the unrestricted release criteria and the screening criteria. Gamma radiation associated with Ra-226 is readily detected with field instruments that are highly sensitive to small changes in Ra-226 soil concentrations. As such, gamma surveys are widely used for characterization of the spatial distribution of radionuclides and uranium at abandoned uranium mine (AUM) sites.

Gamma/Ra-226 correlation techniques have long been recognized as capable of producing reliable characterization of radiological soil contamination (NRC, 2003; Johnson et al., 2006; Whicker et al., 2006 and 2008). Because Ra-226 at uranium mine waste sites is commonly co-located with natural uranium and Th-230, co-variant relationships can sometimes be used to characterize the levels and extent of these radionuclides. Although analytical uncertainty in these predictive relationships is higher at any given location (versus soil sampling and direct laboratory analysis), when evaluated collectively, gamma survey data provide much higher analytical resolution in terms of accurately identifying and characterizing the spatial distribution of residual soil contamination across large areas (Lively, 2013).

All gamma surveys, mine waste sampling, product sampling, and offsite laboratory analysis will be subject to the data QA/QC protocols specified in this QAPP. The purpose of these protocols is to ensure that the analytical data to be generated will be of sufficient quality to meet the project DQOs as defined herein. To meet the DQOs, analytical uncertainties introduced by variability in instrument performance, laboratory methods, and survey techniques will be minimized, and the data evaluated in terms of validation criteria and data useability.

For characterization and treatability purposes, QA includes qualitative aspects of the sampling plan necessary to ensure an appropriate analytical design and proper implementation of planned methods and procedures. QC includes quantitative measures to monitor analytical method performance and to allow respective estimation of data uncertainty (accuracy, bias, and precision).

Data to be collected under this license are classified as one of three categories or levels of QA as follows:

- QA1 – Screening level field measurement data, including gamma surveys and respectively predicted Ra-226 and natural uranium concentrations.
- QA2 – Laboratory analysis of soil samples for correlations with QA1 gamma survey data, and borehole surface soil samples that may be used to quantify and

evaluate uncertainty in predicted PCOC soil concentrations based on gamma survey data.

- QA3 – Laboratory analysis of all soil samples, air samples, water samples, and radon air monitoring samples for quantification of concentrations of radionuclides and metals.

2.1.1 Project QA Specifications

All gamma surveys, waste/product/water sampling, and supporting measurements used for field investigations and treatability measurements will be subject to the data QA/QC protocols detailed in this QAPP. Applicable SOPs listed in Table 2-1 will be followed for all environmental survey and sampling methods. Personnel responsible for field activities shall have appropriate qualifications, education, training, experience, and a satisfactory knowledge of the requirements of the activities to be carried out. All deviations will be officially documented and signed off by the Chief Regulatory Affairs Officer.

Detailed field notes will be kept in field logbooks or computer tablets to document daily activities and any relevant observations regarding environmental conditions or equipment-related performance that could affect data. Standard chain-of-custody protocols will be followed for sampling shipping and offsite laboratory analyses. All field data will be qualitatively and quantitatively reviewed by an experienced health physicist and evaluated in terms of data quality with respect to project DQOs.

The proposed offsite analytical laboratory (Pace - Sheridan, WY) is fully qualified and appropriately accredited for analysis of all analytes in Table 1-3. Pace-WY is NELAP certified by in numerous states to perform radiochemical analysis and analysis of metals/metalloids, and has accreditation across most of the states in the western US with data submitted in MT, WA, ID, WY, NV, CO, ND, NM, UT, TX, and AZ. This lab has provided both compliance and process analytical data for clients under various regulatory programs including EPA, NRC, and state regulatory agencies. Laboratory staff has experience with baseline data collection, process analyses, permit compliance monitoring, and decommissioning and closure of mining/milling sites.

Table 2-1: Project Standard Operating Procedures

SOP	SOP Title
SOP-02	Operational Checkout of Single-Channel Detector with Meter
SOP-03	Operational Checkout of Dual-Channel Alpha/Beta Detector with Meter
SOP-06	Contamination Surveys and Decontamination
SOP-08	Air Sampling

SOP-12	Contamination Surveys
SOP-21	Field Sampling Protocols
SOP-22	3D Volume Estimating

2.1.2 Project QC Specifications

Calibration of all field measurement instruments will be performed within one year prior to use on DISA’s projects. Calibration certificates will be kept on file at DISA’s Mills, Wyoming, facility.

Daily QC measurements (function checks) will be performed in the field for all gamma survey instruments and scanning systems to ensure 1) proper instrument/system performance, 2) acceptable measurement precision within/between instruments, and 3) to allow quantitative evaluation of analytical uncertainty in study results. These data will be documented on standard DISA function check forms.

The commercial laboratory used for analysis of soil, mine waste, and water samples will perform routine QC measurements for each batch of sample results as specified in this QAPP (e.g., field duplicates, duplicate sample analyses, matrix spikes, method blanks, etc.) to provide quantitative indications of accuracy and precision.

2.1.3 Error Determinations

Analytical error in soil sample analysis results from the selected laboratory will be determined using matrix spike (MS) samples and MS duplicates (MSD) or matrix duplicates (MD) per method requirements. For matrix spikes, the laboratory will spike and analyze 14 spike samples (1 spike per 20 samples) with concentrations that span the range of concentrations expected at the mine sites. Samples for radiological analyses will not be spiked. The laboratory will homogenize the samples before analysis. Bias (percent recovery) and precision (coefficient of variation) will be determined according to Section 3.5 of OSWER Directive No. 9360.4-01 (EPA, 1990).

Duplicates will be collected at a rate of 1 per 20 field sample collection. Specifically, subsample field duplicates will be collected by splitting a sample after homogenizing it. Duplicates will be identified as such by adding the code “DUP” at the end of the sample number. Duplicates will be collected from each type of sampling event including:

- Background surface soil
- Background subsurface soil
- Surface soil/mine waste
- Soil boring subsurface soil

Duplicates will be analyzed using the same analytical methods as the analytical sample.

2.2 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, AND COMPLETENESS

2.2.1 Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been.

The project team will determine and document the following:

- Quantitative measurement performance criteria for acceptable sampling and analytical precision for each matrix.
- Analyte-specific measurement performance criteria, if applicable.
- QA/QC activities, or QC samples, that should be performed or analyzed to measure precision for each matrix, analytical group, and concentration level.

Overall project precision is measured by collecting data from co-located field duplicate samples. Precision specific to the laboratory is measured by analyzing laboratory duplicate (or replicate) samples. Comparing overall project precision and laboratory precision will help to identify sources of imprecision if a problem exists. In order to meet the Representativeness criteria, the field personnel will collect and designate the most representative samples of the current event.

Duplicate precision is evaluated by calculating a relative percent difference (RPD) using the following equation (the smaller the RPD, the greater the precision):

Equation 1:
$$RPD = \frac{X_2 - X_1}{\frac{(X_2 + X_1)}{2}} \times 100\%$$

Where: X_1 = Original sample concentration

X_2 = Duplicate sample concentration

Two samples collected from the same sample are considered subsample field duplicates. More than two samples collected from the same sample are called subsample field replicates. [Replicate precision is evaluated by calculating the relative standard deviation (RSD), also referred to as the coefficient of variation, of the samples using the following equation (the smaller the RSD, the greater the precision):

Equation 2:
$$RSD = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100\%$$

Where:

Equation 3:
$$SD = \text{standard deviation} = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}}$$

X_i = Each individual value used to calculate the mean

\bar{X} = Mean of n values

n = Total number of values

EPA's ProUCL software may be used to perform statistical calculations for precision (EPA, 2015).

2.2.2 Accuracy

Accuracy is the degree of agreement between an observed value (sample result) and an accepted reference value. Bias describes the systematic or persistent distortion associated with a measurement process. The terms accuracy and bias are used interchangeably in this document. The project team will determine and document the following:

- Quantitative measurement performance criteria for acceptable accuracy/bias for each matrix, analytical group, and concentration level.
- Analyte-specific measurement performance criteria, if applicable.
- QA/QC activities, or QC samples, that should be performed or analyzed to measure accuracy/bias for each matrix, analytical group, and concentration level.

Analyte accuracy can be evaluated using different types of QC samples. For example, a standard reference material or a laboratory control sample (LCS) that contains a known concentration of analyte(s) spiked into contaminant-free water or other blank matrix provides information about how accurately the laboratory (analysts, equipment, reagents, etc.) can analyze for a specific analyte(s) using a selected method. The cumulative laboratory and method accuracy/bias is calculated as a percentage using the following equation:

Equation 4:
$$\text{Accuracy} = \frac{\text{Measured Value}}{\text{True Value}} \times 100\%$$

Because environmental samples may contain interferences (i.e., other compounds that interfere with the analysis of a specific analyte), the accuracy for a specific analyte should be evaluated in relation to the sample matrix. This is done by analyzing matrix spike samples. A known concentration of the analyte is added to an aliquot of the sample. The difference between the concentration of the analyte in the unspiked

sample and the concentration of the analyte in the spiked sample should be equal to the concentration of the analyte that was spiked into the sample. Blanks (field, method, and calibration) are also indicators of accuracy. Blank contamination is not subtracted from the analytical results but are accounted for in the data validation process. Spike recoveries are calculated as a percentage using the following equation:

Equation 5:
$$\%Recovery = \frac{Spiked\ Sample\ Conc. - Unspiked\ Sample\ Conc.}{Spiked\ Conc. Added} \times 100\%$$

2.2.3 Sensitivity and Quantitation Limits

2.2.3.1 Sensitivity for Analytical Laboratory Data

For analytical laboratory data, sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. The quantitation limit (QL) or reporting limit (RL) is the minimum concentration of an analyte that can be routinely identified and quantified above the method detection limit (MDL) by a laboratory. Sensitivity can be measured by calculating the percent recovery of the analytes at the RL. The project team should document the project required RLs for each matrix, analytical group, concentration level, and analyte.

The following issues were considered in selecting the project specific RLs specified in Table 1-3:

- A laboratory MDL is a statistically derived detection limit that represents a 99 percent confidence level that the reported signal is different from a blank sample. The MDL is lower than the concentration at which the laboratory can quantitatively report. Laboratories determine their “best case” sensitivity for analytical methods by performing MDL studies.
- Frequently, QLs for specific samples are adjusted for dilutions, changes to sample volume/size and extract/digestate volumes, percentage of solids, and cleanup procedures. These QLs are referred to as sample quantitation limits (SQLs).

2.2.3.2 Sensitivity for Gamma Surveys

For gamma survey data, sensitivity is defined as the minimum detectible concentration of a radionuclide while scanning (scan MDC) as described in MARSSIM (EPA, 2000). For the DISA projects, the applicable gamma-emitting radionuclide is Ra-226 (in equilibrium with its short-lived decay products). DISA will use the scan MDC calculator developed by the Environmental Restoration Group, Inc. (ERG) at its website (ERG, 2025) to calculate the scan MDC. The scan MDC calculator is based on a paper by Alecksen and Whicker, 2016.

2.2.4 Representativeness

Representativeness is primarily a study design concern, though the quality of analytical data can affect the representativeness achieved by sampling designs as representativeness is important for data usability assessments. MARSSIM guidance (EPA, 2000) defines representativeness as follows:

“Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that should be evaluated to determine whether in situ and other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and contamination measured or studied.”

“Representativeness is primarily a planning concern. The solution to enhancing representativeness is in the design of the survey plan. Representativeness is determined by examining the survey plan. Analytical data quality affects representativeness since data of low quality may be rejected for use.”

2.2.5 Comparability

Comparability is the degree to which different methods or data agree or can be represented as similar. It describes the confidence that two data sets can contribute to a common analysis and interpolation. For example, comparability of analysis methods is required if existing data will be compared to historic data for the same parameter.. In addition, for DISA projects, the degree of quantitative agreement between predicted (gamma-based) Ra-226 concentrations in surface soil and observed (directly sampled) Ra-226 soil concentrations, at corresponding field locations will be considered a semi-quantitative measure of comparability.

2.2.6 Completeness

Completeness is a measure of the amount of valid data collected using a measurement system. It is expressed as a percentage of the number of measurements that are specified in the QAPP. The goal of this project is to achieve 90% completeness for the soils data. Completeness includes ‘J’ qualified data. Rejected ‘R’ qualified data are not considered to be complete.

2.3 TRAINING REQUIREMENTS

Personnel responsible for field activities shall have appropriate qualifications, education, training, experience, and a satisfactory knowledge of the requirements of the activities to be carried out. These requirements include, but are not limited to, health and safety training and program specific inspector training. Field groups shall have a documented system to ensure that up-to-date records of training are maintained for field personnel.

These records shall include external or internal courses attended and relevant training received, including on-the-job training. For credentialed employees, training records will be maintained to document personnel compliance with this QAPP. Records will be sufficiently detailed to document that personnel performing particular tasks have been properly trained and that their subsequent ability to perform these tasks has been formally evaluated.

All personnel will have the training required in DISA's license application, supporting documents, and SOP-14. All field personnel will be trained in this QAPP, the field sampling procedures, and the project-specific health and safety plan. Training will be documented on training forms that will be maintained in the project files.

2.4 DOCUMENTATION AND RECORDS

2.4.1 Document Control

Examples of controlled documents include approved project planning documents, standard operating procedures (SOPs), and guidance utilized for project implementation and reporting. Document control protocols for this project include the following:

- All controlled documents are reviewed and approved by the NRC or Agreement States for project use and official documentation of completed requirements.
- All controlled documents are current and accurate.
- Current versions of appropriate documents are available at all relevant locations.
- Periodically, documents are reviewed and, where necessary, revised to ensure continuing suitability and compliance with applicable requirements.
- Superseded documents are removed from use on the project but are archived and readily accessible.
- Where practicable, the revised or new text is identified in the document.
- Electronic files will be named as specified in Section 1.8.2.

2.4.2 Records Management

Records generated from field investigations and laboratory analysis results include the following:

- Logbook entries
- Chain of custody forms
- Electronic data files (i.e., gamma survey data, ICPMS analytical data files) in Excel compatible format
- Raw data packages for all methods submitted as pdfs
- Data validation reviews and qualified EDDs
- Photographs
- Maps

To manage all records, all personnel associated with this project will follow the following procedure:

- All record will be legible and will be stored in DISA's servers and file formats will be as follows: YYYY MM DD Site Name File Name.
- Observations, calculations, and measurement entries shall be clearly and permanently recorded at the time they are made.
- Technical records associated with field activities include the identity of personnel responsible for the sampling or inspection activities.
- Each page of project-related records is traceable back to the project, and all logbooks will contain page numbers or page numbers will be legibly written in the lower left or right corners.
- No pages will be torn out of project logbooks.
- All electronic records will be backed up in the cloud using DISA's SharePoint server.
- Records that have been recorded manually are recorded in permanent ink. When weather conditions interfere with use permanent ink, then entries can be made in non-smear pencil. The penciled entries shall be captured permanently by photocopying or photographing the penciled entries, or other acceptable manner.
- Error corrections will not obliterate entries in the original record. Corrections shall be made by marking through the error with a single line then initialing and dating the correction.

3. FIELD DATA COLLECTION

3.1 STUDY DESIGN AND METHOD REQUIREMENTS

The Site Characterization Procedure (SOP-21) contains details of regarding site characterization design and methods. A summary of this procedure is presented below. Field investigation elements, including survey, sampling, and monitoring designs, along with data collection methods, are summarized as follows:

1. Background Study
2. GPS-based Gamma Scans of Waste Piles/Areas
3. Gamma/Soil Correlation Plots
4. Borehole Depth Profile Study
5. Sampling HPSA® Fines Concentrates and Clean Coarse Material
6. Sampling Process Water

Field data will also be collected during HPSA treatment projects. Sample collection activities include the following:

1. GPS-based Gamma Scans of Waste Piles/Areas
2. Clean Coarse Material/Fines Concentrates Sampling
3. Radon Monitoring
4. Air Particulate Sampling
5. Process Water

A summary of the sampling program including types of samples, number of samples, analytical parameters, analytical methods, and QA samples is provided in Table 3-1.



Table 3-1: Sample Collection Summary

Matrix	Depth (cm)	Soil Analytical Methods				SPLP Method 1312	TCLP		Air ²		Water					Sample Handling		
		Ra-226 901.1 Mod	Natural U EPA 200.8	V EPA 200.8	Th-230 ACW01	Radionuclides (Refer to Water Methods)	RCRA Metals Method 6010C	Hg Method 7470A	Rn-222	Air Particulates – Same as Soil	Total RCRA Metals EPA 200.8 ¹	Total Hg EPA 245.1	Unat and V EPA 200.8	Ra-226 SM-7500 Ra-B	Th-230 ACW10	Container	Preserv.	Holding Time
Surface Soil	0-15, composites	X	X	X	X											500 g sample, ZipLock plastic bag	None	6 mos.
Subsurface Soil	15 – 61, Discrete	X	X	X	X											500 g sample, ZipLock plastic bag	None	6 mos.
Fines Concentrates	NA Grab from container	X	X	X	X											500 g sample, ZipLock plastic bag	None	6 mos.
Clean Coarse Material	NA, Grab as generated	X	X		X	X	X	X								500 g sample, ZipLock plastic bag	None	6 mos.
Process Water	NA										X	X	X	X	X	Glass container	Nitric Acid	6 mos.
Air Monitoring	NA								X	X						Track Etch Detector – Continuous Monitor. Air Particulates – Hi-Vol Sampler	None	6 mos.

3.2 SAMPLING METHOD REQUIREMENTS

3.2.1 General Requirements

Methods for collecting surface soil, subsurface soil, and water samples are provided in the SOP-21.

3.2.2 Field Documentation

Procedures in SOP-21:

- Field activities are thoroughly documented.
- Field documentation contains facts and objective observations.
- Documentation consists of individual photographs, video and other audiovisual materials collected during inspections and field activities.

3.3 SOIL SAMPLE HANDLING AND CUSTODY REQUIREMENTS

3.3.1 General Soil Sampling

Once samples are collected, they are to be placed in containers specified in Table 3-1. For soil samples, all samples will be placed in 1-gallon ZipLock plastic bags. Sample bags will be labeled with the following information:

- Sample ID number
- Sample location
- Date of sample collection

Bags may be labeled using a permanent marker directly on the bag. Information must be legible. Samples will be placed in coolers without any ice.

Prior to sealing coolers, samplers will complete a chain of custody form to include each sample in a cooler. Samples will be placed in a cooler and listed on the chain of custody (COC) form. The sampler will maintain possession of the samples until time of shipment. At the time of shipment, the sampler will sign the relinquished line and place the COC in a plastic ZipLock bag in the cooler. The cooler will be taped closed, and a custody seal will be placed on the cooler over the opening. The custody seal will be signed and dated by the sampler and shipped to the laboratory via courier. Overnight shipments are not required. Soil samples will be shipped as UN2910, Limited Quantity, Excepted Packages, as warranted.

3.3.2 Fines Concentrates/Clean Coarse Material Sampling

DISA will collect grab samples of materials as they are being generated using HPSA®. Many samples will be analyzed by portable X-ray fluorescence (XRF) equipment, larger equipment at the Mills, WY, facility laboratory (large XRF equipment and an ICP-OES). However, only samples analyzed by a commercial, accredited laboratory will be used

for final decision making. Collection frequencies for laboratory samples are discussed below.

3.3.3 Justification for Clean Coarse Sampling Frequency

DISA's choices when sampling the clean coarse material are: (1) collecting samples while the clean coarse material is being generated, or (2) sampling this material after treatment is completed prior to demobilization. Sampling the clean coarse material while the process is ongoing is preferable since DISA can get early indications of any treatment issues and make subsequent corrections. The assumption for the stated rate is that the clean coarse material will be relatively homogenous because of the mixing, crushing, grinding, slurring, and ablating that occurs during treatment.

To address the NRC staff's RAI, Disa attempted to utilize ProUCL to calculate a sample size that could be used per 40,000 tons and would satisfy the staff's concern of statistical validity. However, Disa does not have the data to estimate the standard deviation of the clean coarse material. Therefore, Disa proposes the following:

1. Laboratory testing, prior to mobilization, will include analysis of 5 samples of clean coarse material to estimate the standard deviation of a site.
2. This standard deviation will be used to calculate the sample size, in ProUCL, using the Estimating Mean function. This function is size/area independent, but Disa will assume it's for 40,000 tons.
3. As an example, assuming a 95% confidence interval, an allowable error margin of 10, and a standard deviation of 20 units, the sample size is 18 samples per 40,000 tons. This equals approximately 1 sample every 4 days of treatment with a 50 ton per hour unit.
4. The no. of samples/40,000 tons will be presented in the pre-mobilization notification along with the ProUCL output.
5. DISA commits to collecting a minimum of 5 samples of clean coarse material for sites that contain less than 40,000 tons of uranium mine waste.

3.3.4 Justification for Fines Concentrates Sampling Frequency

The sampling frequency for the fines concentrates is 1 sample per 10 to 20 tons, which is approximately 1 to 2 samples for roll-off container. Similar to the clean coarse material, the fines concentrates will be relatively homogenous. Therefore, the proposed sampling frequency will be sufficient to prepare shipping papers, prepare the demobilization notifications, quantify source material for the Additional Protocol requirements, and provide information regarding the HPSA® effectiveness.

3.4 WATER SAMPLING

3.4.1 General Water Sampling

Water sampling will be performed for the treated process water prior to discharge. Treated process water will be stored in polyethylene tanks of approximately 2,000 to 4,000 gallons in capacity. Water samples will be collected from the HPSA unit downstream of the treatment system. A valve will be installed between the treatment system outlet and the treated water storage tank.

Prior to collecting, label the sample bottles using permanent marker and a sample label. Include the following:

- Sample ID: SS-TW-MMDDYY
 - o Where: SS = Site Abbreviation, TW = Treated Water, MMDDYY = Date
- Date of sample
- Location of sample = sample port
- Sampler's initials
- Analytical parameters

Samples will be collected into sample jars that are provided by the laboratory and are pre-preserved. To collect the sample, open the valve and let water run into a bucket for approximately 5 seconds. Then SLOWLY fill the sample jar. DO NOT FILL THE JAR TO THE TOP (see figure below). Analytical parameters are found in Table 2-1 of the Quality Assurance Project Plan

Figure 3-1: Example Water Sample Container



Overfilling the sample jar will result in spilling the preservative which will likely be nitric acid.

3.4.2 Information Regarding Method SM 7500 Ra-B

Method SM 7500 Ra-B measures alpha-emitting radium isotopes by the rate of ingrowth and decay of their progeny in a barium sulfate precipitate. The method uses various chemicals include EDTA, which, because of its slight acidity, will keep other alpha-emitting isotopes in solution. The NRC staff has raised questions regarding the validity

of SM 7500 Ra-B, which is based on ASTM D-2460, because of potential interferences from radium-223 and radium-224. According to Pace Analytical, radium-223 does not occur to any significant extent in natural materials. Regarding radium-224, its half-life is approximately 3.4 days; therefore, if a sample is held long enough, radium-224 will decay out and radium-226 will grow in. Pace Analytical stated that it waits 14 days for radium-224 to decay, which is sufficient to complete the analysis for radium-226. Pace stated its confidence with method SM 7500 Ra-B and commits to using it for DISA's HPSA® treatment projects

3.5 ANALYTICAL METHOD REQUIREMENTS

Table 3-1 contains the analytical methods for each type of sample.

3.6 QUALITY CONTROL REQUIREMENTS

Quality control will be accomplished in the following manner:

- Duplicates – DISA will collect up to 1 duplicate every 20 samples. According to EPA's QA/QC guidance (EPA, 1990) a minimum of 8 duplicates must be collected for data validation statistics. Therefore, duplicate statistics will likely cover multiple sites.
- Matrix Spike Samples – One in 20 samples will include a matrix spike sample to be analyzed for the parameters in Table 3-1. According to EPA's QA/QC guidance (EPA, 1990) a minimum of 8 matrix spikes must be collected for data validation statistics. This program exceeds that minimum number. No matrix spikes will be performed for radionuclide analyses.
- Laboratory Samples – Pace Analytical will analyze method blanks (1 per 20 samples), calibration blanks (1/10 samples), Initial and Continuing Calibration Standards (1/20 samples), ICP interference check samples (beginning and end of runs or 1 per every 8 hours), laboratory control samples and serial dilution samples (1/20 samples), ICPMS Internal Standards (in every sample) will be analyzed to ensure the analytical equipment is functioning properly.

3.7 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

DISA maintains an SOP for instrument checks for gamma meters that will be used for this project. These are the only instruments for which instrument testing and checks are required.

3.8 INSTRUMENT CALIBRATION AND FREQUENCY

Field monitors to be used include gamma radiation detectors. Ludlum calibrates these meters annually. Daily checks are performed to ensure that the meters are working appropriately. DISA maintains a procedure for daily function checks.

3.9 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

Standard plastic bags used for soil samples are sufficient for soil samples as this project does not involve the analysis of organic compounds. Pace Analytical will supply sample bottles for process water samples. Otherwise, no special requirements are needed for approving the remaining field consumables.

3.10 DATA MANAGEMENT

Data generated for this project includes the following:

- analytical data
- gamma scans
- ecological survey
- cultural survey data
- exposure rate measurements
- dose calculations
- contamination survey results
- source material calculations
- material control and accounting

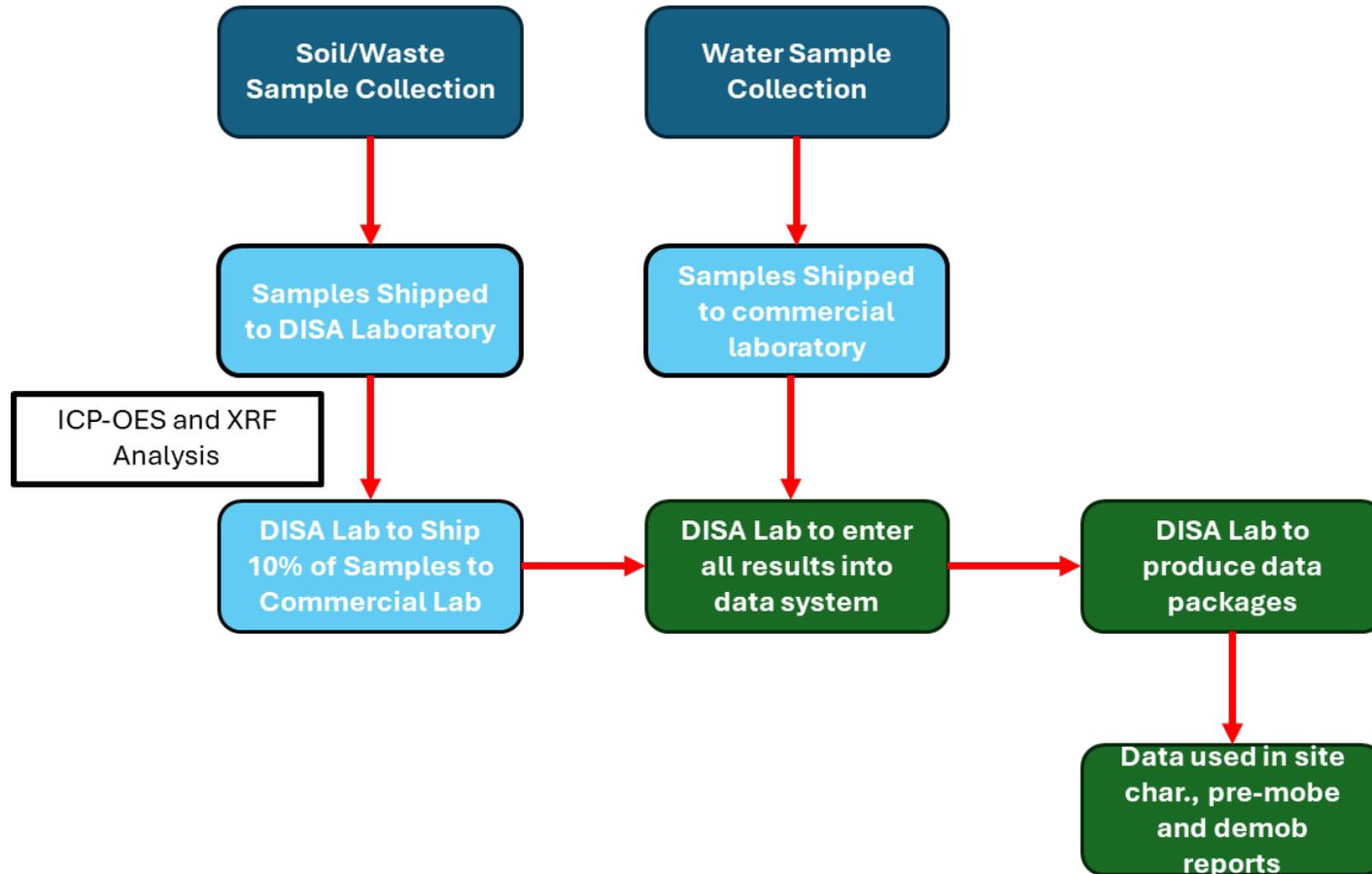
Regarding analytical data, all received data will undergo data validation before further processing and use. Validated data will be entered into spreadsheets or a laboratory information management system. The laboratory will report all numeric analytical results, both radiological and chemical results, even if the result is below the RL or negative values. Results of ND or non-detect will not be accepted by the technical team.

Ecological and cultural survey data will be stored on DISA's cloud servers in folders that are specific to each site. All other data will be stored in spreadsheet form or other type of system or relational database.

3.11 LABORATORY FLOW CHART

The following flow chart describes the path that DISA's samples will take to be analyzed by DISA's laboratory and the analytical laboratory.

Figure 3-1: Sample Collection and Analysis Flow Chart



4. **ASSESSMENTS AND RESPONSE ACTIONS**

4.1 **DATA VALIDATION AND USABILITY**

Data validation will occur pursuant to the procedures presented, herein. Final qualifiers used to qualify data will comply with current standard practices, as follows:

- J: The associated numerical value is an estimated quantity because specific quality control criteria were not met. The bias is indeterminant, such as precision outliers. The validation qualifier is distinct from the laboratory 'J' which denotes a value that is greater than the Method Detection Limit (MDL) and less than the reporting limit (RL)
- U: The associated value is considered to be non-detected at the MDL due to field or laboratory contamination or instrument background.
- R: The sample results are rejected (analyte may or may not be present) due to Quality Control outliers that were outside the acceptance or estimated range defined by the validation process. Any reported value is unusable. Resampling and/or reanalysis is necessary for verification;

The validation process will apply qualifiers that contain the 'J', 'U' and 'R' qualifiers also with specific codes for the outlier (e.g., MS = matrix spike, MB = method blank) and the value of the outlier.

4.2 **SAMPLE HOLDING TIMES**

Were any of the sample holding times exceeded?

- Sample Holding Times:
 - Metals - 6 months
 - Radionuclides – none
- ACTION: If yes, flag as estimated (J) those values above the Instrument Detection Limit (IDL). Values that are less than the IDL can be flagged as estimated (U) or rejected (R) based on the reviewers professional Judgement and the nature of the sample and analyte.

4.3 **BLANKS**

- Do the concentrations of all blanks fall below the IDL for all parameters?
 - ACTION: If no, flag as undetected (U) all reported positive data that have a concentration less than 5 times the blank value. For negative blanks, data are only qualified 'J' if the value is less than 2 x RL.
 - NOTE: In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank
-

having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value.

- Was one method and calibration blank analyzed for each 20 samples?
- ACTION: If no, flag as estimated (J) all data for which a method blank was not analyzed. If only one blank was analyzed for more than 20 samples, the first 20 samples analyzed do not have to be flagged as estimated (J).
- For the radiochemical analyses, a Normalized Absolute Difference (NAD) is also used. When the NAD is found to be greater than 1.96 but less than 2.58, data are qualified ‘U.’

4.4 ERROR DETERMINATION – PERCENT RECOVERY

- Matrix spike MS samples and MS duplicate analyses will be used for error determinations. This is not applicable to the radiochemistry analyses.
- Determination of Bias (% Recovery)
- Were at least eight spiked sample duplicates analyzed, for the overall project or specific event, or 1/20 samples whichever is most frequent.?
- ACTION: If not, flag as estimated (J) for all data for which spiked samples were not analyzed.
- Assess the reported percent recovery for each spiked sample and replicate (MS/MSD). Is the percent recovery within the applicable control limits (75% to 125%)?

Equation 6:
$$\%recovery = \frac{Spiked\ sample\ conc. - Sample\ conc.}{Spike\ conc\ added} \times 100$$

- ACTION: If recoveries are within applicable control limits, no bias is considered. If % Recovery is less than 75% or greater than 125%, the sample data should be flagged with a (J) estimate and a corresponding (-) or (+) sign to show direction of the bias. Only the parent sample is qualified.

4.5 ERROR DETERMINATION - DETERMINATION OF PRECISION

- Replicate Analysis
 - Was a minimum 1/20 replicate samples analyzed? If yes, determine coefficient of variation. If no, flag data with precision not determined (PND) for which replicate samples were not analyzed. The method and validation criteria are the relative percent difference. DISA’s validation criteria are \geq 35% RPD for the MS/MSDs in soils and up to 50% for co-located field duplicates. See the PARCC section.
- For radiochemistry, the Duplicate Error Ratio (DER) is often used rather than an RPD. The DER limit is 1.42
- Coefficient of Variation (Percent Relative Standard Deviation)

- The coefficient of variation (CV) is used in determining the precision or standard deviation. The CV expresses the standard deviation as a percentage of the mean (average) value of the replicate values. The CV is used to determine a false positive or false negative value for results that are respectively greater than or less than a decision level concentration.
- Determine the coefficient of variation using the following equation:

Equation 7:
$$CV = \frac{s \times 100}{X_{DL}}$$

Where:

X_{DL} = the decision level concentration

s = the sample standard deviation, given by Equation 8:

Equation 8:
$$s = \frac{(x_i - \bar{x})^2}{(n-1)^{1/2}}$$

- Apply the CV to the decision level to determine the false negative or false positive value as follows:

$$\text{False Positive Value} = \text{Decision level value} + (CV \times \text{Decision level value})$$

$$\text{False Negative Value} = \text{Decision level value} - (CV \times \text{Decision level value})$$

4.6 PERFORMANCE EVALUATION SAMPLES

- Were recovery limits within those set by the laboratory?
- ACTION: If outside the limits, review on a compound-by-compound basis. If 50% of the compounds are outside of confidence limits or were misidentified, all sample results should be rejected (R).

4.7 OVERALL ASSESSMENT OF DATA

It is appropriate for the data reviewer to use professional judgment and express concerns and comments on the validity of the overall data package for a case. This is particularly appropriate for cases in which there are several QC criteria out of specification. The additive nature of QC factors which are out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform the user about data quality and data limitations. This helps the user to avoid using data inappropriately, while not precluding consideration of the data. The data reviewer would be greatly assisted in this endeavor if the data quality objectives were provided.



4.8 RECONILIATION WITH USER REQUIREMENTS

Once the data have been validated, analytical results will be used for the estimation and assessment objectives of site characterization and HPSA treatment projects.

5. REFERENCES

1. Alecksen, T. and Whicker, R. 2016. Scan MDCs for GPS-Based Gamma Radiation Surveys. Operational Radiation Safety, Health Physics 111 (Supplement 2): S123-S132.
2. Johnson, J.A., H.R. Meyer, and M. Vidyasagar. 2006. Characterization of Surface Soils at a Former Uranium Mill. Operational Radiation Safety. Supplement to Health Physics, Vol. 90, February 2006
3. Lively, J. W. 2013. The Art & Power of Data Imaging. Proceedings of the ASME 2013 15th International Conference on Environmental Remediation and Radioactive Waste Management. September 8-12, 2013, Brussels, Belgium. ICEM2013-96256.
4. U.S. Environmental Protection Agency (USEPA). 1990. Quality Assurance/Quality Control Guidance for Removal Activities. OSWER Directive No. 9360.4-01.
5. U.S. Environmental Protection Agency (USEPA). 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1.
6. U.S. Environmental Protection Agency (USEPA). 2015. ProUCL Version 5.1.002, Technical Guide. October 2015.
7. U.S. Nuclear Regulatory Commission (NRC). 2003. Standard Review Plan for In-Situ Leach Uranium Extraction License Applications. NUREG-1569. Final Report. Office of Nuclear Material Safety and Safeguards. Washington, D.C. June 2003.
8. Whicker, R., M. Whicker, J. Johnson, and H. Meyer. 2006. Mobile Soils Lab: On-site Radiological Analysis Supporting Remedial Activities. Health Physics. Operational Radiation Safety. 91(2) Supplement 1:S24-S31, August 2006.
9. Whicker, R., P. Cartier, J. Cain, K. Milmine, and M. Griffin. 2008. Radiological Site Characterizations: Gamma Surveys, Gamma/Ra-226 Correlations and Related Spatial Analysis Techniques. Operational Radiation Safety, Health Physics, Vol. 95 (Supplement 5): S180-S189; November 2008.



Disa Technologies, Inc.
SOP-21 Rev. 0
Characterizing Uranium Mine Waste Sites
Standard Operating Procedure

Approvals

Chief Operating Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	

1. PURPOSE

This procedure is designed to provide the approved method to characterize uranium mine waste sites at Disa Technologies, Inc. The purpose of mine waste characterization is to determine the quantity of uranium resources that are available for HPSA treatment. Disa's basic methodology is to collect gamma readings that would then be associated with a relative radium-226 and uranium concentration.

2. DISCUSSION

Uranium mine waste site characterization is an essential task in to determine the amount of uranium in Disa's inventory and to render decisions on whether to proceed with treatment of specific waste sites by HPSA. This particular procedure is designed to collect data that can be used to develop statistical relationships between gamma counts and Ra-226 concentrations, and, in-turn, natural uranium concentrations. These relationships may be used in the future to expedite evaluations of waste sites.

Methods presented herein are designed to gather information to efficiently estimate the uranium resource of a waste pile by collecting many surface and subsurface gamma measurements while using the statistical relationships to estimate Ra-226 and natural uranium concentrations. Also, Disa will construct 3-dimensional models using surface and subsurface measurements and data designed to provide final estimates of the uranium resource at a uranium mine waste site.

3. PROCEDURE

3.1 EQUIPMENT

- Radiological survey detector –
 - Ludlum Model 19, Ludlum Model 43-5, Ludlum Model 44-9, Ludlum Model 44-10 detector, Ludlum Model 44-20 detector, or similar.
- Calibrated meter – Ludlum Model 12, Ludlum Model 2221, Ludlum Model 2241, or similar.
- Radiological check sources –
 - For typical function check of an alpha detector, use a thorium-230 (Th-230) source.
 - For typical beta detector function check, use a technetium-99 (Tc-99) or strontium/yttrium-90 (Sr/Y-90) source.

- For typical function check of a high-energy gamma detector, use a cesium-137 (Cs-137) source.
- For low-energy gamma detector, such as a FIDLER, use an americium-241 (Am-241) source.
- Check sources used are dependent upon the goal of the survey. While the sources listed above are for typical function checks, they are not definitive.
- Calibration jig – Used to ensure consistent detector position relative to check source (geometry).
- C-cable – Used to connect detector and meter.
- Forms – SOP-02A Single-Channel Function Check Log Form and SOP-02B Single-Channel QC Counts Form, as needed.

3.2 DOCUMENTATION

3.2.1 Function Check Log

A function check log form (Form SOP-02A) must be created and maintained for each individual detector. The detector should be function checked before each day of use. The function check log form must be retained. Make sure that function checks are performed pursuant to SOP-02.

3.2.2 Logbook

3.2.2.1 Tablet Substitution

Computer tablets may be used in lieu of bound logbooks. However, Disa employees must ensure that the tablet entries contain the same information that would be entered into a logbook. Tablet entries must be saved on the Disa SharePoint site and must be available to other Disa employees.

3.2.2.2 General Requirements

The following items are required for field notation:

- Field logbooks or tablet with note taking abilities
- Sharpies or other permanent waterproof markers (generally fine-tipped)

Field logbooks should be bound (sewn) with water-resistant and acid-proof covers, and each page should have preprinted lines, numbered pages, and a single column. They should be approximately 7.25 by 4.25 inches or in size. Loose-leaf sheets are not

acceptable for use as field notes. Note: Data collection logs and field forms used to record field measurements and data are acceptable as loose-leaf sheets maintained in a three-ring binder with numbered pages. All forms and logs are to be scanned and maintained in Disa's network. The Senior Geologist shall be responsible for maintaining all logbooks at a central location in a locked cabinet or room.

3.2.2.3 General Guidelines

A separate field logbook must be maintained for each project (mine waste site). The logbook should document activities at each site from characterization to final waste treatment. General guidelines are as follows:

- All logbooks must be bound and contain consecutively numbered pages.
- No pages can be removed from the logbook for any purpose.
- All information must be entered using permanent, waterproof ink. Do not use pens with "wet ink," because the ink may wash out if the paper gets wet. Pencils are not permissible for field notes because information can be erased. The entries should be written dark enough so that the logbook can be easily photocopied.
- Pages collected on tablets will need to be PDF'd at end of field day to maintain integrity.
- Be sure that all entries are legible. Use print rather than cursive and keep the logbook pages free of dirt and moisture to the extent possible.
- Do not enter information in the logbook that is not related to the project. The language used in the logbook should be factual and objective. Avoid speculation that could conflict with information presented in subsequent project deliverables and correspondence (see Section 1.0 above).
- Use military time.
- Begin a new page for each day's notes.
- Include the date at the top of each page.
- At the end of a day, draw a single diagonal line through any unused lines on the page, and sign at the bottom of the page.
- Write notes on every line of the logbook. Do not skip any pages or parts of pages unless a day's activity ends in the middle of a page.

- Cross out (with a single line) and initial any edits to the logbook entries. Edits should only be made if the initial entry is illegible or erroneous. Do not make corrections for grammar or style.
- Make sure to document site visitors, document daily safety meetings, and record overall site issues or occurrences.

3.2.2.4 Logbook Cover

Write the following information on the front cover of each logbook:

- Logbook document control number (assigned by issuer)
- “Book # of #” (if there is more than one logbook for the project)
- Name of the site and site location (city and state)
- Beginning and ending dates of activities entered into the logbook

3.2.2.5 Inside Cover or First Page

Spaces are usually provided on the inside front cover (or the opening page in some logbooks) for the company name, address, contact names, and telephone numbers. If preprinted spaces for this information are not provided in the logbook, write the information on the first available page. Information to be included on the inside front cover or first page includes:

- Field Manager name and phone number
- Disa Mills, WY address
- Corporate H&S Officer and phone number
- Emergency contact phone number (911, if applicable, or nearest hospital)

3.2.2.6 Entering Logbook Information

General Daily Entries:

- Arrival time and date onsite.
- Note weather conditions. Weather can affect gamma readings due to radon or attenuation due to moisture.
- Include the date at the top of each page.
- Document that a site safety meeting was held and include the basic contents of the meeting (this could occur on a separate log form).
- List the level of protection to be used for health and safety.
- Summarize the day’s planned activities (very brief).

Field Activity Entries:

- Document soil sample collection information: sample location, sample number, type of sample (background, grab, composite), depth of sample, material sampled, depth of the samples, time of sample collection, names of sampling team.
- Sample number will generally be the site name-location-depth, such as ParadoxD-7-0. Depths are all in inches and “0” inches means the sample was a surface sample.
- Summarize pertinent conversations with site visitors.
- Summarize any problems or deviations from the field sampling plan
- Indicate when utility clearances are completed, including which companies participated.
- Include names, addresses, and phone numbers of any pertinent site contacts, property owners, and any other relevant personnel.
- Document when lunch breaks or other work stoppages occur.
- Include approximate scale for all diagrams. If a scale is not available, write “not to scale” on the diagram. Indicate the north direction on all maps and cross-sections, and label features on each diagram.

Closing Daily Entries:

- Describe decontamination procedures (personnel and equipment).
- Describe handling and disposition of any investigation-derived wastes.
- Summarize which planned activities were completed and which ones were not.
- Note the times that personnel depart site for the day.

Photographic Log Entries:

- For digital photographs, indicate in the text that photographs were taken and the location where the photographs can be found (for example, in the project file).
- Photographer
- Date and time of photograph
- Sequential number of the photograph
- Direction of photograph
- Description of photograph

3.2.3 Chain of Custody Forms

Chain of Custody (COC) forms will accompany all samples whether or not the samples are being analyzed at Disa's Mills Laboratory or a commercial laboratory. All samples sent out for commercial analysis will be sent to Pace Analytical in Sheridan, Wyoming. Therefore, it is acceptable to use Pace's COC form for internal analysis and commercial analysis at Pace.

3.3 URANIUM MINE WASTE SITE CHARACTERIZATION

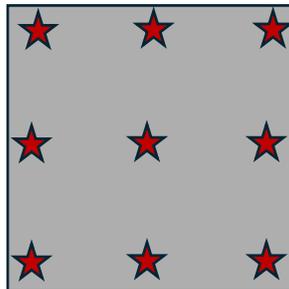
3.3.1 Background Study

Background studies will occur at each site or near a group of sites that are in close proximity (within eyesight). Background studies will be performed by picking a location outside the waste site that demonstrates the following criteria:

- Exhibits gamma counts below approximately 15,000 counts per minute (CPM).
- Located upwind of the waste site.
- Located upgradient of the waste site.

After a location has been selected, a 5-meter square plot will be staked at the site. A complete gamma scan will be performed over the entire 5-meter square plot. The 9 samples will be collected at the sample plot pursuant to Figure 1.

Figure 2: Background Sample Plot Sampling

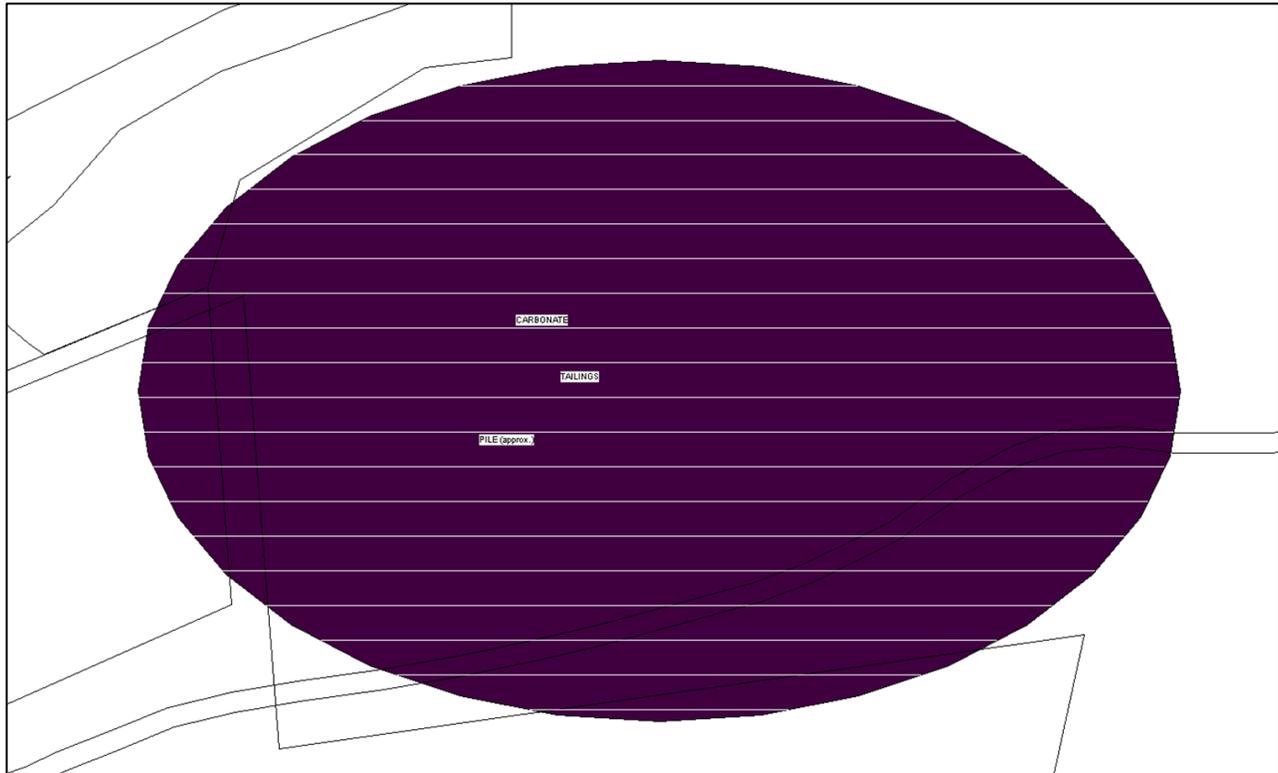


All the samples will be composited and one composite sample will be collected for analysis. Composite samples will be placed in new plastic zip-lock bags. Background samples will be analyzed for natural uranium, vanadium, and Ra-226. Samples will be collected using a stainless steel trowel and samples will be composited in a stainless steel bowl.

3.3.2 Gamma Scans

Disa will perform a walkover gamma scan using the RadScout GPS gamma scan system or similar. Figure 2 shows a sample walkover grid, at 10-m transect spacing. For larger sites, a 30-m transect spacing will be used.

Figure 2: Transects with 10-m Spacing (11-ac Site)



Walkover scans will be performed with the detector at 1 meter above the ground and location and gamma being logged simultaneously. Although Figure 1 shows gamma scans for only the sample area (mine waste site), scans will go beyond the boundaries of the mine waste area to allow for calculation of background radiation doses for the purposes of calculating the unrestricted release criterion pursuant to 10 CFR 20.1402.

3.3.3 Surface Waste Sampling

Surface waste sampling will be performed to associate gamma readings with radium-226 and uranium concentrations. Gamma scans will likely be more closely associated with radium-226, with a looser relationship between radium-226 and uranium. Soil sampling will be performed based on a design using Visual Sampling Plan. A number of

sampling schemes are available based on the purpose. Figures 3 and 4 show a few methodologies.

Figure 3: Sampling Plan for Estimating a Mean (11-ac Site)

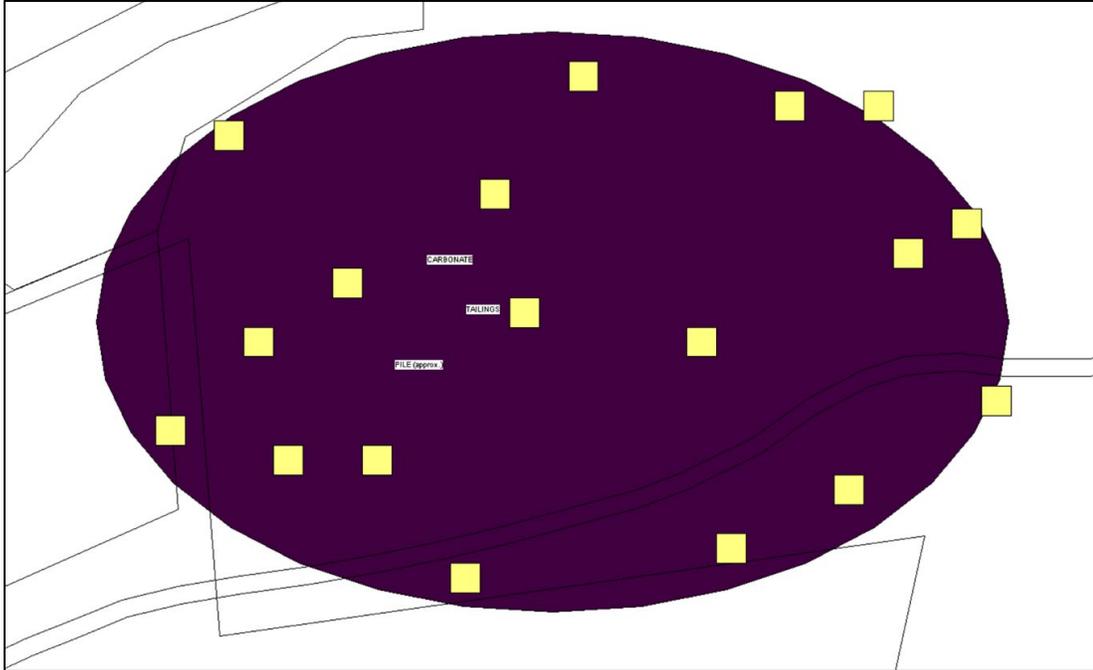
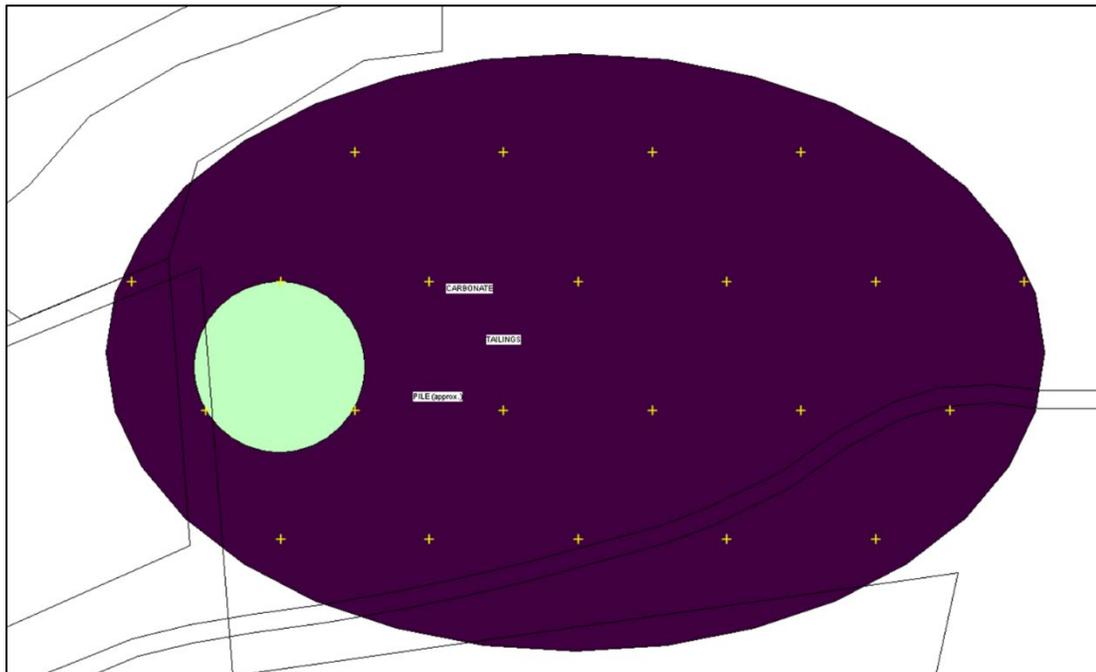


Figure 4: Estimating a Mean and Confidence Interval (11-ac Site)



The circle in Figure 4 is a sample of an unsampled area which is approximately 26,000 ft² (0.6 ac) in area. Note that a minimum of 20 surface samples will be collected.

Sample locations will be developed prior to mobilizing to a site; however, sample locations will be moved to locations that allow for a full range of concentrations (from lowest to highest) to be collected. Do not focus only on high concentrations because that is not the point of the soil sampling exercise. The purpose of this exercise is to develop a valid statistical relationship between gamma measurements and radionuclides to allow for estimates of the uranium resource.

To collect the samples, 2-m x 2-m sample plots will be developed, and composite samples will be collected to facilitate statistical comparisons between the gamma readings and waste sample concentrations. To collect the samples, a complete gamma scan will be performed over the entire sample plot, then 5 samples will be collected. One sample will be collected from each corner and one in the center. All the samples will be composited, and one composite sample will be collected for analysis. Background samples will be analyzed for natural uranium, vanadium, and Ra-226. One note to remember is that without a statistical comparison between actual analytical data and gamma measurements, we will primarily be relying on soil sampling data to estimate the resource.

All samples will be collected in stainless steel trowels and will be composited in a stainless steel bowl. The composite sample will be placed in new plastic zip-lock bags and transported to the Mills laboratory for analysis by ICP-OES for uranium. Radium-226 samples will be sent to a commercial laboratory for analysis along with 10% of all uranium and vanadium samples as a quality control check.

3.3.4 Drilling and Logging

Drilling and logging would only occur on larger sites where the surface resources indicate that HPSA treatment of mine waste would be economical. Drilling would be completed using rotary methods to drill a hole approximately 3 inches in diameter through the mine waste until native ground is encountered or a maximum of 50 feet. After drilling, Disa personnel would collect 30-second, gamma counts at 6-inch intervals until the entire borehole is logged. All drill cuttings will be placed into the borehole.

To characterize subsurface conditions, composite soil samples will be collected using direct-push or auger drilling methods. The following procedure will be used:

A borehole will be advanced to a target depth of 2.5 feet below ground surface (bgs). Drilling will begin at approximately 0.5 feet bgs (to avoid surface organics), and the auger will be allowed to rotate until soil cuttings are no longer surfacing from the borehole. This sample will represent a composite of the interval from 0.5 to 2.5 feet bgs.

All samples will be collected and handled using the same methods outlined in 3.3.3. Additional optional composite samples will be collected at 10-foot intervals, with each sample representing a 2.5-foot vertical segment. For example, a sample collected at 10 feet bgs would composite soil from 10 to 12.5 feet bgs. The auger will be allowed to rotate at each depth until sufficient cuttings from the targeted interval have surfaced. These samples will only be tested using XRF at the Mills Laboratory to ensure modeling accuracy.

Drilling locations will be developed using VSP. Locations will be calculated using the hotspot location method with the following hotspot dimensions:

- For sites ≤ 0.5 acre, assume an ellipse with an axial ratio of 0.8 and a long axis of 30 ft.
- For all other sites, assume an ellipse with an axial ratio of 0.8 and a long axis of 50 ft.

3.3.5 Data Analytics

Surface gamma measurements will be analyzed using geostatistics methods such as kriging to assess the spatial distribution of radionuclide concentrations. Borehole gamma measurements will also be analyzed by geostatistics methods and create cross-sections and 3D models of the mine waste.

Laboratory data will be used to create a relationship between gamma counts and radium-226 and uranium concentrations. Note that because uranium tends to be more soluble and mobile in the natural environment than radium-226, direct statistical relationships between these radionuclides may not be as strong as the relationship between radium-226 and gamma counts.

3.4 POST-TREATMENT PRODUCT SAMPLING

DISA will collect grab samples of materials as they are being generated using HPSA®. Many samples will be analyzed by portable X-ray fluorescence (XRF) equipment, larger equipment at the Mills, WY, facility laboratory (large XRF equipment and an ICP-OES). However, only samples analyzed by a commercial, accredited laboratory will be used

for final decision making. Collection frequencies for laboratory samples are discussed below.

3.4.1 Justification for Clean Coarse Sampling Frequency

DISA's choices when sampling the clean coarse material are: (1) collecting samples while the clean coarse material is being generated, or (2) sampling this material after treatment is completed prior to demobilization. Sampling the clean coarse material while the process is ongoing is preferable since DISA can get early indications of any treatment issues and make subsequent corrections. The assumption for the stated rate is that the clean coarse material will be relatively homogenous because of the mixing, crushing, grinding, slurring, and ablating that occurs during treatment.

To address the NRC staff's RAI, Disa attempted to utilize ProUCL to calculate a sample size that could be used per 40,000 tons and would satisfy the staff's concern of statistical validity. However, Disa does not have the data to estimate the standard deviation of the clean coarse material. Therefore, Disa proposes the following:

1. Laboratory testing, prior to mobilization, will include analysis of 5 samples of clean coarse material to estimate the standard deviation of a site.
2. This standard deviation will be used to calculate the sample size, in ProUCL, using the Estimating Mean function. This function is size/area independent, but Disa will assume it's for 40,000 tons.
3. As an example, assuming a 95% confidence interval, an allowable error margin of 10, and a standard deviation of 20 units, the sample size is 18 samples per 40,000 tons. This equals approximately 1 sample every 4 days of treatment with a 50 ton per hour unit.
4. The no. of samples/40,000 tons will be presented in the pre-mobilization notification along with the ProUCL output.
5. DISA commits to collecting a minimum of 5 samples of clean coarse material for sites that contain less than 40,000 tons of uranium mine waste.

3.4.2 Justification for Fines Concentrates Sampling Frequency

The sampling frequency for the fines concentrates is 1 sample per 10 to 20 tons, which is approximately 1 to 2 samples for roll-off container. Similar to the clean coarse material, the fines concentrates will be relatively homogenous. Therefore, the proposed sampling frequency will be sufficient to prepare shipping papers, prepare the

demobilization notifications, quantify source material for the Additional Protocol requirements, and provide information regarding the HPSA® effectiveness.

3.4.3 Sample Data Analysis

DISA will utilize the data from clean coarse material sampling and analysis to calculate the 95% upper confidence limit (UCL) for the data set. This UCL will be used to compare to the numeric criterion presented in Section 2.1. If dose modeling is required, then the UCL will be used to estimate the source term in dose models. Regarding water samples, analytical samples of post-treatment process water will be collected. Sample results will be compared the effluent limits in 10 CFR 20, Appendix B. These limits are presented above in Section 3.3.3.

3.5 WATER SAMPLING

Water sampling will be performed for the treated process water prior to discharge. Treated process water will be stored in polyethylene tanks of approximately 2,000 to 4,000 gallons in capacity. Water samples will be collected from the HPSA unit downstream of the treatment system. A valve will be installed between the treatment system outlet and the treated water storage tank.

Prior to collecting, label the sample bottles using permanent marker and a sample label. Include the following:

- Sample ID: SS-TW-MMDDYY
 - Where: SS = Site Abbreviation, TW = Treated Water, MMDDYY = Date
- Date of sample
- Location of sample = sample port
- Sampler's initials
- Analytical parameters

Samples will be collected into sample jars that are provided by the laboratory and are pre-preserved. To collect the sample, open the valve and let water run into a bucket for approximately 5 seconds. Then SLOWLY fill the sample jar. DO NOT FILL THE JAR TO THE TOP (see figure below). Analytical parameters are found in Table 2-1 of the Quality Assurance Project Plan



Overfilling the sample jar will result in spilling the preservative which will likely be nitric acid.

4. REPORTING

4.1 TECHNICAL REPORTS

All technical reports prepared for site characterization must follow a standardized structure and have consistent quality. The objective of the technical report is to provide a summary of scientific and technical information regarding the activities taking place leading up to and during the characterization of a site.

When preparing a technical report, it is essential to consider the intended audience, which may include regulators, stakeholders, and decision-makers who are not necessarily experts in mining or geology. While the report must maintain professional and technically accurate language, it should also be clearly written and accessible to readers without specialized backgrounds. The report must include high-quality maps, figures, tables, and cross-sections, each with appropriate legends, scale bars, and labeling to support visual understanding. All measurements should be reported in metric units unless otherwise specified by project requirements. Every report must include a title page, a dated signature page, a table of contents, a list of figures, and a list of tables. Authors must follow the report structure outlined in this SOP to ensure consistency, completeness, and compliance with regulatory and internal standards.

4.2 TECHNICAL REPORT STRUCTURE AND CONTENT

Each report must contain the following sections in the order listed.

4.2.1 Summary

Briefly summarize important information in the technical report. This should provide a clear and concise overview of the purpose, key findings, and conclusions. The summary will also highlight any critical resource estimates, site features, and exploration results

4.2.2 Introduction

The introduction will include –

- The author(s), their qualifications, and the scope of the report
- A description of the project's context and the intended use of the report
- Sources of information and data used for the report or its preparation, with citations if applicable

4.2.3 Reliance on Other Experts

This section will include any information or opinions provided by qualified third parties – such as legal, environmental, or technical experts – that were used to support the report's conclusions.

The author will –

- Document any reliance on legal, environmental, or other technical experts.
- Clearly specify which opinions or data were derived from external parties

4.2.4 Property Description and Location

The author will –

- Describe the area of the site, the location, legal descriptions and claim boundaries (with the identifying name or number)
- Include land ownership status, permits, surface rights, legal access, obligations to retain the property, and the expiration date of claims, licenses or other property tenure rights.
- Include the terms of any royalties, back-in rights, payments, or other agreements and encumbrances the site is subject to.
- Include all environmental liabilities the site is subject to.

- Include all permits that need to be acquired to conduct the work onsite, and if those permits have been obtained.
- Include any other significant factors and risks that would affect access, title, or the ability to perform the work

4.2.5 General Site Information

This section will address accessibility, climate, local resources, infrastructure, and physiography by describing -

- The topography, elevation, and vegetation
- The means of access to the property
- The proximity of the site to the nearest town and navigable water source
- The climate and length of operation

4.2.6 General Geologic Information

This will address the geology of the site and surrounding area by describing –

- The regional and local geology, lithologic units, and structural features.
 - Include known mineral occurrences, historical production, and geophysical data.
- Deposit types being investigated are waste rock piles

4.2.7 Exploration

Brief descriptions of the nature and extent of all relevant exploration activities excluding drilling, conducted by the issuer, including –

- Descriptions of procedures and parameters relating to site surveys and investigations
- Descriptions of the sampling methods, quality, what the samples represent, and any factors that could result in sample biases.
- Relevant information of location, number, type, nature, and spacing/density of samples collected, and the total area covered
- Significant results and interpretations of data collected

4.2.8 Drilling and Sample Analysis

This section will include –

- Summary of drilling programs, hole locations, total depths and sample depths

- A description of sampling intervals, sampling procedures, equipment used, handling procedures, and any deviations from standard methods.

4.2.9 Data Verification

This section will describe the steps taken to verify the data collected by including –

- Procedures used to verify the accuracy and validity of collected data
- Checks on sampling, lab data, field duplicates, and database integrity
- Any limitations or failures to conduct such verification, and the reasons for those limitations or failures.
- The qualified person's opinion on the adequacy of the data for the purposes used in the technical report

4.2.10 Mineral Resource Estimates

This section will describe the resource estimates by –

- Clearly explaining the assumptions, parameters, and methods used to estimate mineral resources so a non-expert can understand the process
- If reporting mineral grades include
 - The individual grades
 - Prices, recovery rates, and conversion factors used
- Discussing any known factors (e.g., environmental, legal, permitting, socio-economic) that could significantly impact the resource estimate.
- Rounding quantity and grade values to reflect that they are estimates.
- If multiple cut-off grades are used, clearly identify the base case and ensure all scenarios show potential for economic extraction.

4.2.11 Other Relevant Data and Information

Include any additional information or explanation necessary to make the technical report understandable and not misleading. This can include –

- Environmental background data, geotechnical analysis, metallurgical testing, etc.
- Highlight any factors that may influence resource development.

4.2.12 Interpretations and Conclusions

Summarize the relevant results and interpretations of the information and analysis being reported on.

- Provide a professional, defensible interpretation of significant data
- Summarize key conclusions, uncertainties, and recommendations

4.2.13 References

Include a detailed list of all references cited in the technical report.

- This includes all documents, reports, maps, and datasets referenced.
- Use a consistent citation format.

5. CHARACTERIZATION AND ANALYTICAL DATA MANAGEMENT GUIDELINES

5.1 GIS AND SURFER PROJECTS

GIS and Surfer Projects, Downloads pertaining to those projects, and raw RadScout Data will be in respective folders located in

- DISA Uranium – Documents > 9.0 Operations > 9.8 ArcGIS and Surfer Projects

5.2 GPS-GAMMA DATA (RADSCOUT)

RadScout Tracking and Calibration Sheets will be in

- DISA Uranium – Documents > 9.0 Operations > 9.7 RadScout Tracking and Calibration Sheets

5.3 FINAL TALBES AND FIGURES

Final Tables and Figures, .csv, .shp, COCs, Original Lab Reports, Field Notes, Characterization Reports, Site Photos, will be in

- DISA Uranium – Documents > 10.0 Site Folders > State of Site > County of Site > Individual Site Folder > Folder Matching format of what is being saved
- Sites in Navajo Nation will have their own separate folder

6. REFERENCES

1. Quality Assurance Project Plan



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Disa Technologies, Inc.

SOP-22, REV. 0

3D Volume Estimating

Approvals

Chief Operating Officer

Date

Radiation Safety Officer

Date

REVISION LOG		
Revision Number	Description of Changes	Pages Affected
0	Initial Release	

1. PURPOSE

This procedure is designed to provide the approved method to obtain estimates of volumes and mass using GIS software and 3D modeling software. This data is essential to the Uranium Recycling Business as the estimates generated by this procedure are reviewed by external parties including regulatory agencies.

2. DISCUSSION

Uranium mine waste site characterization is an essential task in to determine the amount of uranium in Disa's inventory and to render decisions on whether to proceed with treatment of specific waste sites by HPSA. This particular procedure is used to determine which sites will be characterized by the DISA Geology Team. This procedure will also be used to ultimately calculate estimates of uranium and vanadium content in a waste area.

3. PROCEDURE

3.1 EQUIPMENT

- Computer capable of handling large GIS and modeling files – laptop or desktop
- ArcGIS or similar GIS software
- Surfer or similar 3D modeling software

3.2 INITIAL SITE IDENTIFICATION

3.2.1 Specific Sites

DISA Geology Team will identify sites to investigate using Google Earth or other GIS software. Once identified, the site will be entered into the Monday.com database (see Section 3.5). After entering the site into Monday.com, a 3D model of the site will be generated according to Sections 3.3 and 3.4 below. The basic procedure for identifying sites is as follows:

1. Two basic directions for site identification:
 - a. Sites on Private Surface
 - i. Private Surface, Private Minerals, same owner – simplest
 - ii. Private Surface, Private Minerals, separate owners, 1 each –
 - iii. Private Surface, Private Minerals, separate owners, multiple owners
 - iv. Private Surface, Public Minerals, separate owners, multiple owners
 - v. More permutations but the above covers most situations
 - b. Sites of Public Land
 - i. Public Surface, Public Minerals, same owner – simplest
 - ii. Public Surface, Public Minerals, different owners
 - iii. Public Surface, Private Minerals, separate owners
 - iv. Public Surface, Private Minerals, separate owners, multiple owners

- v. More permutations but the above covers most situations
2. For site characterization, we should not intentionally avoid any of the above scenarios.
 3. How to identify sites
 - a. Data used for site ID:
 - i. Google Earth overlay data for mine
 - ii. EPA has GIS location data
 - iii. Western Mining History
 - iv. National Uranium Resource Estimate (NURE) data – Airborne Gamma Scans
 - v. The Diggings
 - vi. EPA Location Database
 - vii. Surface/Mineral Ownership
 - b. Criteria for Ranking Sites
 - i. Volume of waste (cy); Area if waste is buried (ac)
 - ii. Existing site activity
 - iii. Existing claims/leases
 - iv. Surface/Mineral ownership complexity
 - v. Accessibility

3.3 ARCGIS – 3D MAP FRAME

1. Upload rasters of DEM for area
 - a. Merge multiple files if needed using ‘Merge Rasters’ in Raster Functions
 - b. Change symbology to shaded relief to get better view of pile.
2. Convert point cloud LAZ file to LAS if needed.
3. Upload LAS file – file name will be ‘SiteNameFullArea’
 - a. Merge multiple files if needed using ‘Create LAS Dataset’
 - b. Unselect layer
4. Create a polygon around the pile with ‘Create Feature Class’ tool
 - a. Pile needs Z coordinates
 - b. To create polygon Edit > create feature
5. Create a polygon around the surrounding area with ‘Create Feature Class’ tool
 - a. Surrounding Area needs Z coordinates
 - b. To create polygon Edit > create feature
6. Save pending edits and open attribute table for pile polygon.
 - a. Add field – acres, Alias - acres, Data Type – double
 - i. Save changes to fields
 - b. Calculate geometry for acres field
 - i. Property – Area

- ii. Area Unit – US Survey Acres
 - iii. Coordinate system – same as FullArea.lasd
7. Use Pairwise Erase function
 - a. Input – Area, Erase – Pile S
8. Create Group in 3D Layers with Site Name
 - a. Create 2 Group Layers in ‘Site Name’ layer named Polygons and LAS
 - b. Place polygon and LAS layers in respective group to stay organized
9. Use Extract LAS function for Nat Terrain around pile and pile itself
 - a. Input – Original LAS file (FullArea.lasd)
 - b. Output LAS Dataset
 - i. Same file as downloads
 - ii. Name – SiteNameNatTerrain.lasd for Natural Terrain and SiteNamePile.lasd for pile
 - c. Processing extent (Extent of a Layer)
 - i. For Nat Terrain use Pairwise layer
 - ii. For Pile use Pile layer
 - d. Extraction boundary is the same as the processing extent
10. Use LAS Dataset to Raster
 - a. Input LAS Dataset – LAS for Nat Terrain or Pile
 - b. Output Raster – add ‘_pile’ or ‘_NatTerrain’ to end of generated name
 - c. Value Field - Elevation
 - d. Interpolation Type – Binning
 - e. Cell Assignment – Average
 - f. Void Fill Method – Simple
 - g. Output Data Type – Floating Point
 - h. Sampling Type – Cell Size
 - i. Sampling Value – 1
 - j. Z Factor – 1
11. Repeat step 10 for other LAS Dataset
12. Use Raster to Point
 - a. Input Raster – Raster for Pile or Nat Terrain
 - b. Field – auto populated
 - c. Output Point Features - add “_pile or _NatTerrain” to end of generated name
13. Create Group in 2D Layers named ‘SiteName’
14. Open Attribute Table for both point features
15. Add Fields to Point Features Attribute Tables
 - a. Add Fields for X and Y coordinates
 - i. Field Name X or Y, Alias X or Y, change “grid_code” to Z
 - ii. Data Type - Double
 - iii. Save changes to fields
16. Use Calculate Geometry Attributes to find X and Y coordinates
 - a. Input Features – Point Layer for Pile and Nat Terrain

- b. X is X-coords, Y is Y coords
 - c. Coordinate system is same as original LAS layer
17. Export Point layers as Tables into Surfer Folders
- a. File should be a .csv file
18. Export Pile polygon as Feature
19. File should be a .shp file

3.4 SURFER

1. Using Grid Data in Home Ribbon
 - a. Gridding Method – Kriging
 - b. Data Type – XYZ
 - c. Dataset 1 – Browse and find csv file for Nat Terrain
 - i. X is X
 - ii. Y is Y
 - iii. Z is Z or “grid_code”
 - d. Hit Finish
2. Repeat step 1 for the Pile csv file
3. Drag Pile.grd above NatTerrain.grd in the Contents frame
4. Change Pile.grd to a 3D surface
 - a. Right click > convert layer to > 3D surface
 - b. Change upper material color to “Terrain”
5. Change NatTerrain.grd to a 3D surface
 - a. Repeat step 4a do not change color
6. In Grids Tab select ‘Volume’ in the calculate section
 - a. Upper Surface – Pile.grd
 - b. Lower Surface – Select Grid File > NatTerrain.grd
 - c. Options stay the same
 - d. Polygon boundary – browse to find pile.shp file
 - e. Select OK
7. Scroll down in created window and use positive volume [Cut]
 - a. Convert Volume from cubic meters to cubic yards (*1.308)

3.5 MONDAY.COM

Monday.com serves as the primary database and repository our site identification and resource estimating work. The procedure for entering new sites is as follows:

3.5.1 Sites with Unknown Resource

If a mine waste pile is observed in Google Earth but the resource is not known, add the site to the Monday.com database. Once 3D modeling work is completed, and an assessment is made that this is high confidence AUM, under the “Implied Resource Eligible” column, toggle to “yes” (refer to the document: [2025_06 Implied Resource Definition](#) for full criteria). In this manner the database will not artificially inflate the resource. . The site identification team will deliver the high priority sites for completion



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of 3D modeling to the characterization team at the commencement of each working week.



JHA STEP/TASK, HAZARD, AND CONTROLS		
Step/Task	Hazard	Control