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| **Reviewed By:** MDG 5/24/2012; MDG 3/13/2013; JWC 3/24/2013; MDG 7/2/2013; JWC 7/7/2013; | ***Final Approval:*** CHARLES KELSEY<br>Digitally signed by CHARLES KELSEY<br>DN: cn=CHARLES KELSEY, o=LOST CREEK ISR, ou=UR-ENERGYUSA, email=charles.kelsey@ur-energyusa.com, c=US<br>Date: 2013.07.17 13:33:07 -06'00' |

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to detail the program for the routine environmental monitoring of potential gamma radiation exposure rates at various sampling locations at the Lost Creek ISR (LC-ISR) project. Dosimeters, such as a Thermoluminescent Dosimeter (TLD) or equivalent as approved by the RSO, are used to measure the gamma dose rates at fixed locations on a quarterly basis. Monitoring provides assurance that ALARA is achieved at the boundary of the unrestricted project area, and that potential doses to members of the public do not exceed regulatory limits. The continuous monitoring of environmental gamma radiation is used in demonstrating that if an individual were continuously present in an unrestricted area, the dose from external sources above background would not exceed 0.05 rem in a year (10 CFR 20.1302).

Measuring gamma exposure rates is part of facility environmental monitoring as described in NRC Regulatory Guide 4.14 (RG 4.14) to comply with the 100 mrem/yr dose limit for members of the public set forth in 20.1301 and the reporting requirements pursuant to 10 CFR 40.65.

## 2.0 RESPONSIBILITIES/AUTHORITY

The Radiation Safety Officer (RSO) and/or Health Physics Technician (HPT) are responsible for:

- Ensuring the dosimeters are deployed and replaced properly;
- Submitting dosimeters to an approved laboratory;
- Comparing data to exposure limits to verify dose rates are within limits; and
- Maintaining records of acquired field and analytical data.

## 3.0 PREREQUISITES AND TRAINING

Measurements are made with a passive integrating device which will be referred to herein as "dosimeter". Devices should be protected from weather conditions such as precipitation or direct sunlight. Monitoring stations have been prepared that will shelter the dosimeters.

A dosimeter with a range of at least 1 mrem to 500 rem will be used.

Training includes familiarization with this procedure and completion of field work under the direct supervision of the RSO or other qualified person to demonstrate that the procedure is understood and followed.

## 4.0 DEFINITIONS

Duplicate: A quality control measure comprised of a second dosimeter deployed at the same location as another. The purpose is to determine the precision/consistency of the measurements.

Effective dose equivalent (EDE or $H_E$): the sum of the products of the dose equivalent to the organ or tissue ($H_T$) and the weighting factors ($w_T$) applicable to each of the body organs or tissues that are irradiated ($H_E = \Sigma\, w_T H_T$).

NVLAP: The National Voluntary Laboratory Accreditation Program administered by the National Institute of Standards and Technology (NIST) provides third-party accreditation to testing and calibration laboratories.

Deploy Control: A quality control measure by which a dosimeter is carried out to the field and back when deploying and retrieving dosimeters. This is to determine the effect of handling the dosimeters on radiation measurements.

Transit Control: A quality control measure by which a dosimeter is shipped with dosimeters for analysis but is not carried to the field. This is to determine the effect shipping the dosimeters has on the radiation measurements.

Total Effective Dose Equivalent: The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

## 5.0 HAZARD ASSESSMENT AND PPE

Task hazards may include:

- Weather extremes
- Slips, trips, falls
- Barbed wire fence
- Pinch points from gates or doors on air sampler boxes
- Monitor caps are possible places for spiders to live.

PPE requirements or recommendations:

- Standard site PPE including:

- Hardhat;
- Safety boots;
- Safety eyewear.

- Leather or work gloves for handling gates

## 6.0 PROCEDURE

Passive gamma radiation will be monitored continuously and analyzed on a quarterly basis as described in TR Section 5.7.7.1 at five (A sixth location has been added at Lost Creek East to support a future amendment application.) air particulate sampling locations as well as seven additional locations. The Lost Creek sample stations are shown in TR Figure 2.9-27 (included in this SOP - Lost Creek East location not shown). At least one duplicate will be deployed for quality control. The sample stations are summarized on the following table and shown on the included map:

| Sample Station ID | Corresponding Air Monitoring Station ID | Area | Comments |
|---|---|---|---|
| PR-1 | AP-1 | Lost Creek | Nearest Residence, Bairoil, WY |
| PR-2 | AP-3 | Lost Creek | SW Boundary of LC, Upwind of CPP |
| PR-3 | AP-5 | Lost Creek | NW Boundary of LC, Upwind of CPP |
| PR-4 | - - | Lost Creek | N of CPP, 100m |
| PR-5 | AP-2 | Lost Creek | E Adjacent to CPP; Highest Expected |
| PR-6 | - - | Lost Creek | NE Boundary of LC, Downwind CPP |
| PR-7 | - - | Lost Creek | W Boundary of LC, Upwind of CPP |
| PR-8 | - - | Lost Creek | S Boundary of LC, Upwind of CPP |
| PR-9 | - - | Lost Creek | In Mine Unit, S of CPP |
| PR-10<br>PR-10DUP | AP-4 | Lost Creek | E Boundary of LC, Downwind of CPP<br>Duplicate sample located here |
| PR-11 | - - | Lost Creek | S Boundary of LC, Upwind of CPP |
| PR-12 | - - | Lost Creek | SSE Boundary LC, Over Ore Trend |
| PR-13 | AP-6 | Lost Creek East | Added Oct 1, 2012 for permitting process. Located in SE corner of Section 2 T25N R92E. |

Following onset of operations, quarterly dosimetry values for each location will be compared with corresponding quarterly Pre-Operational monitoring levels (background levels) to determine if a potential dose to the public occurred, which, when corrected for background, will be compared to the members of the public dose limit to demonstrate compliance with the 50 mrem/yr public external exposure limit (10 CFR 20.1302(b)(2)(ii)). Results will be tabulated, included and discussed in the Semi-

Annual Effluent and Environmental Monitoring Report. Background dosimetry levels were determined by averaging the quarterly values obtained at each location over the years of Pre-Operational monitoring, 2008-2013.

### 6.1 Preparations

To prepare dosimeters for deployment:

1. Label the new dosimeter packing list with the monitoring station identifier at which each dosimeter will be placed. Monitoring station PR-10 will have a duplicate dosimeter. Also write on packing list the year's quarter the dosimeters are monitoring.

2. Create a PDF document (scan) of the dosimeter packing list. Store document in appropriate folder in the following location:

   Radiation Passive Environmental

3. Store the new Transit Control dosimeter in the badge holder in the Casper office. Deploy Control dosimeters are stored in the Casper office with the Transit Control until needed for deployment of the environmental dosimeters.

4. Prepare the following items to be brought to the field:

   - The full set of new dosimeters including the Deploy Control dosimeters from the current quarter and the new quarter.
   - Zip ties for each of the dosimeters
   - Tool for cutting zip ties
   - Packing list for the new dosimeters to ensure placement at correct monitoring stations
   - Maps of the locations of the monitoring stations (included with this SOP)

### 6.2 Field Procedure

When in the field at the monitoring stations:

1. Inspect the monitoring station and repair any defects. The elastic straps holding the wire mesh will need to be replaced occasionally.

2. Remove the elastic strap holding the wire mesh on the underside of the monitor cap. It is recommended that the inside of the monitor be visually checked for spiders before placing your hand inside.

3. Since radon canisters are deployed at the same monitoring stations, radon canisters may be changed at the time of dosimeter changes. See SOP_LC_ENV-014: *Environmental Radiological Monitoring - Radon* for removal of the radon canister from the monitoring station.

4. Remove the dosimeter from the wire mesh by cutting the zip tie and unclipping. Confirm the number on the new dosimeter matches the number on the vendor's dosimeter packing list and record the location on the list.

5. Clip the new dosimeter to the wire mesh and secure with a zip tie. Place the dosimeter and wire mesh directly under the monitor cap. The dosimeter should be on the inside of the mesh when the wire mesh is reattached.

6. Secure the wire mesh with the elastic strap.

### 6.3 Post Field Procedure

Upon returning to the office following retrieval and deployment of the dosimeters:

1. Prepare for shipment of the current quarter's dosimeters, the deploy control, and the transit control. Make sure that the correct controls are sent. The control dosimeters for the current quarter will remain in office until the end of the quarter.

2. Create a PDF scan of the dosimeter packing list and post the PDF at:

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3. Place the dosimeters with the packing list in the envelope provided by the vendor. The shipping address should be on the envelope.

### 6.4 Data Analysis

The resulting data from the analysis of the dosimeters will be used in the determination of compliance with the dose limit to members of the public exclusive of background radiation contributions. Background values have been calculated through statistical analysis of the background radiation measurements taken during LC-ISR's pre-operational period. The data will be evaluated as follows:

1. Results are obtained from the laboratory report which provides doses in mrem.
2. The background value is subtracted from the result
3. The background subtracted dose value is compared to the 50 mrem compliance limit. The percentage of the limit for the result will be calculated.
4. The resulting dose is included with other environmental measurement results (i.e. radon and air particulates) for the overall determination of compliance with the 100 mrem/yr limit as described in SOP_LC_HP-016.

### 6.5 Quality Assurance/Quality Control

Data will be reviewed by the RSO and compared with previous results to determine if any anomalies exist or if any potential doses exist. Data should fall within the confidence interval to be accepted. Any unusual results of the monitoring will be discussed in the Annual Radiation Protection Program (RPP)/ALARA Report.

The following are quality control (QC) measures:

- Dosimeters collocated at PR-10 will provide duplicate analysis. Values for the sample and companion duplicate will be evaluated for Relative Percent Difference (RPD):

$$RPD = \frac{|S - D|}{(S + D)/2} \times 100$$

Where: S = Sample Reading
D = Duplicate Reading

If the RPD is greater than 20% the data and the laboratory QA/QC may be reviewed for adequacy. Anomalies may be discussed in the Semi-Annual Effluent and Environmental Monitoring Report as appropriate.

- Transit control samples provided by the vendor will be submitted with the sample batch to measure potential radiation exposure while in shipment from and back to the laboratory;
- Deploy control samples provided by the vendor will be carried with the batch to the field to determine if there are any radiation effects from field conditions.

Control badge values will be used only if it has been determined that a dose has been likely accumulated in transit. For example, if all badges have accumulated a dose above baseline then the control badge value will be subtracted from all of the badges in the sample batch. The resulting net exposure value will then be compared with the baseline to determine if there may be a dose above background.

## 7.0 DOCUMENTS AND RECORDS

The results of the monitoring will be included in the Semi-Annual Effluent and Environmental Monitoring Report and the Annual RPP/ALARA Report. An example reporting table is included at the end of this procedure.

The following records shall be maintained in hard copy format or electronic format in EHS Department files for the life of the project:

- Dosimeter packing lists including serial numbers and deployment locations
- Monitoring data results

## 8.0 REFERENCES

Code of Federal Regulations Title 10 Part 20.1302

Code of Federal Regulations Title 10 Part 40.65

NRC License Application Technical Report for the Lost Creek Project, Section 2.9.2: *Radiology*

NRC License Application Technical Report for the Lost Creek Project, Section 5.7.7: *Airborne Effluent and Environmental Monitoring*

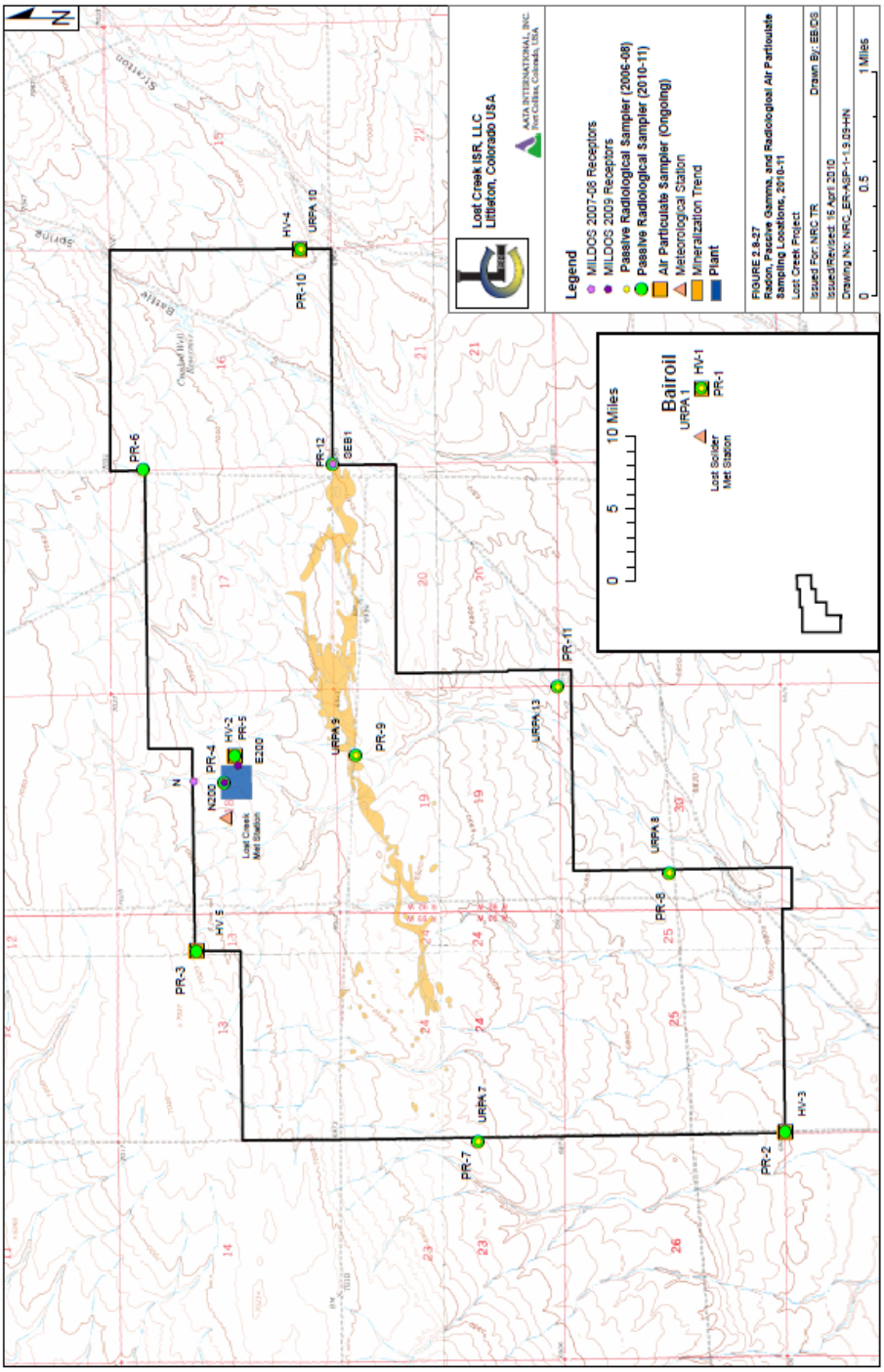
NRC Regulatory Guide 4.13: *Performance, Testing, and Procedural Specifications for Thermoluminescent Dosimetry: Environmental Applications*, July 1977

NRC Regulatory Guide 4.14: *Radiological Effluent and Environmental Monitoring at Uranium Mills*

SOP_LC_HP-016_Radiation Dose Determinations_02Jul2013

SOP_LC_ENV-014: *Environmental Radiological Monitoring – Radon*

## SAMPLE LOCATION MAP



**EXAMPLE TABLE XX**
**DIRECT RADIATION (GAMMA) MEASUREMENT DATA**
**ENVIRONMENTAL MONITORING SITES**
**1st & 2nd QUARTERS 2013**

| SAMPLE LOCATION | | | 2013 SAMPLE PERIOD | 2008-2013 QRTLY AVG (BKGD) | BKGD AVG ERROR (mrem) | NET EXPOSURE (mrem) |
|---|---|---|---|---|---|---|
| **AP1/PR-1** | | | 1st Quarter | | | 16.7 |
| **Nearest Residence** | | | 2nd Quarter | | | |
| **Bairoil, WY** | | | | | | |
| **AP2/PR-5** | | | 1st Quarter | | | 19.3 |
| **Highest Expected** | | | 2nd Quarter | | | |
| **Adjacent to CPP, East** | | | | | | |
| **AP3/PR-2** | | | 1st Quarter | | | 17.6 |
| **Upwind of CPP** | | | 2nd Quarter | | | |
| **SW Boundary of LC** | | | | | | |
| **AP4/PR-10** | | | 1st Quarter | | | 35.5 |
| **PR-10Dup** | **Rel% Diff =** | **11.0** | | | | 31.8 |
| **AP4/PR-10** | | | 2nd Quarter | | | |
| **PR-10Dup** | **Rel% Diff =** | **#DIV/0!** | | | | |
| **Downwind of CPP** | | | | | | |
| **E Boundary of LC** | | | | | | |
| **AP5/PR-3** | | | 1st Quarter | | | 20.7 |
| **Upwind of CPP** | | | 2nd Quarter | | | |
| **NW Boundary of LC** | | | | | | |
| **PR-4** | | | 1st Quarter | | | 28.0 |
| **N of CPP, 100m** | | | 2nd Quarter | | | |
| **PR-6** | | | 1st Quarter | | | 17.4 |
| **NE Boundary of LC** | | | 2nd Quarter | | | |
| **Downwind of CPP** | | | | | | |
| **PR-7** | | | 1st Quarter | | | 23.4 |
| **W Boundary of LC** | | | 2nd Quarter | | | |
| **Upwind of CPP** | | | | | | |
| **PR-8** | | | 1st Quarter | | | 22.1 |
| **S Boundary of LC** | | | 2nd Quarter | | | |
| **Upwind of CPP** | | | | | | |
| **PR-9** | | | 1st Quarter | | | 23.0 |
| **In Mine Unit** | | | 2nd Quarter | | | |
| **S of CPP** | | | | | | |
| **PR-11** | | | 1st Quarter | | | 22.4 |
| **S Boundary of LC** | | | 2nd Quarter | | | |
| **Upwind of CPP** | | | | | | |
| **PR-12** | | | 1st Quarter | | | 20.0 |
| **SSE Boundary of LC** | | | 2nd Quarter | | | |
| **Over Ore Trend** | | | | | | |