Northeast Church Rock Mine Site Removal Action

Attachment L-1

Radiation Protection Plan

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FIGURES

ATTACHMENTS

LIST OF ACRONYMS

ALARA	As Low As Reasonably Achievable
ALI	Annual Limits on Intake
CC	Construction Contractor
CDE	Committed Dose Equivalent
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
cm	centimeters
cpm	counts per minute
DAC	Derived Air Concentration
DDE	Deep Dose Equivalent
dpm	disintegrations per minute
EDE	Effective Dose Equivalent
gm	gram
HASP	Health and Safety Plan
hr	hour
ICRP	International Committee on Radiation Protection
LLD	Lower Limits of Detection
lpm	liters per minute
MDA	minimum detectable activity
MDC	Minimum Detectable Concentration
ml	milliliter
mm	millimeter
mrem	millirem
Mill Site	Northeast Church Rock Mill Site
Mine Site	Northeast Church Rock Mine Site
NECR	Northeast Church Rock
NIST	National Institute of Standards and Technology
NMAC	New Mexico Administrative Code
NRC	U.S. Nuclear Regulatory Commission
NMED	New Mexico Environmental Department
OSHA	Occupational Safety and Health Administration
pCi	picocuries

PPE	personal protective equipment
RA	Removal Action
RPP	Radiation Protection Program
RSO	Radiation Safety Officer
SOP	Standard Operating Procedure
TEDE	Total Effective Dose Equivalent
TLD	Thermoluminscent Dosimeter
µCi	microcuries per milliliter
µR	micro Roentgen

1.0 INTRODUCTION

This section describes the Radiation Protection Program (RPP) that will be implemented to provide radiation protection to workers, the general public, and the environment during the Removal Action (RA) associated with removing and transporting uranium ore impacted soil at the Northeast Church Rock Mine Site (Mine Site) to the Repository at the Church Rock Mill Site (Mill Site). Although the mine waste from the Mine Site will be disposed of in the Repository on top of the Tailings Impoundment, the disposal activities will not involve handling any byproduct material (tailings) during the RA. The Repository will be above the existing tailings radon barrier cover; that radon barrier cover will be scarified and compacted during the RA activities. This RPP complies with the Occupational Safety and Health Administration (OSHA) requirements 29 CFR 1910.1096 for exposure to ionizing radiation, which is based on US Nuclear Regulatory Commission's (NRC's) regulations of 10 CFR 20 (*Standards for Protection Against Radiation*) and New Mexico Administrative Code (NMAC) 20.3.4 (*Standards for Protection Against Radiation*). The RPP includes necessary radiation safety training, organization and responsibilities; occupational health physics monitoring for internal and external exposure assessment; and administrative and engineering exposure control measures and protection.

1.1 Radiation Safety Organization

The RPP will be implemented under the guidance of a radiation safety officer (RSO) for the Northeast Church Rock (NECR) and UNC Mill Sites. The RSO, or his site designee, will implement this plan and have the authority to stop work should radiation safety concerns arise. All employees, contractors, and visitors to the NECR Site will adhere to the RPP. All individuals involved with the construction work or other related activities onsite have responsibility for radiation safety. The RSO or his designee will have the primary responsibility for overseeing and implementing the RPP.

Supervisory personnel for GE/UNC: The Site Manager (SM), the Construction Supervising Contractor (CSC), and the Construction Contractor (CC), and any subcontractors used for the work have an important role in the radiation protection of their subordinates or other personnel working on site. The supervisory personnel will be responsible for ensuring that their subordinates and other personnel working for the CC are supplied with required radiation training and personal protective equipment. They shall ensure that the personnel under their supervision follow the rules and regulations of the RPP. Supervisors are also responsible for knowing the radiation hazard conditions and the need for radiation personal protective equipment (PPE) through necessary communications with the radiological staff. All individuals, including supervisors, working in the Exclusion or Controlled areas will be trained for radiation hazards and radiation safety. The CC's supervisors will immediately notify the RSO of any radiation hazardous condition observed by or reported to the contractors.

1.2 Worker Training

All workers in potentially impacted areas will attend a radiation safety training program. Emphasis will be placed on site-specific activities and radiological safety practices, including personal decontamination. The RSO will retain documentation of the training. The radiation safety training will include:

- General History and Site Overview
- Regulatory Overview
- Fundamentals of Radiological Protection
- Biological Effects
- Radiation Limits
- As Low As Reasonably Achievable (ALARA)
- Personnel Monitoring Program
- Radioactive Contamination Control

- Radiological Postings and Site Control
- Emergency Procedures

Site safety personnel also will conduct brief daily tailgate safety meetings (see Section L.7.1 of the Health and Safety Plan [HASP]) to discuss any safety issues that may concern onsite workers or the Radiation Safety Officer (RSO).

1.3 Standard Operating Procedures

Standard operating procedures (SOPs) for performing all major tasks associated with this plan have been developed and are attached to this plan. Major tasks include radiation surveys, airborne radioactivity measurements, respiratory protection, contamination control, equipment decontamination, access/egress control. The SOPs will be maintained onsite during the construction activities and revised as necessary.

1.4 As Low as Reasonably Achievable Policy

The project team is committed to keeping individual and collective radiation doses to ALARA levels and supports an administrative organization for radiation safety. The RPP will utilize, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are ALARA. The Site RSO will assess the radiation protection plan monthly. The RSO will review operating and maintenance procedures and equipment and facilities to reduce exposures to ALARA. In addition to maintaining doses to individuals as far below the limits as is reasonably achievable, the sum of the doses received by all exposed individuals will also be maintained at the lowest practicable level.

2.0 RADIATION DOSE LIMITS

The radiological hazard from uranium ore dust is from uranium and its decay products. The uranium ore presents a potential for exposure due to internal radiation hazards from alpha emitting radionuclides (U-nat, Ra-226, Th-230, and Rn-222 progeny) and external radiation hazards from gamma emitting radionuclides (primarily Pb-214 and Bi-214).

2.1 Occupational Dose Limits

The dose limits from occupational exposure to radiation at the Site are listed below.

a. The annual limit is the more limiting of:
   1. The total effective dose equivalent equal to 5 rems; or
   2. The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems.

b. The annual limits to the lens of the eye and to the skin are:
   1. An eye dose equivalent of 15 rems; and
   2. A shallow-dose equivalent of 50 rems to the skin or to any extremity.

2.2 Dose Limit to an Embryo/Fetus

The radiation dose limit to an embryo/fetus during entire pregnancy, due to occupational exposure of a declared pregnant woman, will be 0.5 rem (500 mrem). All female workers will be required to notify the RSO, in writing, of their pregnancy immediately upon knowledge or suspicion of such pregnancy. The RSO will review work assignments of any declared pregnant woman to assure that the embryo/fetus dose does not exceed the 0.5 rem limit and is maintained ALARA. If the dose equivalent to the embryo/fetus is found to have exceeded 0.5 rem (500 mrem) or is within 0.05 rem (50 mrem) of this dose, by the time the woman declares the pregnancy, the dose will be deemed to be in compliance with paragraph (a) of this section if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (50 mrem) during the remainder of the pregnancy.

2.3 Planned Special Exposures

Due to low levels of radioactivity associated with the uranium ore, planned special exposures will not be authorized at the Site.

2.4 Summation of External and Internal Doses

Summation of external and internal doses as specified in 10 CFR 20 and NMAC 20.3.4.406 is not likely to be required at the Site, because the doses from either the external or internal radiation exposures are not likely to exceed 10 percent of the limit. The construction activities at the Site involve excavation or disturbance of uranium ore impacted soil and material. Based on the site data from previous investigations and RA activities, it is very unlikely, with appropriate administrative and engineering controls, that during the construction activities any individual will receive an external radiation dose in excess of 10 percent of the limits, or an intake of radionuclides in excess of 10 percent of Annual Limits on Intake (ALIs) for uranium and its daughters. However, if surveys indicate that both the internal and external doses are likely to exceed 10 percent of the limit, one of the two methods will be used to demonstrate compliance with the limits:

- Summation of Internal and External Doses - If it is determined that both the internal radiation dose from air sampling measurements, and the external radiation dose from personal dosimeters, is likely to exceed 10 percent of the limit, the Committed Effective Dose Equivalent (CEDE) and Deep Dose Equivalent (DDE) will be summed. This will demonstrate compliance with Total Effective Dose Equivalent (TEDE). The internal radiation dose will be calculated as described in Section 5.0, and the external radiation dose will be assessed as described in Section 6.0.
- Summation of External Dose and DAC Hours - If routine air sampling and thermoluminescent dosimeter (TLD)

results indicate that the dose from either internal or external radiation exposure could exceed 10 percent of the limit, the summation requirements of internal and external radiation doses will be met. Compliance with this summation will be met if the sum of the DDE (mrem, as determined by personal dosimeters) divided by 5000 (mrem, TEDE) and the total number of Derived Air Concentration (DAC) hours for all radionuclides (as determined in Section 6.1) divided by 2000 does not exceed one. Based on average Ra-226 soil concentrations and average external radiation exposure rates, exposures are expected to be less than 10 percent of the limit for both external and internal exposures with adequate dust control during construction activities.

2.5 Determination of Prior Occupational Dose

If any individual at the NECR Site is likely to receive, in one year, an occupational dose in excess of 10 percent of the limit in Section 5.0, the RSO will determine the individual's prior occupational dose as follows:

- A determination will be made based on information on the nature and the amount of prior occupational dose disclosed in a signed statement from the individual, or from the individual's most recent employer, for work involving radiation exposure for the current year.
- An attempt will be made to obtain the records of life-time cumulative occupational radiation.

2.6 Radiation Dose Limits for Individual Members of the Public

The dose limits for individual members of the public will be consistent with NMAC 20.3.4.413 as follows:

- Total effective dose equivalent of 0.1 rem (100 mrem) per year to individual members of the public, exclusive of the dose contributions from background radiation; and
- Maximum dose rate of 0.002 rem/hour and 0.05 rem per/year in the unrestricted area from external radiation sources.

If any member of the public enters any controlled area, which is located outside the Exclusion Area, the above dose limits will apply.

3.0 SITE CONTROL

Site control is necessary to prevent unauthorized, untrained, or unprotected personnel from entering the site. Areas where construction activities associated with uranium ore impacted soils and material are conducted will be designated as the Exclusion and Controlled areas for the purpose of radiation protection. This RPP is developed to address radiation protection for Removal Action (RA) activities at the NECR Mine Site as well as associated activities in the tailings area of the NECR Mill licensed site. Access to these areas will be controlled for radiation protection. This measure will be taken to limit the spread of impacted materials and to reduce the radiation exposures to ALARA levels.

3.1 Designated Controlled Areas

The Mine Site RA area, which includes haul roads and a construction support area, will be designated as a Controlled Area.. Each area of the Mine Site within the Controlled Area may present a different type and extent of radiation hazard. Some areas will be designated as separate Exclusion Areas within the Controlled Area depending on the degree of potential for, and nature of, any exposure to radiation. Controlled areas are established to limit radiation exposures to visitors and the general public. The designation of an area and associated barriers, and necessary precautions will be established, changed, or removed. An Exclusion Area may be established outside the Controlled Area if a radiation hazard exists. Access will also be managed in any Exclusion Area outside the Controlled Area, and the occupational dose limit in this area will be the same as the limit for members of the public. The fenced NRC Mill licensed site is designated as the Controlled Area. The Repository work area and the evaporation pond area within the NRC licensed Controlled Area will be designated as a Restricted Area for protecting individuals against undue risks from exposure to radiation and radioactive materials during the implementation of construction associated with the Repository (the evaporation pond area is currently designated as a Restricted Area under the NRC license).

The NECR Mine Site RA presents an added component to the radiation protection to members of the public. The mine waste from the Mine Site will be hauled and consolidated into the Repository at the Tailings Impoundment. The mine waste haul road from the Mine Site to the Repository crosses public NM highway 566. The highway crossing will be controlled during haul operation. A traffic control signal system, as discussed in Appendix M, and other control measures and radiological surveys of the highway crossing will be implemented for radiation protection of members of the public during the haul operation. The highway crossing traffic signal system will stop public traffic while haul trucks are crossing and regularly reopen, stopping haul traffic and allowing public traffic to proceed. Control measures will include mud grates at each end of the haul road when leaving the Mine Site and the Repository. Once past the mud grates, the trucks would stop for a radiologic frisking and any loose contamination above the field screening level would be brushed or scraped from the trucks until they are determined by frisking to be below the screening level prior to leaving the Controlled Areas. Mud grates will also be located at the highway crossing. At the end of each haul work day, the highway crossing surface would be checked for any contamination. Any identified contamination in the crossing will be collected and moved to the repository for disposal. Accumulation of mud and dirt on the paved section of the crossing will be prevented. Any uncontaminated sediment or soils would be swept to the shoulder. Temporary gates will be installed to restrict haul road access when the crossing is not in use.

3.2 Radiation Areas

Based on the exposure rate levels at the NECR Site, a Radiation Area, where an individual could receive a whole-body radiation dose of 5 mrem per hour or 100 mrem during five consecutive work days, is not expected at the Site.

3.3 Airborne Radioactivity Areas

Any area where the airborne uranium ore dust (uranium and its decay products) exists in concentrations:

1. in excess of the 6 $x10^{-11}$µCi/ml; or
2. to such a degree that an individual present in the area without respiratory protective equipment could exceed, during a 40-hour work week, an intake of 0.6 percent of ALI or 12 total DAC hours (airborne concentration of 30 percent of DAC averaged over a 40-hour work week),

will be designated and posted as an “Airborne Radioactivity Area”.

Based on radionuclide levels, the work areas being outdoors, and with appropriate controls (dust control), airborne radioactivity areas are not expected during construction activities. However, if an area is designated as airborne radioactivity area, respiratory protective equipment will be provided for individuals in this area. Additional reasonable control measures will be implemented to lower airborne concentrations, since the respirator use should be the last resort for radiation protection. Time spent in these areas by each individual will be logged for exposure assessment.

3.4 Clean Areas

Any area where the radioactivity level is not high enough to require radiation protection may be designated as a “Clean Area”. The Clean Area will not exceed the surface radionuclide levels of 5,000 dpm/100 cm^2 averaged over one square meter, with a maximum level of 15,000 dpm/100 cm^2, not to exceed 100 cm^2 area for total alpha, and 1,000 dpm/100 cm^2 of removable alpha contamination. If any location, within the Controlled Area, meets the Clean Area criteria, that area may be designated as a Clean Area. Areas such as work break activities (eating, drinking, smoking, etc.) within the project Support Area will be maintained as Clean Areas. Each worker will be informed of Clean Areas during radiation safety training.

4.0 RADIOLOGICAL MONITORING

The RSO will conduct general work area monitoring to assess potential radiation exposures to workers and for planning purposes to verify that radiation exposures are ALARA. The two principal radiation exposure pathways are inhalation of long-lived airborne particulate radionuclides and direct gamma radiation from impacted soil and material. Airborne radon and the short-lived particulate radon progeny should not present a significant hazard because of the low levels of radionuclides in soil and because all activities will be performed outdoors.

Radiation monitoring instruments such as alpha scintillometers, gamma scintillometers, gamma radiation exposure rate meters and Geiger-Mueller detectors will be function-checked prior to use each day using appropriate check sources. The Site RSO will calibrate radiation monitoring equipment, including air samplers, annually unless damaged, in which case it will be sent for repair and replaced with another calibrated meter. Radiological field and laboratory analysis equipment will be calibrated using National Institute of Standards and Technology (NIST) traceable standards. Frequency of calibration will be on an annual basis by qualified personnel and using approved procedures. A background and function check will be made on each radiological instrument for each day of use.

All procedures used for radiation surveys and health physics monitoring will meet appropriate Lower Limits of Detection (LLDs) requirements and quality assurance program as defined in the NRC Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities,” and Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring”.

5.0 INTERNAL RADIATION DOSE ASSESSMENT

Internal radiation dose is received from intake of radioactive material, primarily alpha radiation emitters. The radionuclides of significance in the uranium decay series of the uranium ore at the Site which would result in committed dose equivalent are U-nat, Ra-226, Th-230, and Rn-222 progeny. If required, the internal radiation dose will be assessed in accordance with Section 5.1.

5.1 Internal Radiation Exposure from Inhalation

The internal radiation exposure in terms of DAC hours for radionuclide will be calculated as follows:

DAC hrs = (C/DAC) x h

Where:

C = area airborne concentration of radionuclide, microcuries per milliliter (µCi/ml)
DAC = DAC of radionuclide, µCi/ml
h = hours worked in the area

The DAC hours for all radionuclides will be summed to obtain total DAC hours. The DAC applicable to limiting exposure to airborne uranium ore dust in restricted areas is given in paragraph 3 of the Note to 10 CFR 20, Appendix B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage". For gross alpha counting of the air sample, the DAC value is 6 x 10^{-11} microcuries (µCi) of alpha activity per milliliter (ml) of air. This concentration applies to the alpha emissions of U-238, U-234, Th-230, and Ra-226. The uranium ore dust concentration is applicable to areas where only uranium ore, prior to chemical separation of the uranium from the ore, is handled. Therefore, the DAC hours calculated for gross alpha activity of uranium ore dust DAC for the Site will include all alpha emitting radionuclides (U-238, U-234, Th-230, and Ra-226).

5.2 Internal Radiation Dose from Inhalation

The Committed Dose Equivalent (CDE) to any organ (bone surface and lungs) and CEDE will be calculated using the following equation if an individual is likely to receive Intake in excess of 10% of the Annual Limit of Intake of 1.44E-01 uCi for uranium ore dust (equivalent to 6.0E-11 uCi/ml DAC):

CDE, mrem = C x h x IR x f

Where:

C = area airborne concentration, µCi/ml
h = hours worked in the area
IR = inhalation rate, 1.2E+06 m^3/hour
f = exposure to dose conversion factor, mrem/µCi

The radionuclide exposure to dose conversion factor (f) from Table 2.1 of the International Committee on Radiation Protection (ICRP), Publication 30 (ICRP 30) will be used. The most restrictive (conservative) factor (f) of the lung clearance class (D, W, or Y) will be used for dose calculations.

Following are the factors (f) listed in ICRP 30 for CEDE for stochastic effect that will be used for calculations:

Ra-226 (W): 8.58E+03 mrem/µCi
Th-230 (W): 3.26E+05 mrem/µCi

U-nat (Y): 1.25E+05 mrem/µCi

There is no conversion factor listed in ICRP 30 for Rn-222 progeny. The CEDE will be calculated on the basis that the intake of one ALI (100 µCi) is equal to 5,000 mrem CEDE. The CEDE from all of the above radionuclides will be summed as total CEDE.

The most highly exposed organ from intake of insoluble uranium and Ra-226 are the lungs and the bone surface from intake of Th-230. The CDE to the bone surface from the inhalation of uranium and Ra-226, according to ICRP 30 is insignificant. The CDE to the bone surface from the inhalation of insoluble uranium is less than the CEDE. The factors (f) listed in ICRP 30 that will be used for the calculation of CDE, non-stochastic dose, to the bone surface and lungs are as follow:

Ra-226 (W) = 5.96E+04 mrem/µCi
Th-230 (W) = 7.99E+06 mrem/µCi
U-nat (Y) = 1.04E+06 mrem/µCi

The CDE from Ra-226 and U-Nat for the lungs will be summed to demonstrate compliance with the organ limit. Thorium compounds in uranium ore dust are likely to be insoluble oxides. About 97% of insoluble Th-230 is excreted following inhalation exposure by exhalation and through excretion into the intestines by ciliary clearance. Therefore, Th-230 is not included in the dose calculations.

5.3 Oral Ingestion and Skin Absorption

Intake of uranium and its daughters, through oral ingestion and skin absorption could be received during break activities (eating, drinking, smoking, chewing, etc.) and from contact with uranium ore dust by individuals. During any construction activity, if potential exists for oral ingestion and skin contact of uranium ore dust, appropriate PPE (such as coveralls and gloves) must be used.

All individuals will be provided with Clean Areas for break activities. All Clean Areas will be equipped with a water supply where all individuals will wash their hands prior to any break activity. These Support Area facilities will be maintained to assure that they meet the radionuclide level criteria for Clean Areas.

All personnel will be frisked for radiological contamination prior to leaving the controlled area or contacting potentially impacted soil at the Site. A portable alpha radiation detector or a beta/gamma detector will be used for personnel contamination monitoring. Construction personnel will remove contaminated PPE (such as gloves, boot covers, and coveralls). Disposable PPE will be placed in a designated radioactive waste container for disposal as radioactive waste. Non-disposal PPE or work clothing will be removed prior to entry into the decontamination area for later reuse. The contamination limit for skin and clothing shall be 1,000 dpm of gross alpha radiation activity per 100 cm^2.

Personnel will clean any skin with a contamination reading above the 250 dpm/10 cm^2 exposure control and ALARA limit by washing the affected area. The RSO will re-survey the affected area following washing to confirm no contamination remains. Skin contamination is easily removed by washing with soap and water.

5.4 Surveys and Monitoring for Internal Radiation Exposure

As discussed previously, the internal radiation dose is not likely to exceed 10 percent of the limit. However, area air sampling will be performed for airborne gross alpha activity from uranium and its daughters (U-nat, Ra-226 and Th-230). The frequency of air sampling will be established in SOPs based on soil radionuclide levels and any previous airborne concentrations during comparable activities.

Individual DACs for uranium and its alpha emitter daughters, as specified in Table 1, of Appendix B, 10 CFR 20 are listed below:

U-nat 2.0E-11 µCi/ml

U-238	2.0E-11 µCi/ml
U-234	2.0E-11 µCi/ml
Th-230	6.0E-12 µCi/ml
Ra-226	3.0E-10 µCi/ml

The long lived gross alpha activity in the uranium decay chain is made up primarily of U-nat (U-234 and U-238), Th-230 and, Ra-226. A conservative approach for radiation protection is that all of the airborne gross alpha activity from construction activities associated with uranium ore is from U-234 and U-238, Th-230 and Ra-226. Since RA activities at the NECR Site will be associated with handling only the uranium ore impacted material, the DAC for gross alpha activity of uranium ore will address all alpha emitters.

If needed, individual airborne concentrations for U-nat, Ra-226, and Th-230 will be determined. It is not practical in the field to perform isotopic analyses for U-238, U-234, Ra-226, and Th-230 on the routine occupational airborne particulate sample filters. The airborne concentration of U-nat, Ra-226, and Th-230 can be determined from their activity fraction of the gross alpha activity of uranium ore dust material which has the potential for becoming airborne. Since these radionuclides (U-234, U-238, Ra-226, and Th-230) are in secular equilibrium in uranium ore dust, their airborne concentrations will be determined by multiplying the airborne gross alpha activity by 0.25. Secular equilibrium of U-238, U-234, Ra-226, and Th-230 in uranium ore waste at the NECR is supported by analysis of U-nat and Ra-226 analytical results for 375 surface and subsurface soil samples collected during the RSE activities and performed by vendor laboratory. The soil sample results, and U-238, U-234, Ra-226, and Th-230 fraction calculations are discussed in Attachment 5 to this plan.

Based on the assumption that U-238 is in secular equilibrium with its decay product in uranium ore, an airborne gross alpha activity limit of 2.4E-11 µCi/ml would assure that the Th-230 DAC of 6.0E-12 µCi/ml, lowest of the four radionuclides, is not exceeded. For a mixture of radionuclides, the sum of the fractions of the concentrations divided by the respective DACs need be equal to or less than unity. Since the mixture of radionuclides U-234, U-238, Th-230 and Ra-226 in uranium ore being in equilibrium, activities of all four radionuclides will be equal. Therefore, if the airborne gross alpha activity from uranium ore is equal to or less than 1.48E-11 µCi/ml, the sum of the fractions of the radionuclide concentrations divided by their respective DACs will be equal to or less than unity. Therefore, airborne gross alpha activity of 1.48E-11 µCi/ml will be used as action level at the NECR Site for radiation protection for activities associated with mine site material.

5.4.1 Work Area Air Sampling Using RAS Sampler

The RSO or the Radiation Safety Technician (RST) will collect work-area airborne particulate samples using an appropriate intermediate volume air sampler with a flow rate of approximately 50 liters per minute (lpm). Samples will be collected on 47-mm glass fiber filters installed in the air samplers. The sampling station will be located at a point as near to the workers as practical and will be changed as the work tasks and other factors change. Considerations for locating the sampler include the prevailing wind direction, site activities, and soil radionuclide level. Air samples will be collected at a height of 1 to 1.5 m above ground level in locations free from unusual micrometeorological or other conditions that could result in artificially high or low concentrations. General work-area air monitoring will be performed during intrusive work or when the site activities can create airborne radioactivity.

A short sampling period would be required to measure radionuclides in air at DAC-levels, because the flow rate of these samplers is approximately 50 lpm. Based on a flow rate of about 50 lpm, along with counting sample filters for 30 minutes using an alpha counter with a background counting rate of 20 counts per hour and an efficiency of about 30 percent would provide Minimum Detectable Concentration (MDC) of below 5.0×10^{-12} µCi/ml, less than 10 percent of the gross alpha DAC. The filters will be counted for gross alpha activity using the alpha tray counter after the filters have been aged sufficiently, at least 72 hours for radon progeny decay. An initial count may be performed after the sample filter has been aged for 24 hours for information and exposure control.

5.4.2 Work Area Air Sampling Using Lapel Sampler

If the RSO determines that there is a potential for airborne gross alpha activity to exceed 10 percent of the DAC for gross alpha activity, an individual of the group having the potential for the greatest exposure in the work area will be equipped with a personal air sampler. Airborne concentration measurements from the personal air sample will be used to determine the exposure of individuals in that area.

A lapel sampler (MSA Air Sampler or equivalent) with a flow rate of approximately 1.5 to 2 lpm and a 37-millimeter (mm) filter cassette with a Type A/E glass fiber filter will be used. The RSO will analyze the effectiveness of the lapel samplers as follows. The samplers are assumed to be operating for an 8-hour day, resulting in 960 liters of air being pulled through the filter. The sample will be removed and counted 12 or more hours later, after the radon-222 progeny have decayed. A final count will be made after four days when most of the radon-222 progeny has decayed. Gross alpha emissions will be counted on Ludlum Model 2929/Ludlum Model 43-10-1 tray counters. These counters have an alpha background count rate of less than 10 counts per hour and an efficiency of approximately 0.4 counts per minute (cpm) per dpm for thorium-230. This corresponds to a minimum detectable activity (MDA) of 0.5 dpm or an MDC of 1.0×10^{-12} µCi/ml, less than 10 percent of the gross alpha DAC for the lapel sampler under the assumed conditions.

Work area air sampling will be performed on three days for the first week (1st, 3rd, and 5th day) of RA activities associated with handling of mine waste. Air sampling will also be conducted at the background (upwind) location. If the work area net airborne concentrations are less than 10 percent of DAC for gross alpha activity, the work area air sampling will be continued at a rate of once per week. If the work area airborne concentrations are greater than 10 percent of DAC, personal air sampling will be conducted (an individual of the group having the greatest potential for exposure in the work area will be equipped with a personal air sampler). The personal air sampling frequency will remain at three days per week as long as the net airborne concentrations are greater than 10 percent and less than 30 percent of the DAC. When the airborne concentrations decline below 10 percent of the DAC as a result of implementation of necessary control measures, the air sampling frequency will be reduced to once per week.

5.4.3 Work Area Radon Monitoring

It is not anticipated that the radon or radon progeny concentrations will be significant because of the low levels of Ra-226 in soil and because the work is being conducted outdoors. The winds should disperse the radon and progeny to levels much below concern for worker protection. If needed, track etch radon monitors will be utilized for airborne radon and radon progeny concentrations.

5.4.4 Bioassays

As discussed previously, internal exposures from airborne ore impacted soil are expected to be less than 10 percent of the intake limit from the construction activities associated with low levels of radionuclides in soil (average of about 35 pCi/gm Ra-226) and adequate dust control. In addition, uranium in ore is not sufficiently soluble for Bioassay (urinalysis) to be an effective monitoring method. Bioassay (urinalysis) sampling is not planned for the current work. However, bioassay will be performed for uranium analysis for intake assessment for any individual exposed to an airborne uranium concentration of 30 percent of DAC averaged over a 40-hour work week. Since entrance bioassays are not performed, the baseline uranium level will be considered zero.

5.5 Exposure Control

All individuals will be instructed in procedures necessary to minimize the intake of uranium and its daughters. Clean Areas will be designated within the work areas during break activities such as eating, drinking, smoking, or chewing.

Exposure controls will be achieved through personal monitoring, evaluation of radiological hazards, and PPE. Exposures will also be controlled by using engineering control measures to minimize airborne particulate concentrations. Some of the control measures that may be used when needed include:

- Applying water to areas to be excavated
- Spraying water during excavation and material handling operations
- Modifying or stopping work during windy conditions (presence of visible dust)
- Controlling locations of work stations relative to wind direction
- Conducting intrusive work during low wind conditions (normally in the morning)

5.6 Respiratory Protection

As discussed above, airborne exposures through inhalation will be controlled by using engineering control measures, such as keeping the ore impacted soil moist by spraying water to minimize airborne particulate concentrations. Respiratory protection will not be used during routine construction activities. Respiratory protection will only be used during corrective actions for lowering airborne concentrations. Construction personnel working where airborne concentrations of uranium ore dust in the work area exceed that defined as an “airborne radioactivity area will wear air-purifying respirators. The respiratory protection program will comply with 10 CFR 20. Other acceptable methods meeting the requirements include limiting exposure times and controlling access.

5.7 Administrative Control Limits

To prevent any inadvertent overexposure, the administrative control limit for airborne radioactive material is established at 25 percent of the DACs. This control limit will be used as an action level to implement any necessary control measures.

5.8 Compliance with Dose Limits for Individual Members of the Public

As discussed previously, due to low levels of radionuclides and adequate control measures any significant offsite airborne release of impacted dust is unlikely. Airborne particulate radionuclides will be monitored at the downwind boundary to assess dose for individual members of the public as described in the Dust Control and Air Monitoring Plan (Appendix Q of the 95% Design Report). The airborne concentration of U-nat, Ra-226, and Th-230 will be determined from their activity fraction of the gross alpha activity of uranium ore, which has the potential for becoming airborne. Since these radionuclides (U-234, U-238, Ra-226, Th-230 and Po-210) are in secular equilibrium in uranium ore dust, their airborne concentrations will be determined by multiplying the airborne gross alpha activity by 0.20. Eberline RAS-2 air samplers or an equivalent air sampler, with 47-mm Type A/E glass fiber filters will be used to evaluate airborne concentrations. Air filters will be counted onsite for gross alpha activity, which will be compared to the limits.

Compliance with dose limits for individual members of the public will be demonstrated. The 10 CFR 20.1101(d) ALARA constraint on air emissions of 10 mrem per year to members of the public likely to receive the highest dose will be demonstrated by comparing the net annual average airborne concentrations at the Mill Downwind air monitoring station or at the Mill Downwind Nearest Residence air monitoring station to 20% of the effluent concentration limits. The following are the applicable effluent concentration limits:

U-nat:	9.0E-14 µCi/ml
Ra-226:	9.0E-13 µCi/ml
Th-230:	3.0E-14 µCi/ml
Po-210	9.0E-13 µCi/ml
Rn-222:	1.0E-10 µCi/ml (“with daughters present”)

6.0 EXTERNAL RADIATION DOSE ASSESSMENT

Uranium ores pose a potential for a deep dose from exposure to external radiation sources from gamma emitting radionuclides of the uranium decay chain, primarily Bi-214 and Pb-214. The shallow dose (skin dose) from exposure to beta radiation from uranium ore and tailings material is insignificant because of low concentrations of beta emitting radionuclides, and self-absorption of beta radiation in the uranium ore matrix.

6.1 Monitoring for Occupational External Exposure

All individuals, including workers, vendors, and visitors in the work areas will be monitored for exposure to external radiation. The RSO will take exposure rate measurements in the work areas using a Ludlum Model 19 µR meter or equivalent. RSO will produce site exposure-rate maps to guide construction activities toward minimizing radiation exposure.

The RSO will issue personal dosimeters, such as Luxel+ OSL dosimeter, to all construction personnel to monitor their external exposure. The dosimeter processor will be NVLAP accredited. Construction personnel will wear the dosimeter under protective clothing to prevent possible impacts of the dosimeter from dirt or airborne dust. All dosimeters, as well as controls, will be placed in the Support Area when not in use. Personal dosimeters will be provided and read quarterly.

6.2 Monitoring for External Exposure to General Public

Direct gamma radiation exposure rate measurements will be used at the NECR Site perimeter upwind and downwind boundary to determine external radiation exposure to the public. In addition, periodic direct gamma radiation exposure rate measurements will be performed at the mine waste haul road and the NM highway 566 crossing for radiation protection to the public.

6.3 Exposure Control

Based on the average gamma radiation exposure rates, the external radiation doses during construction activities are expected to be less than 10 percent of the limit. To control external radiation exposures, access to the Exclusion and Controlled areas will be restricted. Personal monitoring, area radiological hazard evaluations and PPE will be used to control exposures. The administrative control limit for external exposure is set at 25 percent of the limit.

There is no area or source at the NECR Site where the exposure rate is high enough that an individual will receive a dose equivalent to 0.1 rem (100 mrem) in one hour. Therefore, there is no “high” or “very high” radiation areas at the NECR Site.

7.0 RELEASE OF EQUIPMENT AND MATERIAL

Materials and equipment used for excavation and handling of impacted soil will be monitored for contamination prior to release to the unrestricted area. An alpha scintillation detector, coupled to a ratemeter, will be used to scan or make static counts on potentially impacted items. Removable contamination monitoring will also be performed for equipment and material when the total contamination levels are measured above the removable contamination level. The RSO will wipe an area of 100 cm^2 with a dry filter or soft absorbent paper while moderate pressure is applied. At least one wipe sample will be collected from each item. The RSO will collect wipe samples for removable contamination from all one square meter areas in large items where direct readings indicate that the removable limit may be exceeded. The wipe samples will be counted for gross alpha using the Ludlum Model 2929/Ludlum Model 43-10-1 alpha-beta tray counter or equivalent. The counting time will be adjusted to produce an MDA of 50 percent of the applicable limit.

Any equipment or material with contamination level above the limits specified in the NRC Regulatory Guide 8.30 (as listed in the table below) will be decontaminated. There also is a requirement to reduce surface contamination to ALARA levels below the limits. Items that cannot be decontaminated to ALARA levels below these limits will be considered radioactive waste and disposed of accordingly.

Nuclide	Acceptable Surface Contamination Limits		
	Total Average	Total Maximum	Removable
Natural uranium, uranium-235, uranium-238, and associated decay products	5,000 dpm alpha / 100 cm^2	15,000 dpm alpha / 100cm^2	1,000 dpm alpha / 100 cm^2

If decontamination is required, the following procedures will be implemented:

- Equipment or material will be decontaminated in the designated area
- The method of decontamination shall be based on the type and extent of contamination of the equipment or material
- Decontamination shall be achieved by wet methods, such as high pressure water, steam cleaning, or wet scrubbing of elevated areas, to minimize airborne radioactive materials

All decontaminated equipment or material will be allowed to dry prior to the surface contamination survey. Equipment or material will be released only after it has been surveyed for contamination.

All expendable material (such as disposable coveralls, gloves, towels) generated during construction activities has the potential to be impacted from uranium ore dust. These materials will be disposed in designated disposal areas at the NECR Site.

8.0 INCIDENTS, NOTIFICATION REQUIREMENTS AND RECORDS

The Site RSO will thoroughly document all incidents. Incidents will be reported as required by 10 CFR 20.

Before the project starts, the RSO, SM, SSO, CC and CSC will coordinate with the applicable response organizations to properly treat potentially contaminated victims in the event of an accident. McKinley Christian Hospital in Gallup, NM is equipped to accept radiologically contaminated victims and will be the designated hospital for medical treatment. Industrial accident victims will be monitored and decontaminated, if necessary, prior to leaving the site only if their injuries are not life threatening and decontamination will not affect the injury. A RST, the Site RSO, or the SM will accompany the victim for treatment to facilitate communication with medical response personnel.

Any events that require reporting will be reported by the RSO or his designee through the CSC, and the appropriate regulatory agencies. In non-emergencies, federal or state agencies will not be contacted. Immediate reporting is required when a loss of control of radioactive material that presents a real or potential hazard to off-installation populations, such as:

- Loss of control of radioactive material that presents a threat to life or health.
- Any event, such as fire, explosion, or toxic gas release, involving radioactive material that prevents taking the immediate protective actions needed to avoid exposures to radiation or radioactive material, or to avoid releases of licensed or permitted material, above regulatory limits.
- Any unexpected event involving radioactive material or radiation exposure deemed serious enough to warrant the interest or action of officials or agencies. This includes:
    - Events that may cause inquiries by the public or press
    - Events requiring immediate OSHA, NRC, and/or New Mexico Environmental Department (NMED) notification

Any event that causes a significant reduction in the effectiveness of any authorized shipping package during use. The Site RSO will detail the defects and their safety significance, explain how the defects were repaired and detail the plan to prevent their recurrence.

Although highly unlikely at the NECR Site, immediate notification to the Assistant Secretary of Labor or their duly authorized representative, for employees not protected by the NRC by means of 10 CFR part 20; or State of New Mexico Regulations NMAC 20.3; is required by telephone (1-800-321-6742) or online at www.osha.gov is required for incidents involving radioactive material that can or has caused the following exposures:

- 25 rem TEDE
- 75 rem effective dose equivalent (EDE)
- 250 rem SDE
- Potential intakes of 5 times the ALI in 24 hours

Likewise, unlikely at the NECR Site, twenty-four-hour notification is required for incidents involving radioactive material that can or has caused the following exposures:

- 5 rem TEDE
- 15 rem EDE
- 50 rem SDE
- Potential intakes exceeding the ALI in 24 hours

Written notifications will be submitted within 30 days to the Assistant Secretary of Labor or their duly authorized representative, for employees not protected by the NRC by means of 10 CFR part 20 or State of New Mexico Regulations, for the following:

- Doses exceeding occupational limits for adults
- Doses exceeding occupational limits for an embryo/fetus
- Doses exceeding license limits
- Levels of radiation or concentrations of radioactive material in the exclusion area exceeding applicable license limits
- Levels of radiation or concentrations of radioactive material in unrestricted areas exceeding 10 times applicable license limits

Records of the RPP implemented during construction activities will be maintained by the RSO. The records shall include surveys and calibrations, individual monitoring results, prior occupational doses, special exposures, dose to public, notifications of incidents, reports to individuals and any planned special exposures.

FIGURE

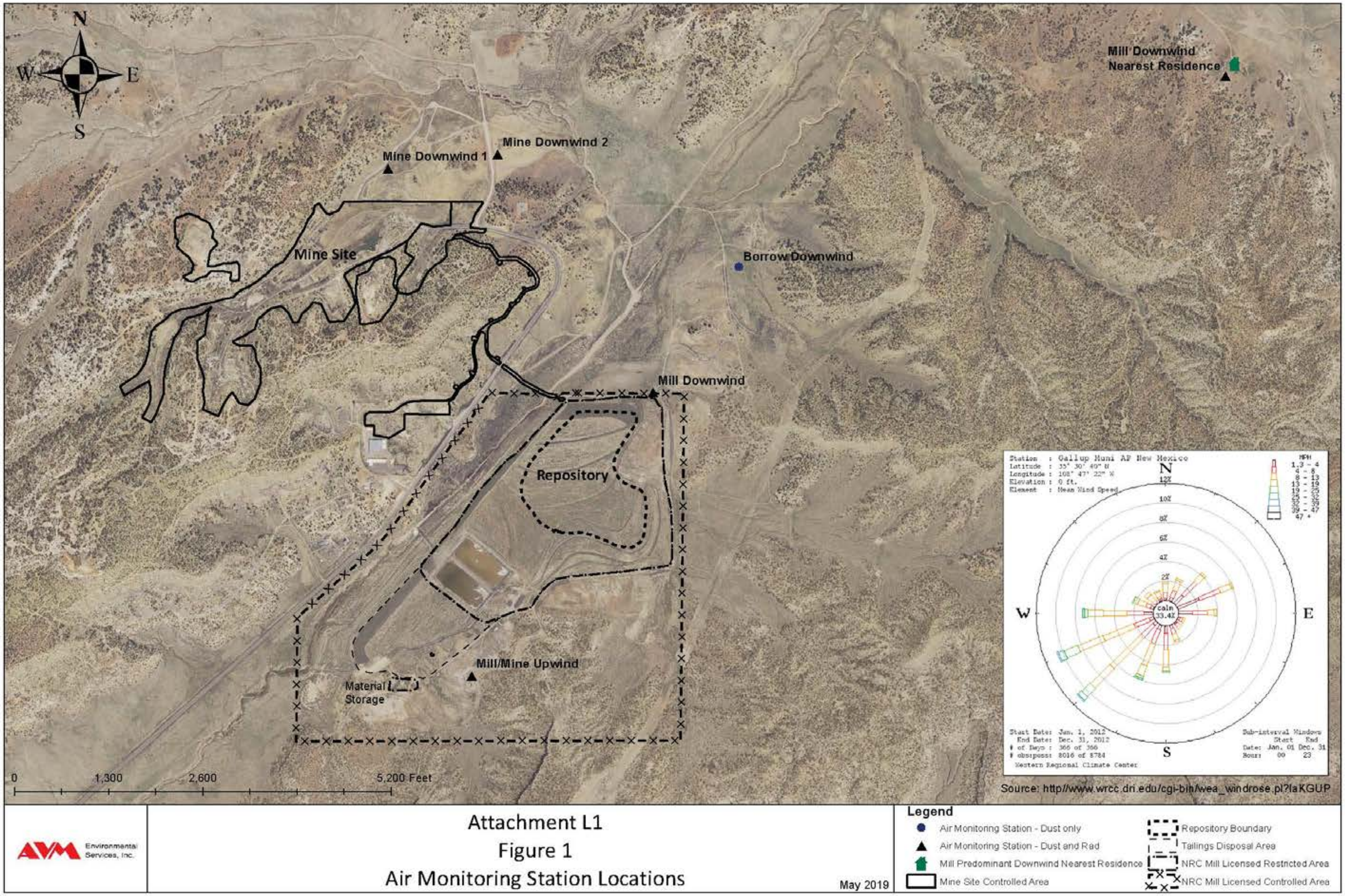

Figure 1: Air Monitoring Station Locations

ATTACHMENTS 1 TO 4

STANDARD OPERATING PROCEDURES

(TO BE UPDATED BY CONTRACTOR PRIOR TO BEGINING OF CONSTRUCTION)

RPP SOP-1
Gamma Radiation Exposure Rate Survey
UNC NECR RA Radiation Protection Program

1.0 SCOPE

This procedure will be used to measure gamma radiation exposure rate for radiation protection and may be used during characterization and remedial action at uranium mine and mill tailing sites.

2.0 EQUIPMENT AND MATERIALS

2.1 A vendor calibrated Micro-R-Meter (Ludlum Model 12S, Ludlum Model 19 or Eberline PRM-7.

2.2 Map of survey areas, ink pen and appropriate field survey Forms to record survey readings and notes.

3.0 INSTRUMENT CONFIGURATION & OPERATIONS

The gamma exposure rate survey will be performed using Micro-R-meter (µR meter) for radiation protection and exposure rate characterization at uranium mine and mill tailings mill sites. The µR meters are totally configurated (consisting of 1x1 NaI detector and ratemeter) exposure rate measurement equipment. Micro-R-Meter, such as Ludlum model 12S. Ludlum Model 19 or Eberline PRM-7 contain a 1x1 NaI detector. Prior to any instrument function check or the operation, the technician will read the Technical Manual for the instrument operations.

3.1 Instrument Function Check

An operational function check will be performed on the µR meters each day prior to any field surveys. Calibration date for the instruments must be within one year. If not, the instrument must be calibrated with a certificate in file. The function check will be performed in field office. The following function check procedures will be used and the pertinent information recorded on the Function Check Form (Attachment A or equivalent).

3.1.1 Visual Inspection

Perform a visual inspection of the instrument, checking for signs of any damage.

3.1.2 Calibration Due

Verify calibration validity of instruments. Calibration date for the instruments must be within one year.

3.1.3 Battery Charge

Assure that the meter battery is functional. The meter indicator should be within “Battery OK” position.

3.1.4 Background Exposure Rate

The background exposure rate measurement will be performed at the designated location in the field office. A location will be designated in the field office for obtaining the required daily function check. Keep all beta/gamma radiation sources away from the detector while performing the background check. The background function check exposure rate readings must be within 20% of the background counts obtained following calibration at same location.

3.1.5 Source Function Exposure Rate

Obtain the gamma radiation source, (1% U_3O_8 ore standard sealed in a red can marked Function Check Source" or Cs-137 check source). The function check source was used to determine the acceptable count range for the µR meters immediately following calibration. Place the source at the same location on the µR meter (circle drawn on front of the meter) to obtain the source function check reading following calibration. Select appropriate scale and wait about 10 seconds for reading to stabilize. The source function check reading must be within 20% of the source reading following calibration.

3.1.6 Technician

After completing the function check, initial in the column marked TECH of the Function Check Form (Attachment A).

4.0 FIELD GAMMA RADIATION SURVEYS

The gamma radiation exposure rate survey will be conducted as either scan survey (walkthrough) or static survey (stationary) measurements.

4.1 Scan Exposure Rate Survey

Scan exposure rate surveys (walkthrough surveys) will be performed by walking with the µR meter/detector at waist high from the ground surface with the meter response in "FAST" Mode and audio speaker ON to determine exposure rate range and identify and locate any hot spots within an area.

4.2 Static Radiation Survey

Static exposure rate surveys will be performed at any point or location of interest. The µR meter/detector will be held at about waist high from the ground surface with the µR meter response in "SLOW" Mode, and allowing at least 10 seconds to stabilize and taking a reading for that point or location.

Record the exposure rate survey data in the Exposure Rate Survey Field Form (Attachment B)

5.0 ATTACHMENTS

Attachment A	µR meter Function Check Form
Attachment B	Exposure Rate Survey Field Form

Attachment A

AVM Environmental Services, Inc.
Micro R Meter Function Check Form

Micro R Meter: ____________________

Function Check Source ID: ________________

Function Check @ Calibration ___________________________
Acceptable Function Check Reading (uR/hr) Range (20%) __________________ to ____________________

Date	Physical Check	Cal Date	Battery[1] Volts or OK	BKG Reading uR/hr	Source Reading [2] uR/hr	Within Acceptable Range Y or N	Cal Due	Tech

Note: (1) Battery Voltage must be within BAT TEST Range (2) Function Check Source must be placed in the circle on the front side of the meter

Attachment B
AVM Environmental Services, Inc.
Exposure Rate Survey Field Form

Instrumentation :____
Instrument Calibration Date: ____________________, Instrument Daily Function Check Performed: __________

Survey Area/Unit Description
____

Survey Date/Time	Survey Area/Location ID/Description	Exposure Rate (uR/hr)	Comments/Notes

RPP SOP-2
OCCUPATIONAL AIRBORNE RADIOACTIVE PARTICULATE MONITORING
UNC NECR RA Radiation Protection Program

1.0 SCOPE

1.1 Purpose

This procedure describes two techniques for determining the concentration of airborne radioactive particulate. The techniques differ only in sample collection; the analytical technique for determining the concentration from the filter media is the same for either sample collection method. The procedure is intended to:

1.1.1 Demonstrate compliance with the intake limits for workers specified in the Radiation Protection Program.

1.1.2 Meet the posting requirements for airborne radioactivity areas specified in the Radiation Protection Program.

1.1.3 Determine whether precautionary measures such as process or engineering controls, increased surveillance, limitation on working times, provision of respiratory protective equipment, or other precautions should be considered to meet the Radiation Protection Program.

1.1.4 Determine whether exposures to radioactive materials are being maintained As Low As Reasonably Achievable (ALARA) as stated in the Radiation Protection Program.

1.2 Applicability

This procedure applies to all personnel under Radiation Safety Officer (RSO) supervision performing airborne particulate monitoring at uranium mine and mill tailings sites.

2.0 REFERENCES

2.2 Portable Instrument/Survey Record Procedure for Field Projects.

2.3 10 CFR 20, "Standards for Radiation Protection"

2.4 NRC Regulatory Guide 8.30, Health Physics Surveys in Uranium Mills

2.5 NRC Regulatory Guide 8.25, Calibration and Error Limits of Air Sampling Instruments for Total Volume of Air Sampled.

3.0 EQUIPMENT AND MATERIALS

3.1 Air Sampler: Either Area, Breathing Zone, or High Volume

3.2 Particulate Filters GF A/E (37mm or 47mm, to fit air sampler), Envelopes for Filter Storage or Petri dishes.

3.3 Alpha radiation Counting Instrument (Ludlum 2929)

3.4 Air Particulate Sampling Survey Report/Form (Appendix A or equivalent).

4.0 AIR SAMPLE COLLECTION INSTRUCTIONS

4.1 Area Air Samples

4.1.1 Select a calibrated Regulated Air Sampler (RAS-1). Install a 47mm diameter filter in the filter head.

4.1.2 Select a suitable location for sampling. The location chosen is based upon an evaluation of the operation being performed. The ideal location would approximate the breathing zone of a worker and would be between the source of the potential airborne material and the location of the worker(s).

4.1.3 Determine the time and flow rate necessary to sample a volume sufficient to ensure that a required Lower Limit of Detection (LLD) will be met.

4.1.4 Turn on the air sampling unit, adjust the flow rate to a calibrated value, and record the starting time, flow rate, vacuum and initials of the technician.

4.1.5 Record the exact location of the air sampling unit and the nature of the work being performed. Record any other pertinent comments.

4.1.6 Periodically check air sampler unit for proper operation.

4.1.7 After the minimum collection time to meet the LLD requirement in Step 4.1.3, record ending flow rate, vacuum and time, and turn off the air sampling unit. Remove the air filter and place in sample envelope or Petri dish and label it.

4.2. Lapel (Personal) Samples

4.2.1 Select a calibrated lapel air sampler and install a 25mm diameter filter in the filter cassette head. Install the cassette into the cyclone.

4.2.2 Determine the time and flow rate necessary to sample a volume sufficient to ensure that an adequate LLD is obtained. Due to the low flow rate of lapel air sampling pumps, it is usually necessary to operate the pump for a longer period of time then the RAS-1 pumps. A two (2) to eight (8) hour sample, if possible, is preferable.

4.2.3 Select a worker of a ground with a highest potential for exposure to airborne materials. Instruct the worker regarding the wearing of the lapel sampler. Ensure the filter head is positioned in the breathing zone.

4.2.4 Record the name of the worker and the nature of the work being performed. Record any other pertinent information.

4.2.5 Turn on the air sampling pump, adjust the flow rate to a calibrated value, and record the start time, start flow rate, and initials of the issuing technician.

4.2.6 Periodically, check the work area and air sampling unit for proper monitoring and operation.

4.2.7 Record the ending flow rate and ending time, and turn off the air sampling unit. Remove the air filter and place it in the sample envelope or Petri dish.

NOTE: Any period of time which the sampler is left running outside work area (e.g. during lunch break) shall be deducted from the total run time used in calculating airborne concentrations.

5.0 COUNTING INSTRUCTIONS

5.1 An initial 24 hour decayed count may be performed for informational purposes. Allow a minimum of 72 hours from the end of sample collection before counting sample (to allow for decay of interfering short-lived radon daughters) as appropriate. The MDC/LLD should be less than 10% of 6.0E-11 µCi/ml DAC for gross alpha for the final counting of the sample.

5.2 Count the samples per Reference 2.1

5.3 Record the results per Reference 2.1

6.0 RECORDS

All forms generated as a result of this procedure shall be maintained throughout the duration of the project and then retained in the permanent project file.

UNC NECR RA Radiation Protection Program
AIR PARTICULATE SAMPLING FIELD DATA SHEETS

Sample #/Dish #____________________ Date:____________________________

SOP:______________________________ Field Tech:________________________

Area/Location/Assigned to:____

____

Sampler Used:_______________________ Filter Used:_______________________
Sampler Serial #:_____________________ Vac./Roto. Rdg(start)_______________
Sampling Rate(SR):________________LPM Vac./Roto. Rdg(stop)_______________

Time Start:____________Stop:____________ Elapsed(E):_____________(min)
Volume of Air Sampled____(ml) (SR x E x 1000)

Initial Count

Alpha Counter_________________________, Efficiency__________________ Bkg.__________________

Count Date and Time____________________________
Alpha Counts____________________________, Count Time____________________________________
Bkg. Counts_____________________________, Count Time____________________________________
Gross Alpha_____________________________ µCi/mL MDC______________________________µCi/mL
% DAC_________________________________

Final Count

Alpha Counter_________________________, Efficiency__________________ Bkg.__________________

Count Date and Time____________________________
Alpha Counts____________________________, Count Time____________________________________
Bkg. Counts_____________________________, Count Time____________________________________
Gross Alpha_____________________________ µCi/mL MDC______________________________µCi/mL
% DAC_________________________________

Gross Alpha Activity, µCi/ml = (Gross cpm–Background cpm)(FA*) / FE** x 2.22E+6 (dpm/µCi) x Eff (cpm/dpm) x Sample Volume (ml)

Estimated Error (uncertainty 95%), µCi/ml = 1.96 x (FA*) x [(Gross cpm/t min,Gorss)+(Bkg cpm/t, min Bkg)]$^{0.5}$ / FE** x 2.22E+6 (dpm/µCi) x Eff (cpm/dpm) x Sample Volume (ml)

MDC, µCi/ml = (2.71+3.29) (FA*) x [BKG cpm x Gross Count Time, min (1+ Gross Count Time, min/BKG Count Time, min)]$^{0.5}$ / FE** x Air Sample Volume (ml) x Counter Eff (cpm/dpm) x 2.22E+6 (dpm/µCi) x Gross Count Time (min)

*Filter Absorption (FA) = 1.25 for glass fiber filters and 1.0 for Cellulose nitrate filters; ** FE = Fractional filter efficiency

RPP SOP-3
SURFACE CONTAMINATION SURVEYS
UNC NECR RA Radiation Protection Program

1.0 SCOPE

1.1 Purpose

This procedure describes general methods and techniques to be used when performing surface contamination surveys. Contamination surveys are performed and documented to demonstrate compliance with regulatory surface contamination limits and to determine:

- Protective clothing and respiratory protection requirements;
- Contamination levels for release of material and equipment from the restricted area;
- The effectiveness of contamination control and decontamination methods; and
- Personnel contamination survey.

1.2 Applicability

This procedure applies to personnel under RSM supervision performing contamination surveys at uranium mine and mill tailings sites.

2.0 REFERENCES

2.1 US NRC Regulatory Guide 8.30, Health Physics Surveys in Uranium Mills".

3.0 EQUIPMENT AND MATERIALS

3.1 Survey Maps (plan view of area, items or equipment to be surveyed)

3.2 Smear papers and envelopes, Plastic Bags, Petri dishes, or equivalent for holding individual smears

3.4 Gloves, appropriate anti-contamination clothing

3.5 Portable Radiation Survey Instruments: Alpha detector (such as Ludlum 43-5 or Eberline AC-3) and beta/gamma detector (such as Eberline HP-210); and scaler/rate meter (such as Ludlum Model 12 or 2224-1).

3.6 Laboratory Alpha and Beta Counters (such as Ludlum Model 2929)

3.7 Contamination/Radiation Survey Report Form (Appendix A or equivalent)

4.0 PROCEDURE

4.1 Survey Locations

4.1.1 Smear and direct contamination surveys should be taken on floors, walls, and on representative items contacted by personnel to the contamination area, such as table tops where break activities are conducted..

4.1.2 Smears should be taken where total direct contamination level exceeds the removable contamination limit (1000 dpm/100 cm^2).

4.1.3 Smears and/or direct contamination readings shall be taken on all equipment removed from the restricted area.

4.1.4 Direct contamination scan shall be performed on personnel hands, clothing, and bottom of shoes or boots.

NOTE: All alpha radiation surveys shall be taken on dry surfaces.

4.2 Direct Surface Contamination Surveys

4.2.1 Select a portable survey instrument(s) for making an alpha or beta-gamma survey, or both, and determine that the instrument(s) is calibrated and operating properly by performing function check.

4.2.2 Pass the detector slowly over the surface to be surveyed holding the detector as close as possible (no more than 1 cm) to the surface without actually touching the surface. Locate area of maximum count rate by using the audible response of the instrument. Record measurement(s) at this position and take a smear if applicable (see paragraph 4.2.2).

4.2.3 Record the direct surface contamination readings on Contamination/Radiation Survey Form in the appropriate columns for gross alpha, open-window (OW) beta-gamma, or closed-window (CW) gamma results.

4.2.4 Calculate the alpha dpm/probe by subtracting the background cpm from the gross cpm and multiplying the net cpm by the instrument's calibration factor. Record in the dpm/probe column.

4.2.5 Conversion of dpm per probe area to dpm per 100 cm^2 should be done for all direct contamination measurements.

4.2.6 Calculate the beta net count rate by the background cpm. Determine the gamma disintegration rate using the detector efficiency and detector active area.

NOTE: DO NOT USE AN INSTRUMENT WHICH DOES NOT HAVE A POSTED CALIBRATION FACTOR, OR ONE WHICH IS OUT OF CALIBRATION.

4.2.7 For surveys of equipment, if necessary, make sketches and recorded readings on sketches and/or recorded readings on Contamination/Radiation Survey Form using descriptions of survey locations adequate to re-locate the area surveyed again.

4.3 Removable Contamination Surveys

4.3.1 Wipe smear paper over an area of approximately 100 cm_2 (wipe a square area 4 inches by 4 inches or an "S" pattern 16 inches long).

NOTE: SMEAR LOCATION SHOULD BE IDENTIFIED BY MARKING ENVELOPES OR SMEARS WITH NUMBERS WHICH CORRESPOND TO THOSE OS THE SURVEY MAP.

4.3.2 Protect smears from cross contamination by immediately placing them in their individual envelopes or bags.

4.3.3 Complete survey and counting information on heading of Contamination/Radiation Survey Form using current calibration and background determinations.

4.3.4 Enter minimum detectable activity (MDA) for counter used. (Background Count time should equal sample count time.)

4.3.5 Count each smear for at least 5 minutes and enter data on Contamination/Radiation Survey Form.

NOTE: COUNT RATES LESS THAN MDA WILL BE SO NOTED BUT ALL SPECIFIC NUMERICAL VALUES SHALL BE RECORDED EVEN IF THEY ARE NEGATIVE NUMBERS.

Attachment A

UNC NECR RA Radiation Protection Program
Surface Contamination/Radiation Survey Form
Pre-Design Sampling

Instrument ____________ ____________ ____________
Instrument SR# ____________ ____________ ____________
Function Check ____________ ____________ ____________
Detector Efficiency ____________ ____________ ____________
Detector Area/Factor ____________ ____________ ____________

Equipment or Location : ____

	Total Alpha		Removable Alpha		Total Beta-Gamma		
Area	cpm	dpm/100cm^2	cpm	dpm/100cm^2	cpm	dpm/100cm^2	Location/Comment

Notes: ____
____

Technician: ______________________ Date: ______________________

Attachment

Acces Control Log Form

NECR RA Radiation Protection Program

											Personnel Contamination Limit CPM:		
Date	Worker Name	Personal Dosimeter ID	Work ID	Hours in Work Area						Time Out	Vehicle Frisked for Contamination	Personnel Frisked for Contamination	Comments
				Time In	Area	Area	Area	Area					

ATTACHMENT 5

NECR MINE SITE URANIUM ORE DUST ISOTOPIC ANALYSIS

AVM Environmental Services, Inc.

NECR Mine Site Uranium Ore Dust Isotopic Analysis

The NECR mine site is a uranium mine site impacted by uranium ore, in which uranium and its decay products (primarily U-238, U-234, Th-230 and Ra-226) prior to chemical separation are naturally at or near secular equilibrium. This analysis is performed to support that U-238, U-234, Th-230 and Ra-226 in uranium ore at NECR are at or near secular equilibrium. U-nat and Ra-226 were analyzed on a total of 375 surface and subsurface soil samples as a part of the Removal Site Evaluation during 2006-2007. Th-230 was not analyzed on the samples. Based on a conservative assumption that gross alpha activity from uranium ore dust sample would be from the four long lived radionuclides (U-238, U-234, Th-230 and Ra-226), Th-230 fraction was calculated using U-nat and Ra-226 results (see US Nuclear Regulatory Commission 10 CFR 20, Standards for Protection Against Radiation, Appendix B, Footnote 3). The soil sample analytical results are presented in Table 3.15 and Table 3.16 of the October 2007 Final RSE Report for the NECR and are summarized in the attached table.

As shown in the table, the uranium (U-nat) mass concentration results mg/Kg for average of samples from each area were converted to activity concentrations in pCi/g using conversion factor of 1 mg/kg = 0.677 pCi/g (see https://www.nrc.gov/docs/ML1627/ML16271A362.pdf). The U-234 and U-238 activity concentrations from U-nat (U-238, U-234 and U-235) activity were calculated using their fraction of 0.4889 of U-nat (see www.lm.doe.gov/fernald/2010aser_unitsconversns.pdf). The Th-230 concentration in pCi/g were calculated using U-234, U-238 and Ra-226 concentrations and assuming that gross alpha activity in soil samples would be from U-238, U-234, Th-230 and Ra-226. An average of 375 samples calculated to be 25.7 pCi/g, 25.7 pCi/g, 30.7 pCi/g and 27.4 pCi/g for U-238, U-234, Ra-226 and Th-230, respectively. Based on the average results, the isotopic activity percentage calculated to be 23.5%, 23.5%, 28.0% and 25.0% for U-238, U-234, Ra-226 and Th-230, respectively, as shown in the table, which shows that these radionuclides are near the equilibrium? Therefore, 0.25 fraction for Th-230 is appropriate to determine its activity from uranium ore dust air sampling gross alpha activity results.

March 9, 2018

AVM Environmental Services, Inc.
NECR Mine Site Uranium Ore Dust Isotopic Analysis Table

Soil Sample Type	Area	Number of Samples	U-nat (U-234, U-235 and U-238)		Mean U-234 pCi/g (2)	Mean U-238 pCi/g (2)	Mean Ra-226 pCi/g	Estimated Mean Th-230 pCi/g (3)
			Mean, mg/Kg	Mean pCi/g (1)				
Surface Soil	NECR-1	31	116.2	78.7	38.5	38.5	39.3	38.7
	NECR-1 Step Out	16	14.4	9.7	4.8	4.8	9.7	6.4
	NECR-2	15	50.3	34.1	16.6	16.6	27.7	20.3
	NECR-2 Step Out	4	2.7	1.8	0.9	0.9	5.7	2.5
	Sandfill 1	15	8.8	6.0	2.9	2.9	10.2	5.3
	Sandfill 1 Boundary	3	2.7	1.8	0.9	0.9	4.5	2.1
	Sandfill 2	13	51.4	34.8	17.0	17.0	27.7	20.6
	Sandfill 3	13	65.8	44.5	21.8	21.8	28.7	24.1
	Sandfill 3 Boundary	2	2.9	2.0	1.0	1.0	1.4	1.1
	Ponds 1 and 2	19	125.3	84.8	41.5	41.5	105.9	62.9
	Ponds 1 and 2 Boundary	4	1.7	1.2	0.6	0.6	1.5	0.9
	Pond 3/3a	15	437.1	295.9	144.7	144.7	102.1	130.5
	Sediment Pad	14	195.7	132.5	64.8	64.8	60.5	63.4
	NEMSA	5	2.7	1.8	0.9	0.9	1.5	1.1
	Boneyard	5	4.6	3.1	1.5	1.5	10.4	4.5
	Venthole 3/8	5	77.2	52.3	25.6	25.6	31.5	27.5
	Trailer Park	5	42.8	29.0	14.2	14.2	16.6	15.0
	Homesites	45	4.5	3.0	1.5	1.5	3.9	2.3
Subsurface Soil	NECR-1 Soil Boring	28	99.9	67.6	33.1	33.1	21.4	29.2
	NEFCR-2 Test Pit	6	33	22.3	10.9	10.9	5.9	9.2
	Sandfill1 Test Pit	9	38	25.7	12.6	12.6	39.4	21.5
	Sandfill 2 Test Pit	5	10.1	6.8	3.3	3.3	2.2	3.0
	Sandfill 3 Test Pit	7	162.6	110.1	53.8	53.8	27.8	45.1
	Pond 1 and 2 Soil Boring and Test Pit	14	116.7	79.0	38.6	38.6	71.2	49.5
	Poind 3/3a Soil boring and Test Pit	14	23	15.6	7.6	7.6	3.4	6.2
	Sediment Pad soil boring and test pit	9	161	109.0	53.3	53.3	70	58.9
	NEMSA Test Pit	13	121.4	82.2	40.2	40.2	45	41.8
	Boneyard Test Pit	11	46.2	31.3	15.3	15.3	11	13.9
	Arroyo Soil Boring	30	27.2	18.4	9.0	9.0	16.4	11.5
	Sample (N = 375) average				25.7	25.7	30.7	27.4
	Radionuclide Activity Percentage of Gross Alpha Activity				23.5%	23.5%	28.0%	25.0%

Data Source: Table 3.15 and Table 3.16, NECR Final RSE Report, October 2007

Notes: (1) U-nat activity calculated using 1 mg = 677 pCi conversion factor; (2) U-234 and U-238 activities calculated based on each at 48.89% of U-nat activity

(3) Th-230 activity calculated based on assumption that Gross Alpha activity is from U-234, U-238, Th-230 and Ra-226.