Reviewed By: JWC 3/29/2013; MDG 4/17/2013; CTK 6/12/2013; MDG 7/11/2013; JWC 7/11/2013	***Final Approval*:** CHARLES KELSEY Digitally signed by CHARLES KELSEY DN: cn=CHARLES KELSEY, o=LOST CREEK ISR, ou=UR-ENERGYUSA, email=charles.kelsey@ur-energyusa.com, c=US Date: 2013.07.17 13:47:27 -06'00'

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for screening and decontamination of potentially contaminated or contaminated materials for unrestricted use at the Lost Creek ISR (LC-ISR) Project site. Screening and decontamination is necessary to prevent the spread of radioactive contamination. Contamination shall be controlled from spreading to different areas of the facility, as well as, preventing contaminated items from leaving restricted areas of the facility. The unrestricted use of materials includes using or transporting potentially contaminated materials from a restricted or contaminated area in or into an unrestricted area. This SOP is based on the recommendations in NRC Regulatory Guide (RG) 8.30 Section 2.7 which also references NRC's *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material.*

2.0 RESPONSIBILITIES

The EHS Department is responsible for:

- Providing training and education relevant to screening and decontamination;
- Ensuring that screening and decontamination methods are effective;
- Ensuring proper instruments and cleaning materials are available;
- Maintaining and auditing records of screening.

The Radiation Safety Officer (RSO) or Health Physics Technician (HPT) is responsible for:

- Performing screening of materials prior to release into an unrestricted area;
- Ensuring instruments are calibrated and functioning within established parameters;
- Determining if removable contamination surveys are necessary;
- Determining if decontamination is necessary;
- Declaring objects acceptable for unrestricted use.

LC-ISR employees (radiation workers) are responsible for:

- Understanding responsibilities and receiving appropriate training according to their assigned duties;
- Receiving training in general understanding of screening and what to do with contaminated materials.

3.0 PREREQUISITES AND TRAINING

Requirements of the screening process include the use of appropriate instruments. Specifications for what instruments to use include:

- Are based on detection capability for each radionuclide/mixture
- Can measure the radionuclides at or below action levels.
- Calibrated NIST
- Operated and maintained by qualified personnel

Instruments that may be used for screening may include (alternate instruments of comparable capability are acceptable):

- Alpha/Beta detector (e.g. probe Ludlum Model 43-93)
- Beta-Gamma detector (e.g. probe Ludlum Model 44-9)
- Swipe sample counter (e.g. Ludlum M3030P)
- Filter Paper

Requirements of the decontamination process may include the appropriate cleaning agents and materials to facilitate decontamination such as:

- Paper towels
- Clean water supply
- Cleaning brushes
- Soap, detergent, acid, or decontamination agent such as Radiacwash™

The RSO or HPT performing shall be qualified based on the requirements of their positions (as described in the EHS-MS Health Physics Program), trained in this SOP, and be knowledgeable in the use of the appropriate detectors.

4.0 DEFINITIONS

Counts per minute (cpm): This is measurement of the number radioactive particles measured. No information about the type or energy is given.

Disintegrations per minute (dpm): This is usually a calculated measurement based on the cpm. The dpm is the number of atoms decaying in one minute.

Radiation worker: Any LC-ISR employee who through their duties has the potential to be exposed to radiation associated with ISR operations and is knowledgeable in the use of radiation detection equipment.

Unrestricted use: Free use of an object or area that has previously been classified as restricted and either declared free of contamination by radiological survey or successfully decontaminated.

Swipe (Smear): A radiation survey technique which is used to determine levels of removable surface contamination. A medium (typically filter paper) is rubbed over a surface (typically of area 100 cm2), followed by a quantification of the activity on the medium (NUREG-1757).

5.0 HAZARD ASSESSMENT AND PPE

When screening, there shouldn't be need for additional PPE if the items being screened are used as a regular part of someone's duties. If the item is used before screening then the PPE for that task should already account for the expected radiation exposure.

Standard required PPE should be worn in the Plant or wellfield including:

- Hard hat
- Safety eyewear
- Safety toed boots

In situations where excess contamination is expected then extra precautions may be needed, such as gloves. Disposable gloves should be worn when cleaning contaminated objects. Additional PPE can be used as necessary such as coveralls.

6.0 PROCEDURE

The purpose of screening is to prevent the spread of contamination most commonly from a restricted area to a non-restricted area. All objects leaving a restricted area or objects that are suspected of contamination shall be screened and the results compared to the screening limits to either determine if decontamination is needed or to declare the object unrestricted. Items that may be frequently surveyed may include:

- 11e2 byproduct waste articles
- Vehicles
- Instruments or tools
- PPE (respirator screening is covered in SOP_LC_OHS-007)
- Equipment, wood, metal objects, and piping
- Drums or other containers

Suspected 11e2 byproduct waste materials may be released through the screening process for unrestricted use and disposal as non-11e2 waste (see SOP_LC_HP-013: *11e2 Byproduct Waste Management*).

Screening of objects entails surveying for potential contamination on the objects surface by instrument survey and, if necessary, swipe surveying. The data resulting from the surveys is compared to the contamination limits for the associated nuclide.

Packages that are to be shipped from the Plant such as yellowcake drums and 11e2 containers will be screened for release according to SOP_LC_TR-007: *Radioactive Materials Shipping and Transport*.

6.1 Contamination and Limits

The radionuclide contamination of interest depends on what step in the mining process the screening is associated with. The contamination from yellowcake associated the precipitation, the dryer, and the drum storage area which is primarily alpha radiation since the uranium yellowcake is refined and separated from the daughters. The rest of the mining process includes potential for contamination from uranium and associated daughter products such as radium-226 which can produce alpha and gamma radiation. Ra-226 can be a concern in association with piping since it can precipitate with calcium scale on the interior surface. Unlikely beta contamination from aged

uranium (i.e. uranium daughters from in-growth) will be included in the screening and compared to levels independently of alpha.

The contamination limits based on the nuclide are provided in Table 6-1 below. Table 6-1 limits are taken from NRC Regulatory Guide 1.86 (RG 1.86) as referenced in RG 8.30.

Perform calculation of dpm from instrument cpm using the formula:

$$dpm = \frac{cpm - cpm_{background}}{E_{counting} \times E_{collection}}$$

A conservative collection efficiency of 10% may be assumed; however, attention must be given to the definition of the limits on which action is determined. Use the following equation to determine the dpm (Frame and Abelquist).

Table 6-1: Acceptable Surface Contamination Limits

NUCLIDE[a]	AVERAGE[b c]	MAXIMUM[b d]	REMOVABLE[b e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm β-γ/100 cm^2	15,000 dpm β-γ/100 cm^2	1000 dpm β-γ/100 cm^2

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

If Ra-226 is expected or determined to be an issue for any type of object, the screening limits will be used for Ra-226. It is reasonably anticipated that the only source of Ra-226 will be from buildup of scale on piping, valves and fittings or in the groundwater within the production circuit lines. For example, if a technician performs maintenance on a wellfield line or production line and scale has built up within, screening to radium limits may be necessary to release equipment associated with the repair. Radium is not expected within any system downstream of the ion exchange circuit. Radiological characterization events by the health physics staff should help to identify if Ra-226 is an issue.

Equipment and surfaces shall not be painted over for the purpose of meeting release criteria. However, if painting over an area with contamination that cannot reasonably be removed is determined by the RSO to be ALARA, it may be allowed as long as the contamination on the article or surface is characterized and documented.

6.2 Screening Procedure

A handheld radiation detection instrument shall be used initially when screening materials or objects. Screening instruments may include the following:

- Alpha/Beta detector (e.g. probe Ludlum Model 43-93)
- Beta-Gamma detector (e.g. probe Ludlum Model 44-9)

Items that cannot be representatively surveyed by either instruments or swipes due to issues such as geometry or other reasons may not be released for unrestricted use. Porous objects cannot be properly surveyed because contamination can be hidden in the pores where it cannot be detected by alpha/beta instruments. Therefore, porous objects such as cardboard boxes or heavily pitted/rusted objects might not be released for unrestricted use (and if at all possible should be excluded from the restricted area). Unreleased objects will need to either stay in the restricted area or be disposed as 11e2 waste. Objects will be allowed to completely dry before alpha/beta surveys since alpha/beta particles will be attenuated by the moisture and may not be detected by the survey instrument.

To screen an object in question:

1. Notify the RSO or HPT that screening needs to be performed.
2. Make sure instruments have been calibrated and are functioning properly.
3. Make sure object is free of visible contamination such as yellowcake dust. If object was washed down or was wet, make sure object is dry prior to surveying.
4. Screen a representative area of the object using a radiation detection probe.
5. If the surface is not amenable to screening with an instrument due to irregular surfaces, perform a swipe survey (see Section 6.3).
6. Document screening results on FORM_LC_HP-014A or record electronically as appropriate.
7. Compare the results from the instrument to the applicable contamination limit. See the following table for actions based on the results:

If initial dpm is:	**Then:**
< removable limit	Object is released for unrestricted use
> removable limit < average and maximum limit	Perform swipe test or decontaminate object and resurvey
> average < maximum	Object must be decontaminated and resurveyed
> average > maximum	Object must be decontaminated and resurveyed

8. If the object needs to be decontaminated see Section 6.4.
9. After decontamination, resurvey the object with the appropriate detection instrument after it has dried. The actions based on the results are as follows:

If after decontamination dpm is:	**Then:**
< removable limit	Object is released for unrestricted use

> removable limit < average and maximum limit	Contamination is not removable but fixed contamination is below limits and object may be released
> average < maximum	Object is not released and must be disposed or remain in restricted area
> average > maximum	Object is not released and must be disposed or remain in restricted area

10. If an object is contaminated and cannot be decontaminated and is not to be disposed it must be labeled clearly as a contaminated object and must remain within the restricted area.

6.3 Swipe Surveying

Swipe surveys are described in SOP_LC_HP-010: *Surface Contamination (Swipe) Surveys*. Swipes will be collected by swiping an area approximately 100 cm^2. Swipes will be counted on alpha/beta detectors suitable for swipe counting. The following table provides the actions based on the counting results:

If swipe dpm is:	Then:
< removable limit	Object is released for unrestricted use
> removable limit < average or maximum limit	Object must be decontaminated and resurveyed
> average > maximum	Object must be decontaminated and resurveyed

If the object needs to be decontaminated see Section 6.4, and proceed as with steps 9 and10 of the preceding section.

6.4 Decontamination and Disposal

Decontamination is cleaning an object to mitigate surface contamination. The person cleaning should use PPE for protection from the contamination such as gloves, coveralls, boot covers, respirator as necessary. Regular decontamination methods includes the use of paper towels, water, brushes for scrubbing, washer/dryer for

clothing, and most other regular cleaning supplies. Associated disposable waste generated from the decontamination process will be declared 11e2 byproduct waste.

If something cannot be decontaminated, it will be disposed of as 11e2 byproduct waste. If the item is disposable and would be inefficient to screen or create more waste from decontamination then it should be disposed as 11e2 waste. See SOP_LC_HP-013: *11e2 Byproduct Waste Management* for details on radioactive waste disposal.

An area within the Plant will be designated as a decontamination station with supplies to perform cleaning and necessary PPE. It should be near enough to the Plant sump system so that wash water can be directed into the sump for disposal.

If an object needs decontaminated:

1. Bring the object to the decontamination area for cleaning or, if convenient, the object may be decontaminated where it is screened if a wash down is not necessary.
2. The object may be cleaned with rags or paper towels and cleaning solution as needed.
3. If necessary, clean the object using the appropriate wash down technique using the water supply hose for washing. Use a brush if needed. Use care not to splash wash water thus spreading contamination.
4. Let object dry completely so there will be no interference from the water on the follow-up alpha/beta screening process.

6.5 Quality Assurance/Quality Control

6.5.1 Data Objectives

The data objective of screening and decontamination of materials is to be able to measure contamination at the unrestricted release limits (Table 6-1) with 95% certainty. A measure of the confidence is provided by the determination of the Minimum Detectable Activity (MDA) and the control chart of the function check results. The following table provides a summary of the instruments used for screening and decontamination:

Detector*	Measure	Applicable Units	MDA** (dpm/100cm^2)
Ludlum Model 3 w/ Model 44-9 Pancake GM Detector	Alpha, Beta, and Gamma surface radiation	0-500,000 cpm	See SOP_LC_HP-004 Target: 500dpm/100cm^2
Ludlum Model 3 w/ Model 43-93 100cm^2 Alpha/Beta Scintillator Detector	Alpha and Beta surface radiation over 100cm^2	0-500,000 cpm	See SOP_LC_HP-004 Target: 500dpm/100cm^2
Protean ASC-950-DP Or Ludlum 3030M	Alpha and Beta sample counter (filters/swipe/soil)	Counts (Scaler measurement)	See SOP_LC_HP-004 Target: 100cpm/100cm^2

* *Detectors equivalent to these mentioned may be used. Data quality may vary dependent upon the make and model.*
***Actual MDA will be calculated for each instrument*

6.5.2 Measurement Quality Control

The quality of the screening instruments will be controlled by:

- Routine calibrations of the radiation detection equipment
- Function checks/control charts
- Proper training to help maintain consistency in screening technique
- Determining the MDA each time the instrument is factory calibrated
- Control charts of function check data to ensure that the instrument is consistently measuring accurately.

6.5.3 Calibration

Calibration, efficiency, and MDA for detection instruments used for screening and decontamination of materials are included in SOP_LC_HP-004: *Radiation Detection Instrumentation*, and SOP_LC_HP-018: *Alpha-Beta Counting Systems*.

6.5.4 Data Verification and Validation

The individual performing the screening and decontamination needs to understand the potential contamination and the likely contamination. When making measurements, the person screening will assess the reasonableness of the measurement. The RSO is also responsible for verifying and validating the screening and decontamination data. The RSO should be vigilant for unexplained changes.

6.5.5 Audits/Corrective Actions/ALARA

Any anomalous results of measurements and function checks, or trends in data will be investigated and corrective actions proposed. Investigations will be provided in the annual Radiation Protection Program/ALARA Report.

7.0 DOCUMENTS AND RECORDS

Records that shall be retained for surface contamination surveys include:

- Material survey screening data (electronic or hard copy)
- FORM_LC_HP-014A: *Screening Results Log*, as necessary.

8.0 REFERENCES

NRC, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*. April, 1993

NRC Regulatory Guide 1.86: *Terminating Operating Licenses for Nuclear Reactors*, Jun74

SOP_LC_TR-007: *Radioactive Materials Shipping and Transport*

SOP_LC_HP-004: *Radiation Detection Instrumentation*

SOP_LC_HP-010: *Surface Contamination Surveys*

SOP_LC_HP-013: *11e2 Byproduct Waste Management*

Use of Smears for Assessing Removable Contamination. Paul W. Frame and Eric W. Abelquist. http://www.hps1.org/sections/rso/ophpinfo/smears.PDF