	UR-ENERGY USA, INC. LOST CREEK ISR, LLC STANDARD OPERATING PROCEDURE	
GAMMA SURVEYS		
Edition: 15Jul20132013	**SOP Number:** SOP_LC_HP-006	**Author:** MDG/CJP

Reviewed By: MDG 9/25/2012; JWC 2/25/2013; MDG 3/1/2013; CJP 07/15/2013	***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 13:46:17 -06'00'

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the process for conducting surveys to determine gamma exposure rates in various areas of the Lost Creek ISR (LC-ISR) Central Processing Plant (Plant). The surveys are conducted on at least a quarterly basis with a direct reading instrument to determine exposure rates from potential gamma radiation.

This SOP is pursuant to 10 CFR 20, LC TR 5.7.2, and the ALARA program.

2.0 RESPONSIBILITIES

The EHS Department and Radiation Safety Officer are responsible for:

- Performing investigations for areas that are determined to be radiation areas;
- Maintaining proper detection equipment in a functioning and calibrated state;
- Determining daily or pre-survey backgrounds and efficiencies for survey instruments;
- Documenting survey results;
- Designating radiation areas according to 10 CFR 20.1902(a);
- Maintaining ALARA;

3.0 PREREQUISITES AND TRAINING

Gamma survey meters will be operated and calibrated according to manufacturer specifications and shall be checked for proper operation and calibration each day of use with a check source in a reproducible geometry.

Training includes reading and understanding this SOP and demonstrating the proper preparation and use of the gamma detector. Practical demonstration of the proper use of the instrument shall be conducted under the supervision of the RSO or other qualified person. Personnel involved in surveying shall have completed the general radiation training described in EHS-MS Volume II: *Radiation Protection Program*.

4.0 DEFINITIONS

ALARA: Means "As Low As is Reasonable Achievable". Maintaining occupational doses and doses to members of the public as low as is reasonably achievable using, to the extent practical, procedures and engineering controls based upon sound radiation protection principles.

ALARA Investigation: To determine the nature and source of elevated radiation levels and to attempt to reduce potential exposures through mitigation, engineering controls, or administrative controls that follow the concept of exposure reduction through time, distance, and shielding.

Gray (Gy): The SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 Joule/kilogram (100 rad).

Ion (or ionization) chamber detector: Gas-filled detectors used exclusively for the determination of exposure rates. Radiation causes a current to flow in an ion chamber detector and the magnitude of electric current is proportional to the exposure rate.

NaI scintillator: NaI or sodium iodide is a solid crystal that reacts with radiation by emitting a pulse of light. The light is measured by a photomultiplier tube and converts the signal to a response or "count" by which the intensity of the light is proportional to the detected radiation.

Qualified person: In the scope of this SOP, a qualified person is one who has demonstrated proficiency in the use of radiation detection equipment through training, education, or experience.

Radiation Absorbed Dose (rad): The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 Joule/kilogram (0.01 gray).

Radiation Area: Any area with radiation levels greater than 5 mrem/hr at 30 cm from the source or any surface through which the radiation penetrates.

Roentgen (R): A unit of measure of the dose to air caused by ionizing radiation from x-rays or gamma rays. A Roentgen is typically close in value to a rem, but the difference may change depending on the situation.

Roentgen Equivalent Man (rem): The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem=0.01 sievert).

Sievert (Sv): The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv=100 rem).

5.0 HAZARD ASSESSMENT AND PPE

The individual who performs gamma surveys should be mindful of the presence of the radiation that may be present when measuring. When determining the dose rate, the individual should minimize the time spent in an area that is determined to be a radiation area.

Gamma radiation may emanate from the decay products of the uranium in solution as it proceeds through the plant systems. Some may be from the plating or deposition of small amounts of precipitates or radium scale within piping or tanks.

Personal Protective Equipment (PPE) shall be worn within the Plant or in the mine units when performing surveys including:

- Standard LC-ISR PPE including:
  - Hard hat;
  - Safety eyewear; and
  - Safety-toed footwear.
- Personal dosimeter
- Disposable gloves, as necessary;
- Coveralls or lab coat, as necessary.

6.0 PROCEDURE

Direct gamma exposure rates will be measured daily to validate locations defined as Radiation Areas (5mrem/hr at 30cm), and at least semi-annually at all employee work stations. In addition a passive gamma dosimeter will be maintained in the control room to be exchanged and evaluated quarterly. Initially, monthly surveys will be performed at the locations on the attached figure.

6.1 Instruments

LC-ISR will use Ludlum's model 19 NaI scintillator, or Ludlum's model 44-3 NaI scintillator probe or equivalents to perform gamma measurements.

6.2 Calibration and Pre-Survey Instrument Preparation

Instruments shall be calibrated according to manufacturer's specifications. Calibration, function checks, efficiency calculations, and background measurements are described in SOP_LC_HP-004: *Instrument Calibration*.

The following shall be performed at least daily before using gamma detection instruments:

1. Perform function checks
2. Measure and record the background levels.

6.3 Characterization

The initial survey to characterize the Plant shall be performed shortly after startup to determine baseline levels at the locations designated in the attached figure, and monthly until production stabilizes. Areas outside of the Plant, including header houses, well heads, deep disposal wells, etc will be surveyed weekly for characterization until production stabilizes.

6.4 Gamma Surveys

Complete gamma surveys of the facility per the attached figure will be performed semi-annually. Radiation Areas will be surveyed daily as part of the daily inspection. Surveys should also be performed whenever there are significant changes at the

facility, such as an increased production volume. The following procedure shall be used when conducting gamma surveys:

1. Perform pre-survey instrument preparation.
2. Take readings in the locations designated in the attached figure.
3. If the measured exposure rate exceeds the action level of five (5) millirem (mrem) per hour at thirty (30) cm from the source, designate the area a radiation area in accordance with 10 CFR 20.1902(a). The radiation area shall be marked by a stanchion and rope, or other appropriate means. A sign will be hung with the radiation trefoil symbol and the words, "Caution, Radiation Area".
4. If an area is designated as a radiation area, increase the frequency of the surveys in those areas to quarterly (the marked boundary will be verified daily per the daily inspection checklist, FORM_LC_HP-003A Radiation Safety Inspections. Perform an ALARA investigation when designating a new area to determine the source or nature of the radiation and if corrective actions are necessary.
5. Determine if the source of the radiation in a newly designated area can be reduced through mitigation efforts;
    a. If the radiation source can be reduced, resurvey to determine if the dose is below the 5 mrem/hr, remove the posting, and document the process;
    b. If the radiation is not or cannot be reduced, minimize exposures through the use of engineering or administrative controls (e.g. shielding or reduced residence times).
6. Review the results of the gamma surveying. The data shall be reviewed so that the HPT or RSO can look for trends to understand the radiological characteristics of the facility, and to help maintain ALARA. Trending may be facilitated through the Plant database system.
7. Results and findings of the gamma surveys shall be included in the annual RPP/ALARA report.

6.5 Quality Assurance/Quality Control/ALARA

6.5.1 Data Objectives

The gamma surveys performed should be able to measure an exposure rate below the limit of 5 mrem/hr. The measurements performed in a gamma survey should be validated by a proper calibration, and the function check.

6.5.2 Measurement Quality Control

As a measure of QC, all instruments are regularly function checked, and the function check is analyzed by the use of control charts (SOP_LC_HP-004_*Instrument Calibration* section 6.7). The control charts monitor the background levels, and a source check with consistent geometry to ensure no statistically significant change in the data at a 95% confidence level.

6.5.3 Calibration

Instruments are properly calibrated and prepared as described in Section 6.2 above, and SOP_LC_HP-004_Instrument Calibration. Instruments shall be serviced as necessary according to manufacturer's recommendation.

6.5.4 Data Verification and Validation

The person performing the gamma surveys is the first person to verify the data. After the survey is complete, the gamma surveyor will review the data, and compare to previous years data. The RSO will also be responsible for verification, and will ensure that persons performing gamma surveys understand verifying and validating gamma measurements. Any anomalous data will be explained or re-sampled.

6.5.5 Audits/Corrective Actions

Any anomalous results of gamma surveys or function checks will be investigated and corrective actions proposed. Investigations will be provided in the annual Radiation Protection Program Report. Audits are also discussed in SOP_LC_AD-007: *Internal Audit and Corrective Action Program*.

Data resulting from the gamma survey program will be analyzed for trends and ALARA considerations. If data reveal an upward trend in radiation values, an ALARA investigation will occur to determine if radiation may be mitigated or controls put in place to protect individuals. Results of investigation, if applicable, will be included in the Annual RPP/ALARA Report.

7.0 DOCUMENTS AND RECORDS

The following documents shall be retained for the life of the project until license termination regarding gamma surveys:

- Results of initial characterization survey;
- Calibration and maintenance records;
- Data records from surveys;
- Annual RPP/ALARA reports and recommendations;
- Description of corrective actions such as mitigation or radiation controls;

8.0 REFERENCES

Code of Federal Regulation Title 10 Part 20: *Standards for Protection Against Radiation*

Code of Federal Regulation Title 10 Part 20.1902: *Posting Requirements*

EHS-MS Volume II: *Health Physics*

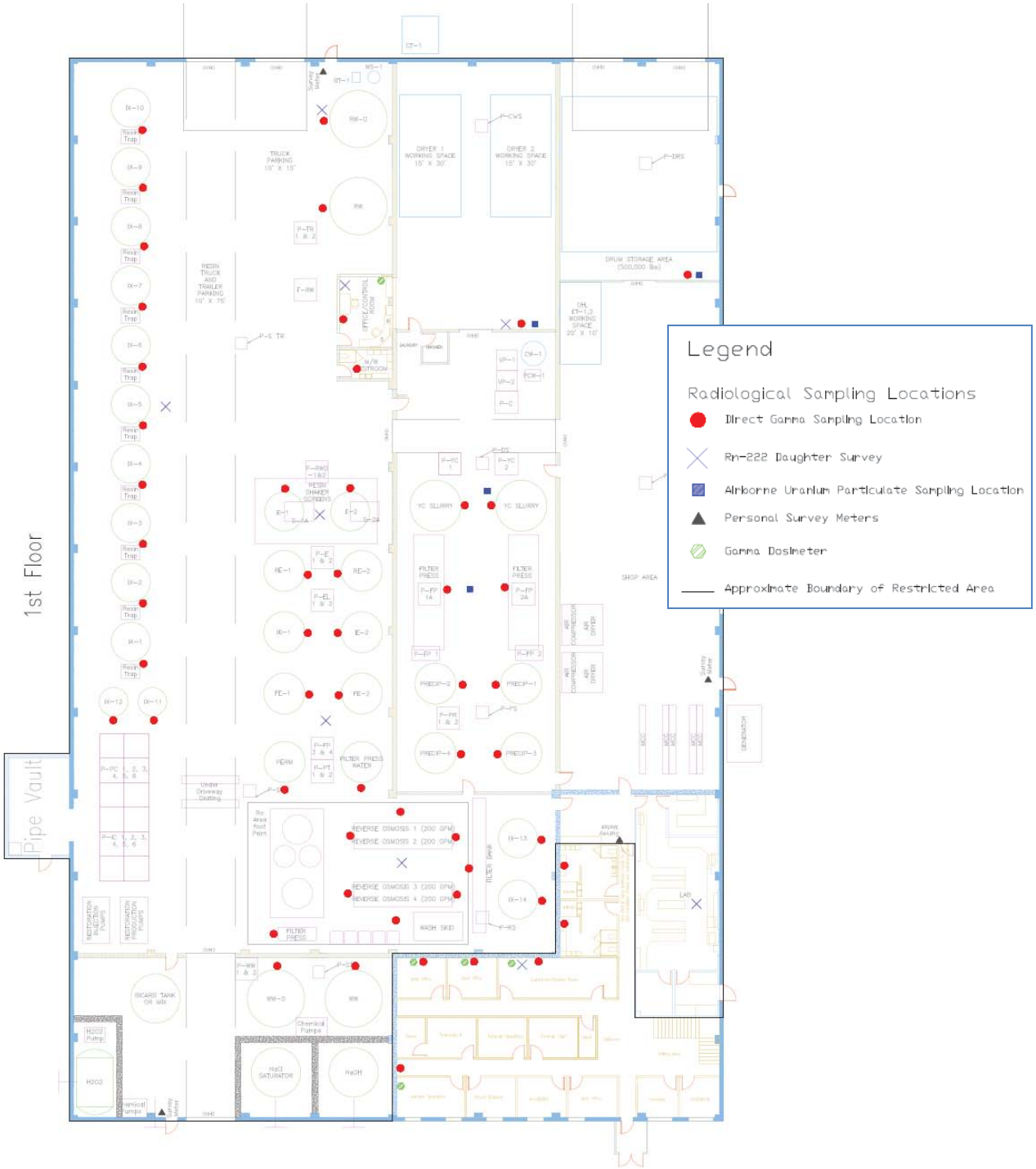
NRC License Application Technical Report, Section 5.7.2.2: *Direct Readings for External Exposure*, April 2010

NRC, Regulatory Guide 8.21: *Health Physics Surveys for Byproduct Material at NRC-Licensed Processing and Manufacturing Plants*, October 1979

NRC, Regulatory Guide 8.30: *Health Physics Surveys in Uranium Recovery Facilities,* May 2002

NRC, Regulatory Guide 8.31: *Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities will be As Low As Reasonably Achievable*, May 2002

SOP_LC_HP-004: *Instrument Calibration*


1st Floor
Pipe Vault
Legend
Radiological Sampling Locations
Direct Gamma Sampling Location
Rn-222 Daughter Survey
Airborne Uranium Particulate Sampling Location
Personal Survey Meters
Gamma Dosimeter
Approximate Boundary of Restricted Area