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 are 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 thing 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

4.1 Radiation Protection Program (RPP)

4.2 SOP-05 Radiological Access and Posting

4.3 SOP-06 Contamination Surveys and Decontamination

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 sourced 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 cm^2)
  - $C_{background}$ = 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 ± 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

ATTACHMENTS

Single-Channel Function Check Log

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

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

Comments:
Scaler Count Time:
Distance To Source:

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

NOTE: For use as needed. Acceptable upper/lower net counts, detector total effiiciecy, 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	Threshhold	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:** _____

Form SOP-02B

Disa Technologies, Inc.

SOP-03 Rev. 0

Operational Checkout of Dual-Channel Alpha/Beta 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 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 sourced 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:

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

Where:

- MDA = minimum detectable activity with 95% confidence (dpm/100 cm^2)
- $C_{background}$ = 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 ± 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

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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		
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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)

Disa, Inc.

SOP-05 Rev. 0

Radiological Area Access and Posting

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 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 of 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 RADIOACTIVTY 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

Form SOP-05-A Controlled Area Access Log Form

Site _____

Name	Date	Time In	Time Out	Respirator (Y or N)	Work Area

Reviewed By: _____ Date_____

Ver. 0, Created 5/19/2021

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 packages[1], 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 cm² [4]	Background
	Equipment Release	5,000 dpm/100 cm² [2] 15,000 dpm/100 cm² [3] 1,000 dpm/100 cm² [4]	200 dpm/100 cm², 25 µR/hr
	UN2910 Excepted Packages	24 dpm/cm² [5] 240 dpm/cm² [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

$$C = \frac{R_S - R_B}{\varepsilon_t\left(\frac{A}{100}\right)}$$

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 µR/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 µR/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.

<u>General Considerations for Equipment Release Surveys:</u>

- 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.

<u>Total (Fixed + Removable) Surface Contamination Survey:</u>

- 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 cm^2) 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 cm^2) 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 cm^2 (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 cm^2.
- 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 cm^2) using Equation 3-1.
- Record the result in the column labeled Removable Alpha Activity on Form SOP-06A *Equipment Release Survey Form*.

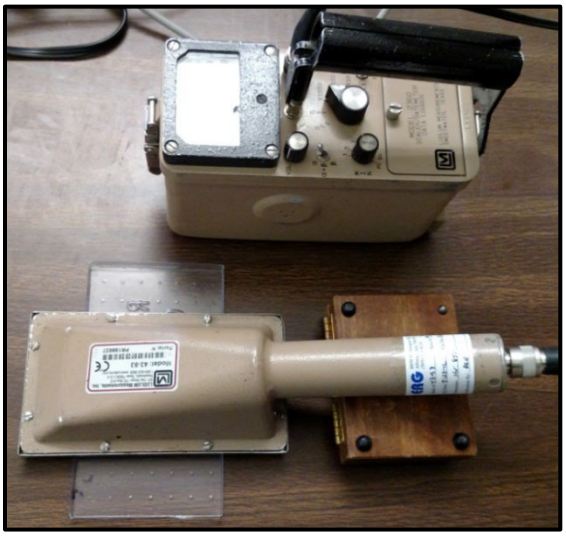


Figure 3-1: Example fixed-geometry measurement jig using a Ludlum 43-93 survey probe to count swipe samples, determine instrument efficiency, and to perform daily QC function checks.

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 cm^2.
- 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. DECONTAMINTION

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 (œ)	NA		NA		NA		(µR/hr)	NA	NA
Model 2929 Swipe Counter (a/)	32								

Contamination Limits: (dpm/100cm²) *		Removable a: **1,000 (200)** dpm/100 cm^2			Removable : **1,000 (200)** dpm/100 cm^2			Total a: **5,000** dpm/100 cm^2			Total : **5,000** dpm/100 cm^2			Net œ: **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**

DISA

Form SOP-06B **Personnel Exit Survey Form**

Date _____ Restricted Area Location _____

Instrument Serial Numbers: Detector_____ Meter_____

Maximum background alpha surface activity prior to first daily entry into Restricted Area _____cpm [1]

ACTION LEVEL = max background_____ (cpm) × 1.5 = _____cpm [2]

(*NOTE*: if background is ≤2 cpm, a value of 4 cpm should be used as the release limit)

Initialing this Exit Survey Form indicates that you have performed and passed the Personnel Exit Survey.

Name (please print)	Company	Survey Result below Action Level (Yes or no)	Initials

[1] The RST will determine the maximum background alpha count rate on his/her clothing/skin first thing in the morning each day, prior to entry of any personnel into the Exclusion Zone.

[2] To account for temporal variability in background levels of short-lived radon progeny on clothing/skin, the daily background alpha activity value is multiplied by a factor of 1.5 to determine the daily personal exit survey limit.

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 E-09 µCi/ml for beta and/or gamma emitter(s) or 2 E-11 µCi/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 CO_2, 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)

Disa Technologies, Inc.

SOP-08, Rev. 0

Air Sampling

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

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.

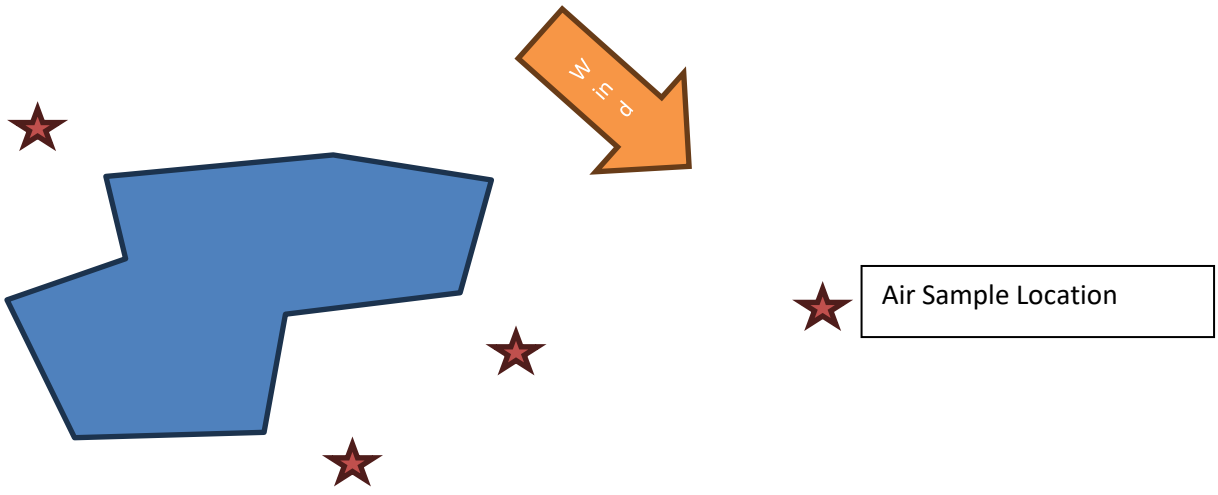
- *Breathing Zone Air Sampler* – This type of air sampler is often called by other names, such as "BZ" (short for breathing zone), "personal air sampler", or "lapel air sampler". A breathing zone air sampler typically has a flow rate of 0 to 5 liters per minute (LPM) but may range higher.

- 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 may be established 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.

3.3 General Area Air Sampling – General area air samples are taken to determine airborne concentrations where workers may be present. 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.

- At the completion of the sample collection 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).*
- Analyze the air sample in accordance with appropriate site or project counting procedures.

3.4 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 may be collected using a low-vol or high-vol air sampler, or a BZ or lapel air sampler provided they are representative of the breathing zone and sufficient air volume collection is feasible. Breathing zone air samples are taken 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.

- Analyze the air sample in accordance with appropriate site or project counting procedures.

3.5 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”

Disa Technologies, Inc.

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

Page ____ of _____

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX ☐ MALE ☐ FEMALE	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER(S)	9A. ☐ RECORD ☐ ESTIMATE	9B. ☐ ROUTINE ☐ PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN ☐Bq or ☐μCi (Check one)

DOSES IN ☐ Sv or ☐ Rem (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)

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.

2. Enter the code for the type of identification used as shown below:

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.

4. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

5. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY. – MM/DD/YY.

6. Enter the name of the licensee or registrant.

7. Enter the Department license or registration number or numbers.

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.

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

FOR ITEMS 10D-18 INDICATE IF THE UNITS ARE SI OR SPECIAL. (SEE RH 4.40.3)

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.

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.

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."

10D. Enter the intake of each radionuclide in Bq or μCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

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.

19. Signature of the person designated to represent the licensee or registrant.

20. Enter the date this form was prepared.

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.

Disa Technologies, Inc.

SOP-09 Rev. 0

External Dosimetry

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 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 that 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 and 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

PART 4

Radiation Management Program
Colorado Department of Public Health and Environment

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

Page ____ of _____

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX ☐ MALE ☐ FEMALE	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER(S)	9A. ☐ RECORD ☐ ESTIMATE	9B. ☐ ROUTINE ☐ PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN ☐Bq or ☐µCi (Check one)

DOSES IN ☐ Sv or ☐ Rem (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)

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.

2. Enter the code for the type of identification used as shown below:

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.

4. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

5. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY. – MM/DD/YY.

6. Enter the name of the licensee or registrant.

7. Enter the Department license or registration number or numbers.

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.

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

FOR ITEMS 10D-18 INDICATE IF THE UNITS ARE SI OR SPECIAL. (SEE RH 4.40.3)

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.

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.

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."

10D. Enter the intake of each radionuclide in Bq or μCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

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.

19. Signature of the person designated to represent the licensee or registrant.

20. Enter the date this form was prepared.

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.

Disa Technologies, Inc.

SOP-10 Rev. 0

Shipping UN2910 Radioactive Material

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 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 A^2 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 µR/hr.

  NOTE: Alternatively, if 500 µR/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

ATTACHMENTS

UN2910 Label

Disa Technologies, Inc.

SOP-11 Rev. 0

Transport of Uranium Source Material as LSA-1

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 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 (% U_3O_8)) 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 (µR/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 (µrem/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 µR/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 µR/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 µR/hr. Confirm on Form SOP-11A that no readings exceed 10,000 µR/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 µR/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 compete 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 µR/hr. Confirm on Form SOP-11A that no readings exceed 2,000 µR/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

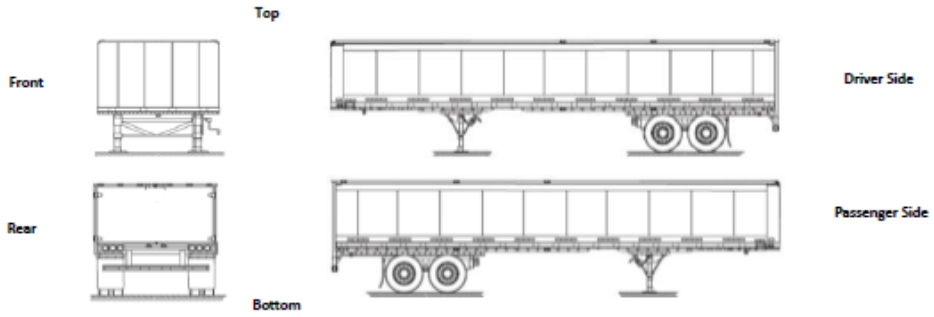
Facility: _____ Transport Vehicle ID: _____ Date/Time: _____

Shipping Container Contents Description: _____ 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)	*Cs-137 Button Source*	*n/a*	alpha:		beta:	
Background (counts):						
MDA (dpm/100-cm²): (4)		*n/a*				

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



Comments:

Technician Signature/Date:

Reviewer Signature/Date:

Notes:

(1) Radiological check sources used:

(2) If instrument function check is within acceptable range then total efficiency number used is based on intial instrument QC counts. The instrument total efficiency is calculated per NUREG 1575; Total Efficiency = 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/n:)		2π dpm
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)

Page _____ of _____

SOP-3A - LSA-I Shipment Survey Form

Facility: _____ Transport Vehicle ID: _____ Date/Time: _____

Shipping Container Contents Description: _____ U3O8 Grade: _____%

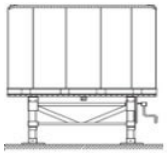
Has a complete and correct Shipping Manifest been provided?		**Yes or No**	
Is the tarp cover assembly and tailgate fully closed and secured?		**Yes or No**	
Is there loose or leaking material observed on vehicle?		**Yes or No**	
Is the vehicle properly marked and placarded?		**Yes or No**	
Maximum exposure 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**	

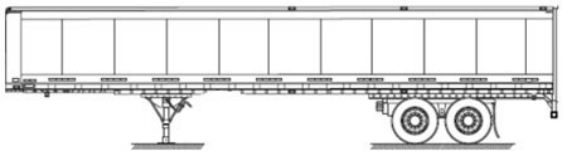
Instrument Make/Model:						
Instrument Serial No.:						
Calibration Due Date:						
Total Efficiency (cpm/dpm): (2)	*Cs-137 Button Source*	*n/a*	*alpha:*		*beta:*	
Background (counts):						
MDA (dpm/100-cm²): (4)		*n/a*				

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

Top

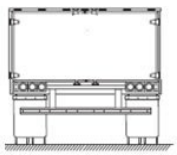
Front

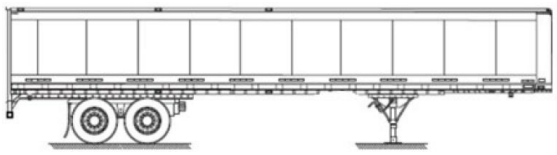




Driver Side

Rear





Passenger Side

Bottom

Comments:

Technician Signature/Date:

Reviewer Signature/Date:

Notes:

(1) Radiological check sources used:

(2) If instrument function check is within acceptable range then total efficiency number used is based on intial 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
Removable **SOURCE** Count Time:		minute(s)
Removable **BKG** Count Time:		minute(s)
Removable **SAMPLE** Count Time:		minute(s)

(3) Smear removal efficiency of 0.10 used in removable activity calculation.

(4) Calculations rely on user set count times:

Disa Technologies, Inc.

SOP-12 Rev. 0

Contamination Surveys, Removable Swipe, and Air Filter Analysis

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 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*.

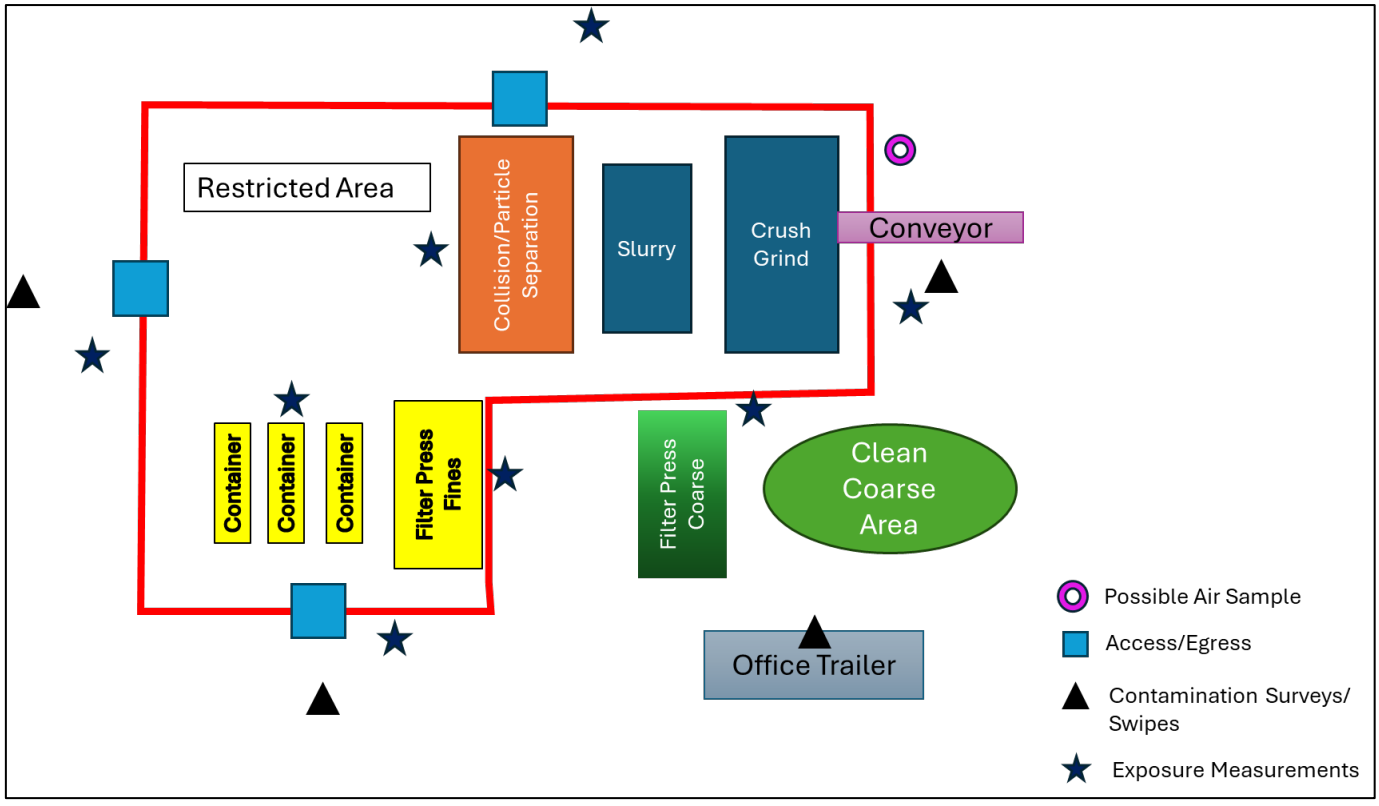
3.3 Exposure and Contamination Survey Procedure

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 cm^2. 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 (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/100cm²) *		Removable α: 1,000 (200) dpm/100 cm^2			Removable β: 1,000 (200) dpm/100 cm^2			Total α: 5,000 dpm/100 cm^2			Total β: 5,000 dpm/100 cm^2			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	

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:** _____

Form SOP-12B

Disa Technologies, Inc.

SOP-13 Rev. 0

Radioactive Materials and Waste Storage

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 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

Disa Technologies, Inc.

SOP-14 Rev. 0

Radiation Safety Training

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 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 knowns 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

Disa, Inc.

SOP-15, Rev. 0

Radioactive Material Receipt

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 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-cm^2 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 expressed as dpm/100 cm^2. NOTE: Use a swipe efficiency of 10-percent in removable activity calculation. If the removable contamination exceeds 240 dpm/cm^2 beta/gamma and low-toxicity alpha emitters or 24 dpm/cm^2 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 show 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.