RARE EARTH ELEMENT SEPARATION AND PROCESSING DEMONSTRATION PROJECT

APPLICATION FOR SOURCE MATERIAL POSSESSION LICENSE

Submitted to the US Nuclear Regulatory Commission

Rare Element Resources

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Acronyms and Abbreviations

ACE	US Army Corps of Engineers
ALARA	as low as is reasonably achievable
BKS	BKS Environmental Associates, Inc.
CCA	chemical containment area
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
Ci	Curie
cpm	counts per minute
dBA	A-weighted decibels
dpm	decays per minute
dpm 100 cm^{-2}	decays per minute per 100 square centimeters
^{o}F	degrees Fahrenheit
DOE	US Department of Energy
DOT	US Department of Transportation
ECR	electrical control room
FOA	Funding Opportunity Announcement
ft / ft^2	feet / square feet
g	gram
GA	General Atomics
HAZOP	Hazard and Operability Analysis
HREE	heavy rare earth elements
HVAC	heating, ventilation, air conditioning
LNV	LNV, an Ardurra Group, Inc. company
MDC	minimum detectable concentration
MeV	mega electron volts

μCi cm^{-2}	microcurie per square centimeter
μCi mL^{-1}	microcurie per milliliter
μR h^{-1}	microroentgen per hour
mrem	millirem
NIST	National Institute of Standards and Technology
NPS	neodymium/praseodymium separation
NRC	US Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Provider
OSL	optically-stimulated luminescent dosimeter
pCi g^{-1}	picocuries per gram
pCi L^{-1}	picocuries per liter
PP	primary processing
PPE	personal protective equipment
ppm	parts per million
PUG	physical upgrade
Pu-239	Plutonium-239
QA/QC	quality assurance / quality control
REE	rare earth element
REO	rare earth oxide
RER	Rare Element Resources, Inc.
RPP	radiation protection program
RSO	Radiation Safety Officer
SEG	samarium/europium/gadolinium
SERP	Safety and Environmental Review Panel
SX	solvent extraction
TCS	thorium/cerium separation
Tc-99	technetium-99
Th-230	thorium-230
TREO	total rare earth oxide
TREO(Th)	total rare earth oxide with thorium concentrate
UIT	Umwelt-und Ingenieurtechnik GmbH Dresden
U-238	uranium-238
US	United States
WCRM	Western Cultural Resource Management, Inc.
WCS	Waste Control Specialists, LLC
WDEQ	Wyoming Department of Environmental Quality

Introduction

Rare Element Resources, Inc. (RER) is proposing to conduct a Rare Earth Element (REE) Separation and Processing Demonstration Project (Demonstration Project) in northeastern Wyoming in collaboration with General Atomics (GA), GA's European affiliate Umwelt-und Ingenieurtechnik GmbH Dresden (UIT) and engineering and construction subcontractor LNV, an Ardurra Group, Inc. company (LNV). RER, GA, UIT, and LNV are collectively referred to in this document as the Team.

The Demonstration Project is being developed as a 50% commercial / 50% government-funded cooperative agreement between the Team and the US Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy under DOE's Critical Materials Funding Opportunity Announcement (FOA) with a total project budget of $43.8 million. The Demonstration Project includes the engineering, construction, and operation of a REE separation and processing Demonstration Plant.

The Demonstration Project proposes to demonstrate the domestic production of neodymium-praseodymium and other rare earth oxides (REOs). Approximately 1,000 tons of exploration sample removed previously from the Bear Lodge project in Wyoming are available for processing. The Team plans to design, construct, and operate a demonstration-scale hydrometallurgical, separation, and refining plant at a processing rate of up to 3 tons of feed material per day as a research and development scale-up. The Demonstration Plant is planned to operate for approximately one year.

This technical report presents RER's application for a source material possession license to the United States (US) Nuclear Regulatory Commission (NRC) for the Demonstration Project. The format and content of this license application generally follow NRC Form 313 and recommendations in NUREG-1556, Volume 12 *Consolidated Guidance About Materials Licenses: Program-Specific Guidance About Licenses for Manufacturing and Distribution* (NRC 2000) as advised by NRC staff (NRC 2021).

References are made in this license application to a May 4, 2015 submittal by RER to NRC which proposed the operation of a commercial scale REE processing facility ("commercial facility") called the Bear Lodge Project (RER 2015). RER requested that NRC suspend its review of the commercial facility (Docket Number 040-38367) on January 21, 2016 (RER 2016). The Demonstration Project is substantially limited in scope and scale compared to the commercial facility; however, its similar location and some of the previous characterizations are applicable to this license application, where referenced.

1 License Action Type

This is an application for a new license, option "A" of item 1 on NRC Form 313 (Appendix A).

2 Name and Mailing Address of Applicant

The name and mailing address of the applicant are provided as item 2 on NRC Form 313 (Appendix A).

3 Address and Site Characterization

Information presented in this section summarizes applicable sections of the Demonstration Project *Environmental Report* (RER 2022). The additional background information in this section is provided based on a request by NRC staff in 2015 (RER 2015) related to the commercial facility.

3.1 Physical Location and Land Use

The physical location of operations is provided as item 3 on NRC Form 313 (Appendix A) and on Figure 1. A proposed site plan for the Demonstration Project is provided on Figure 2.

As described in section 3.1 of the *Environmental Report* (RER 2022), the Demonstration Plant site is an approximately 8-acre parcel of privately-owned land within an area referred to as the Upton Industrial Park; the Upton Industrial Park was purchased by Tiger Transfer, LLC from the Weston County Development Board in 2012. A tenant, Western Biomass Energy, LLC, operated an ethanol plant at the site from 2005-2013 [BKS Environmental Associates, Inc., (BKS 2021)].

3.2 Transportation

As described in section 3.2 of the *Environmental Report* (RER 2022), Interstate 90, US 85, and WY 59 are the major roadways that connect the Demonstration Plant site with the remainder of Wyoming and surrounding states. Primary roads that will be used to access the Demonstration Plant site include Interstate 90, WY 116, and US 16. Buffalo Creek Road, which leads from US 16 to the Demonstration Plant site and connects with WY 116 to the south, is the only Weston County Road that will be used to access the Demonstration Plant site. Rail lines link the Demonstration Plant site to Montana, Idaho, and Washington to the northwest; eastern Wyoming, Colorado, and New Mexico to the south; and South Dakota, Nebraska, and midwestern and eastern states to the southeast. Burlington Northern Santa Fe is the dominant rail operator in northeast Wyoming, transporting freight and coal out of Campbell County's southern Powder River Basin.

3.3 Topography, Soils, and Geology

As described in section 3.3 of the *Environmental Report* (RER 2022), the topography of the Demonstration Plant site is generally flat with slightly higher elevations noted on the south and west end of the property.

Soils at the Demonstration Plant site are generally clay loam or clay textured, which is typical of semi-arid grasslands and shrublands in the western US (BKS 2021, 2013). The risk for both wind and water erosion at the Demonstration Plant site is moderate, and soils are generally low acid, low fertility, and can contain high amounts of sodium. Baseline radiological characterization in soil included sampling at the nearby commercial facility location (ERG 2015), and supplemental soil sampling in 2022 at the Demonstration Project site was completed.

The Upper Cretaceous Belle Fourche Shale is the surficial geologic unit for most of the project area. Minor outcrops of the younger Greenhorn Formation and Carlile Shale are present. The Belle Fourche Shale ranges from 150 to over 700 feet (ft) thick and deepens to the west. Older Upper Cretaceous geological formations consist of the Mowry Shale (about 200 to 250 ft thick in the region) and the Newcastle Sandstone (20 to 50 ft thick). These units are underlain by Lower Cretaceous rock units including the Skull Creek Shale (185 to 210 ft thick) and the Inyan Kara Group, which is comprised of the Fall River Formation (130 ft thick) and the Lakota Formation (100 to 125 ft thick). Beneath the Cretaceous section, an additional 3,000 ft of sedimentary rock represents deposition from the Jurassic Morrison Formation through the Cambrian-Ordovician Deadwood Formation. The top of the Jurassic Morrison Formation likely occurs at depths between 800 and 1,400 ft within the Demonstration Project area.

3.4 Water Resources

As described in section 3.4 of the *Environmental Report* (RER 2022), there is no flow of water at the surface at the Demonstration Plant site, other than stormwater. Surface water hydrology near the Demonstration Plant site is dominated by the southeastward flowing Coyote Creek and its associated tributaries. Most of the Coyote Creek drainage area is composed of minor ephemeral stream channels. Coyote Creek flows approximately five stream channel-miles to Iron Creek. Iron Creek is a tributary to Beaver Creek approximately 11.6 stream channel-miles downstream. Beaver Creek flows approximately 117 stream channel-miles to where it empties into the Cheyenne River near the Wyoming-South Dakota state line. The US Army Corps of Engineers (ACE) previously determined that nearby surface drainages are non-jurisdictional waterways (ACE 2013), and an update is planned to this determination in 2022.

Shallow groundwater (less than 20 ft) is limited to accumulations in perched and isolated zones within alluvial valley fill and the weathered upper portion of the surficial geologic formation: the Belle Fourche Shale. These two layers are considered a single hydrostratigraphic unit. The unit is not considered an aquifer, as 1) well yields in the fine-grained alluvium and weathered shale are low (based on groundwater sampling) and 2) the waters are highly mineralized and not suitable for any use.

Deeper groundwater is found in the Newcastle Sandstone and the Inyan Kara Group, which is several hundred ft below the uppermost Belle Fourche Shale and Mowry Shale. Regionally, the Fall River and Lakota formations of the Inyan Kara Group are referred to as the Dakota Aquifer System. The Newcastle Sandstone is a minor unit of the Dakota Aquifer System that also includes the deeper Inyan Kara Group. Below the Newcastle is the underlying Skull Creek Shale. The depth extending to the Dakota Aquifer is due to the westward dipping Black Hills Monocline.

RER installed 10 groundwater monitoring wells near the Demonstration Plant site to collect geophysical data, perform aquifer characterization tests, and monitor water quality. The wells include four deep wells completed in the Dakota Sandstone, one well completed in the Newcastle/Muddy

Sandstone and five shallow wells completed in alluvium. The monitoring well network at the Demonstration Plant site was sampled between 2012-2014 and in 2018. Groundwater samples exceeded multiple standards for Wyoming Department of Environmental Quality (WDEQ) Class, I, Class II, and Class III groundwaters of the state, and water quality results were generally unchanged between the 2012-2014 and 2018 sampling events.

Approximately 15 acres of wetlands were identified near the site (including one area within the site boundary) consisting of natural features associated with Coyote Creek and Beaver Creek, and reservoirs resulting from the reclamation of past bentonite mining activities. There are no jurisdiction wetlands at the Demonstration Plant site because surface waters do not meet the Significant Nexus standard when evaluating their relationship to the nearest traditional navigable water (ACE 2013).

3.5 Ecological Resources

As described in section 3.5 of the *Environmental Report* (RER 2022), the current ground cover at the Demonstration Plant site consists primarily of gravel. Concrete slabs are present in association with the buildings, either inside or adjacent to them. Some remnants of weeds (Canada thistle) were noted on the northern edge of the site. The six dominant vegetation communities in the area include mixed shrubland, greasewood shrubland, big sagebrush shrubland, upland grassland, meadow grassland, and reclaimed grassland.

Wildlife surveys were conducted in the vicinity of the Demonstration Plant site on several occasions between 2011 and 2018. The 2012 wildlife baseline study (ICF 2014) found that the proposed action would not adversely affect any threatened or endangered species. The updated wildlife baseline found that as of November 2018 there were two species listed under the Endangered Species Act for Weston County: the Ute ladies'-tresses (*Spiranthes diluvialis)* and northern long-eared bat *(Myotis septentrionalis)* (RER 2019). The greater sage-grouse (*Centrocercus urophasianus*) was listed as a candidate species for listing under the Endangered Species Act. In 2015, however, the US Fish and Wildlife Service determined that it is not warranted for listing and would no longer be a candidate species (RER 2019). Seventeen species of birds of conservation concern under the Migratory Bird Treaty Act could occur within the project area based on their known distributions and habitat associations in western Wyoming. Surveys of terrestrial and aquatic wildlife, including important species that are managed by the State wildlife agency for harvest, recreation, and revenue, were also conducted between 2014-2018, the results of which are reported in section 3.5 of the *Environmental Report*.

3.6 Meteorology, Climate, and Air Quality

As described in section 3.6 of the *Environmental Report* (RER 2022), the climate of the region is characterized as interior continental with hot summers and cold winters. The mean monthly temperature is highest in July [72 degrees Fahrenheit (°F)] and lowest in January (22 °F). Winds are common to the region and frequently strong, ranging from an average of 10 miles per hour during July and August to 16 miles per hour during November through April. RER installed a meteorological station in Upton in 2012 to continuously monitor local weather conditions including air temperatures, precipitation, wind speed, and wind direction. Winds are predominantly from the south-southeast (spring and summer; and at night) and north-northwest (winter and during the day).

The Demonstration Plant site and surrounding area are designated as Class II under the Clean Air Act. There are no Class I areas within 50 kilometers (31 miles) of the Demonstration Plant site. Weston County is designated as attainment or unclassifiable for all criteria pollutants, indicating that ambient concentrations of these pollutants in air are less than the National Ambient Air Quality Standards.

RER installed five high-volume air samplers with particle size adapters in June 2012 to monitor background radionuclide, lanthanide, and particulate matter concentrations in ambient air. The results were reported in the *Baseline Radiological Investigation Report* (ERG 2015) and are summarized in section 3.12 of the *Environmental Report* (RER 2022).

3.7 Noise

As described in section 3.7 of the *Environmental Report* (RER 2022), a noise evaluation study was conducted in October 2012 to record ambient levels of sound for 24 consecutive hours near the Demonstration Plant site. The range of measurements at all locations was 23.5 to 63 A-weighted decibels (dBA), which is generally lower than the typical level of noise in urban areas (85-90 dBA) (Behrens 2014).

3.8 Historic and Cultural Resources

As described in section 3.8 of the *Environmental Report* (RER 2022), the Demonstration Project location in the western edge of the Black Hills is characterized by undulating plains. This region of plains is considered to have been occupied continuously by humans for the past 13,000 years [Western Cultural Resource Management, Inc., (WCRM 2013)] and is the ancestral home of Očhéthi Šakówiŋ (Assiniboine and Sioux), Tséstho'e (Cheyenne), and Apsaalooké (Crow) peoples (Native Digital Land 2021). In November 2013, the Fort Peck Assiniboine and Sioux Tribe, Northern Arapaho Tribe, Crow Creek Sioux Tribe, and Northern Cheyenne Tribe conducted a tribal cultural preservation survey. The results of the survey were documented in a combined tribal report (Fort Peck, Northern Arapaho, and Crow Creek) and a separate report from the Northern Cheyenne, previously transmitted to the NRC, the US Forest Service, and State of Wyoming Historic Preservation Office. A cultural resource inventory was conducted in March 2022 for the Demonstration Project area and identified no cultural resources in the area (Antiquus 2022).

3.9 Visual/Scenic Resources

As described in section 3.9 of the *Environmental Report* (RER 2022), the Demonstration Plant site has viewsheds and landscape characteristics common to the windswept, short-grass prairie of the region. Repairs to the exteriors of the existing buildings by the current landowner have improved the overall appearance of the site. There are no visual/scenic resource management guidelines for activities on private land in the Demonstration Project area.

3.10 Socioeconomic

As described in section 3.10 of the *Environmental Report* (RER 2022), the study area where the socioeconomic impacts of the Demonstration Plant are analyzed includes Campbell, Crook, and Weston counties and communities within 65 miles of the Demonstration Plant site. This area is expected to provide most of the workforce for the Demonstration Plant and temporary housing for workers who may relocate to the area to supplement the local workforce. Campbell County is the dominant population center in the study area, with 46,133 residents in 2010. In that year, Crook and Weston counties had 7,083 and 7,208 residents, respectively.

Most of the jobs in the study area are in Campbell County. Several industries that are substantial sources of employment in the study area, *e.g.*, local government, retail trade, health care, and light manufacturing, circulate money within the regional economy to provide local goods and services. While they provide jobs, these industries do not generally inject investment from outside the region into the regional economy to create industries that will export goods and services outside the region and support ancillary industries.

There are four school districts, three hospitals, and nine fire protection agencies in the study area. Sheriff's offices in Campbell, Crook, and Weston counties and police departments in Gillette, Moorcroft, Newcastle, Sundance, and Upton provide law enforcement services.

3.11 Environmental Justice

As described in section 3.11 of the *Environmental Report* (RER 2022), the Demonstration Plant site is in Census Block Group 1 of Census Tract (CT) 9511, which includes Upton and its environs. Based on 2019 and 2020 census data, racial minorities comprised 11.4% of CT 9511's population, persons of Hispanic origin, who may be of any race, comprised 4.9% of CT 9511's population, low-income populations comprised 10.2% of Weston County's population.

3.12 Public and Occupational Health

As described in section 3.12 of the *Environmental Report* (RER 2022), the Demonstration Plant site is currently unoccupied. There are no current sources of exposure to chemicals or radioactive materials. A baseline radiological investigation conducted in 2015 in the vicinity of the Demonstration Plant site included a gamma survey, random soil sampling, exposure rate monitoring, radon flux measurements, radon measurements in air, and airborne particulate measurements (ERG 2015). Further soil characterization in 2022 was conducted for six boreholes at the Demonstration Project site; results are described in section 3.12 of the *Environmental Report.*

3.13 Waste Management

As described in section 3.13 of the *Environmental Report* (RER 2022), no known large-scale hazardous or other solid wastes are generated or stored on the lands included in the Demonstration Project. A Phase I Environmental Site Assessment in April 2021 (BKS 2021) identified materials left by a former tenant. The landowner removed and disposed of these materials as part of the lease agreement for the Demonstration Project.

4 Person to be Contacted About This Application

This information is provided as item 4 on NRC Form 313 (Appendix A).

5 Radioactive Material

As required by 10 *Code of Federal Regulations* (CFR) 40, RER is requesting a radioactive materials license to possess unsealed, non-volatile source material in any bound form. The source material will be uranium and thorium in their natural isotopic abundance with combined concentrations greater than 0.05 percent by weight contained in a REO mineral exploration sample. The weight of the exploration sample is approximately 1,000 short tons. Table 1 provides a summary of the requested radioactive material.

A decommissioning funding plan, as required by 40 CFR 36 (a), is provided in Appendix B.

Table 1. Information about requested radioisotopes

Radioisotope	Chemical/Physical Form	Maximum Possession Limit [a]
Natural uranium and thorium contained in rare earth oxide mineral exploration sample	Any bound form	1,000 short tons (907 metric tons or 9.07E8 g) Natural uranium: 68 mCi Natural thorium: 586 mCi

[a] Radioactivity values are estimated based on an average exploration sample grade of 111 ppm natural uranium and 2,911 ppm natural thorium. Specific activities used were 6.77E-7 Ci g^{-1} for natural uranium and 2.22E-7 Ci g^{-1} for natural thorium.

Ci – Curie
g – gram
mCi – millicurie
ppm – parts per million

6 Purpose for Which Licensed Material Will Be Used

The purpose for which licensed material will be used is the possession of source material incidental to the processing of REE (see Table 1). The source material is collocated with REO in a mineral exploration sample to be used as feed material to the Demonstration Plant described in section 9.

7 Individual(s) Responsible for Radiation Safety Program and Their Training and Experiences

The roles and responsibilities of the Team's executive management, radiation protection staff, users and others in the restricted areas are discussed in the following sections. The roles and members of the Team's Safety and Environmental Review Panel (SERP) also are discussed.

7.1 Organizational Structure

The GA, RER, UIT and LNV team (Team) jointly submitted a formal proposal to the DOE in 2020 for the construction and operation of the Demonstration Plant. The Team received a formal selection notice in January 2021 from the DOE indicating that the Team had been selected to enter negotiations for a financial award pursuant to the DOE Advanced Manufacturing Office DE-FOA-0002232 (DOE 2021). The Team and DOE entered into a cooperative agreement in October 2021.

This license application is limited to the scope and scale of the Demonstration Project as identified by the DOE cooperative agreement. The Team (Figure 3) will construct, operate, and manage the Demonstration Plant throughout its life cycle.

Figure 4 is an organizational chart depicting the management structure by function, reporting paths, and flow of authority between executive management and the Radiation Safety Officer (RSO).

7.2 Executive Management

7.2.1 President & CEO (RER)

The Team empowers the RER President & Chief Executive Officer (President & CEO) with the ultimate responsibility and authority for the radiation safety and environmental compliance programs. The President & CEO is directly responsible for:

- Company compliance with all regulatory license conditions/stipulations, regulations, and reporting requirements.
- Demonstrating a strong commitment to and continuing support for the development and implementation of the radiation protection and as low as is reasonably achievable (ALARA) program.
- Conducting a periodic management audit program that reviews procedural and operational efforts to maintain exposures ALARA.
- Continuing management evaluation of the radiation protection program, its staff, and its allocation of adequate space and money.

The RER President & CEO also has the responsibility and authority to terminate immediately any activity that the Team determines to be a risk to employees, public health, or the environment, or a violation of state or federal regulations. The RER President & CEO has the ultimate authority to allocate corporate resources, *e.g.*, capital equipment, personnel, and funds, to ensure compliance with corporate environmental, health, and safety goals and directives.

7.2.2 Technical Specialist (RER)

The RER Technical Specialist is responsible for compliant implementation of all radiation protection, health and safety, and other environmental programs for RER and ensuring these programs meet applicable regulatory requirements and industry best management practices. The RER Technical Specialist is responsible for ensuring that all company operations comply with all applicable laws and regulations. The RER Technical Specialist reports directly to the RER President & CEO. The RER Technical Specialist has the authority to allocate facility resources and recommend funding, *e.g.,* capital equipment, personnel, and funds, to ensure compliance with corporate environmental, health, and safety goals and directives.

The required qualifications of the Technical Specialist are a) a bachelor's or higher degree in an engineering field, M.S., Ph.D., or P.E. desired or b) in lieu of a degree, ten or more years direct experience in mining or ore processing, plant management or project management.

7.2.3 Principal Investigator (GA)

The Principal Investigator, a GA employee, is the overall manager of engineering and operations for the Demonstration Project and reports directly to the RER President & CEO (Figure 4). The Principal Investigator has the authority to allocate facility resources, *e.g.,* capital equipment, personnel, and funds, to ensure compliance with corporate environmental, health, and safety goals and directives.

The required qualifications of the Principal Investigator are a) a doctoral degree or professional engineer certificate in chemical engineering, or other relevant field, with five or more years of experience in process development, chemical safety and program management, or b) a bachelor’s degree in a related engineering field with 10 or more years of relevant experience.

7.2.4 Safety Supervisor (GA)

The Safety Supervisor, a GA employee, is responsible for compliant implementation of the general site safety and fire prevention requirements. This includes implementation of appropriate standard operating procedures (SOPs) and the emergency response plan. The Safety Supervisor reports to the Principal Investigator (Figure 4), who reports to the RER President & CEO. The Safety Supervisor provides operational input to the Plant Manager.

The required qualifications of the Safety Supervisor are a) a bachelor’s or higher degree in a relevant engineering or applied sciences field with five or more years of experience in laboratory and plant safety, hazardous materials handling, and communications, required safety regulations and implementation, as well as relevant equipment design and operations or b) in lieu of a degree, ten or more years direct experience in the relevant skill set.

7.2.5 Plant Manager (LNV)

The Plant Manager, an LNV employee, will be responsible for implementing all operations at the Demonstration Plant. The Plant Manager will be responsible for compliant implementation of the corporate health, safety, and environmental programs. The Plant Manager will have the authority to terminate immediately any operation of the facility that the Team determines to be a risk to employees, public health, or the environment, or a violation of laws or regulations. The Plant Manager will report directly to the Managing Principal (Figure 4), who reports to the Principal Investigator. The Plant Manager will act promptly on recommendations made by the RSO to correct nonconformances identified in the radiation protection or environmental monitoring programs.

The required qualifications of the Plant Manager are a) a bachelor’s, associate’s, or higher degree in a relevant field with three or more years of experience in manufacturing or chemical processing or b) in lieu of a degree, five or more years direct experience in the relevant skill set.

7.3 Radiation Protection Staff

7.3.1 Radiation Safety Officer

The RSO is primarily responsible for the technical adequacy and implementation of the radiation protection and ALARA programs and has continuing responsibility for surveillance and supervisory action in the enforcement of these programs at the Demonstration Plant. The RSO will report directly to the RER Technical Specialist and provide operational input to the Managing Principal (Figure 4).

The RSO will have the following education, training, and experience consistent with Section 2.4.1 of Regulatory Guide 8.31 (NRC 2002b):

- Education: A bachelor's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university or an equivalent combination of training and relevant experience in source material facility radiation protection. Two years of relevant experience are generally considered equivalent to one year of academic study.
- Health Physics Experience: At least one year of work experience relevant to source material facility operations in applied health physics, radiation protection, industrial hygiene, or similar work. This experience should involve actually working with radiation detection and measurement equipment, not strictly administrative or "desk" work.
- Specialized Training: At least four weeks of specialized classroom training in health physics specifically applicable to source material facilities. In addition, the RSO should attend refresher training on source material facility health physics every two years.

  As an alternative to the refresher training requirement, the RSO may maintain a Certified Health Physicist credential through the American Board of Health Physics.
- Specialized Knowledge: A thorough knowledge of the proper application and use of all health physics equipment used in the source material facility, the chemical and analytical procedures used for radiological sampling and monitoring, methodologies used to calculate personnel exposure to uranium and its daughters, and a thorough understanding of the process and equipment used in the facility and how the hazards are generated and controlled during the REE recovery process.

The RSO may designate authority for responsibilities to another individual (RSO designee) if the individual meets the minimum qualifications of the RSO.

The responsibilities of the RSO, consistent with Appendix D of NUREG-1556, Volume 12 (NRC 2000) include:

- Ensure that licensed material possessed by the licensee is limited to the types and quantities of licensed material;
- Maintain documentation that demonstrates the dose to individual members of the public does not exceed the limit specified in 10 CFR 20.1301;
- Ensure the security of licensed radioactive material;
- Post documents as required by 10 CFR 19.11 and 10 CFR 21.6;
- Ensure that licensed material is transported in accordance with applicable NRC and US Department of Transportation (DOT) requirements;
- Ensure that radiation exposures are ALARA;
- Oversee all activities involving radioactive material, including monitoring and surveys of all areas in which radioactive material is possessed or possessed and used.
- Act as liaison with NRC and other germane regulatory authorities;

- Provide necessary information on all aspects of radiation protection to personnel at all levels of responsibility, pursuant to 10 CFR 19 and 10 CFR 20, and any other applicable regulations;
- Oversee the proper delivery, receipt, and conduct of radiation surveys for all shipments of radioactive material arriving at or leaving from the site and packaging and labeling all radioactive material leaving the site;
- Distribute and process personnel radiation monitoring equipment, determine the need for and evaluate bioassays, monitor personnel radiation exposure and bioassay records for trends and high exposures, notify individuals and their supervisors of radiation exposures approaching established limits, and recommend appropriate remedial action;
- Conduct training programs and otherwise instruct personnel in the proper procedures for handling radioactive material prior to possession or possession and use, both at periodic intervals (refresher training), and as required by *e.g.*, changes in procedures, equipment, and regulations;
- Supervise and coordinate the radioactive waste disposal program, including effluent monitoring and recordkeeping on waste storage and disposal records;
- Oversee the storage of radioactive material not in current use, including waste;
- Perform or arrange for leak tests on all sealed sources and calibration of radiation survey instruments.
- Maintain an inventory of all radionuclides possessed under the license, and limit the quantity to the amounts authorized by the license
- Immediately terminate any unsafe condition or activity that is found to be a risk to public health and safety or property;
- Supervise decontamination and recovery operations;
- Maintain other records not specifically designated by the license;
- Hold periodic meetings with, and provide reports to, licensee management;
- Perform periodic reviews of the radiation protection program (RPP) to ensure that the licensee is complying with: all applicable NRC regulations, the terms and conditions of the license, *e.g.*, leak tests, inventories, possession or possession and use limited to trained, approved users, etc., the content and implementation of the RPP to achieve occupational doses and doses to members of the public that are ALARA in accordance with 10 CFR 20.1101, and the requirement that all records be properly maintained;
- Ensure that the results of audits, identification of deficiencies, and recommendations for change are documented (and maintained for at least three years) and provided to management for review and ensure that prompt action is taken to correct deficiencies;
- Ensure that the audit results and corrective actions are communicated to all personnel who possess or possess and use licensed material;
- Ensure that all incidents, accidents, and personnel exposure to radiation in excess of ALARA or 10 CFR 20 limits are investigated and reported to NRC and other appropriate authorities, if required, within the required time limits;

- Maintain an understanding of, and up-to-date copies of, NRC regulations, the license, and revised licensee procedures, and ensure that the license is amended whenever there are changes in licensed activities, responsible individuals, or information or commitments provided to NRC during the licensing process; and
- Develop, implement, maintain, and distribute up-to-date operating, emergency, and security procedures.

7.3.2 Safety Technician(s)

The safety technician(s) are members of the Operations Staff and report to the Plant Manager (Figure 4). Safety technicians will demonstrate a working knowledge of the proper operation of health physics instruments used in the source material facility, surveying and sampling techniques, and personnel dosimetry requirements. The safety technician(s) and RSO will implement the requirements of the RPP at the Demonstration Plant.

The safety technician(s) will have one of the combinations of education, training, and experience in Table 2 consistent with Section 2.4.2 of Regulatory Guide 8.31 (NRC 2002b).

Table 2. Acceptable education, training, and experience for a safety technician

	Option 1	Option 2
Education	Minimum of an associate degree or two years of study in the physical sciences, engineering, or a health-related field.	High school diploma
Training	Minimum of four weeks of training (up to two weeks may be on-the-job training) in radiation protection applicable to source material facilities.	At least three months of specialized training (up to one month may be on-the-job training) in radiation protection relevant to source material facilities.
Experience	One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures applicable to a source material facility.	Two years of relevant work experience in applied radiation protection.

7.4 Authorized Users

The names and qualifications of authorized users are not currently available. At a minimum, the RER President & CEO, Plant Manager, Principal Investigator, and RSO will be authorized users (Figure 4). The qualifications of an authorized user will be consistent with those described in section 8.7.2 of NUREG-1556, Volume 12 (NRC 2000). The names and individual qualifications of authorized users are included as Appendix D.

An authorized user's primary responsibility is to ensure that radioactive materials are used safely and in accordance with regulatory requirements. The authorized user is also responsible for ensuring that procedures and engineering controls are used to keep occupational doses and doses to members of the public ALARA. Authorized users must have adequate and appropriate training to provide reasonable assurance that they will use the licensed material safely, including maintaining security of and access to licensed material, and respond appropriately to events or accidents involving licensed material to prevent the spread of contamination.

7.5 Safety and Environmental Review Panel

RER will establish a SERP consisting of at least three members: the RSO, an individual with authority to implement managerial and financial changes, *e.g.*, President & CEO, and an individual with authority to make operational changes, *e.g.*, Plant Manager (Figure 4). The SERP may include others, *e.g.*, the Principal Investigator, on a temporary or permanent basis whenever it requires additional technical or scientific expertise. At least one member of the SERP will be designated as chair.

The purpose of the SERP will be to evaluate, discuss, approve, and record any changes to any SOP, the facility, or tests and experiments involving safety or the environment. The changes will not require a license amendment pursuant to 10 CFR 40.44 if the changes do not:

- Create a possibility of an accident unlike what is evaluated in the license application (as updated);
- Create a possibility of a malfunction of a structure, system, or control unlike what is evaluated in this license application (as updated); and
- Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report or the environmental assessment or technical evaluation reports or other analyses and evaluations for license amendments.

The SERP will compile records of its evaluations. These records will provide the basis for determining if implementations of changes do not require a license amendment pursuant to 10 CFR 40.44. Any change approved by the SERP will be documented in writing by showing the date of its implementation; and affected operating procedure, facility, and/or test and experiment before and after the change. A SERP SOP will be developed prior to facility operations as a control to maintain compliance with the radioactive material license and licensing requirements in 10 CFR 40.44.

The SERP will have the authority to raise issues to the Plant Manager and the RER Technical Specialist regarding the health and safety of workers, public, and/or environment due to the operation of the facility.

The SERP will prepare an annual report, describing the actions it took, including changes to operating procedures, the facility, or tests and experiments that involve safety or the environment enacted since the previous report was issued. The report also will document the reason for each change, whether it required a license amendment, and the basis for its determination. This report will be included in the annual report described in section 10.10.1.

8 Training for Individuals Working in or Frequenting Restricted Areas

8.1 Initial Training

Workers or individuals frequenting or working within restricted areas will be instructed by means of a formal, documented training class before beginning work at the site. The course of instruction will include the topics in Table 3.

Training will cover the inherent risks of exposure to radiation and the fundamentals of protection against exposure to natural uranium and thorium and their associated decay products. Additional guidance to be provided to trainees and reviewed within the training material is found in Regulatory Guide 8.13 *Instruction Concerning Prenatal Radiation Exposure* (NRC 1999) and Regulatory Guide 8.29 *Instruction Concerning Risks from Occupational Radiation Exposure* (NRC 1996).

In addition to radiation safety awareness, initial worker training will cover non-radiological hazards and associated occupational safety elements from the Demonstration Project Health and Safety Plan and emergency response plan.

A written or oral test will be given to each worker, with questions directly relevant to the principles of radiation safety and health protection at the site and as covered in the training course. The instructor will review the test results with each worker. The instructor will discuss any wrong answers to test questions with the worker until he or she understands the correct answer. Workers who fail the test (achieve a score below 70 percent) will be retested after receiving additional training. Tests and results will be maintained on site.

Table 3. Topics to be included in initial training for workers

Topic	Content
Radiation Safety	• Radiological and toxic hazards of exposure to natural uranium and thorium and their progeny (biological effects) • How natural uranium and thorium and their progeny enter the body (inhalation, ingestion, and skin penetration) • Why exposures to ionizing radiation should be kept ALARA • Methods to mitigate internal and external exposure to ionizing radiation
Non-Radiological Safety	• Non-radiological hazards of the Demonstration Project processes and facilities • Occupational safety elements from the Health and Safety Plan and emergency response plan
Personal Hygiene	• Proper wearing of protective clothing and its associated risk • Using respirators correctly and their associated risk • Administrative rules to mitigate work dose such as eating, drinking, and smoking only in designated areas • Using proper methods for decontamination
Facility-Provided Protection	• Ventilation systems and effluent controls • Cleanliness of the workplace • Features designed for radiation safety for process equipment • SOPs specific to trainee's job function • Security and access control to designated areas
Health Protection Measurements	• Measurement of airborne radioactive materials • Bioassays to detect radionuclides • Surveys to detect contamination of personnel and equipment • Personnel dosimetry
Radiation Protection Regulations	• Regulatory authority of NRC in Wyoming • Regulatory authority of Wyoming • Authority of RSO • Material control and accountability • Employee rights in 10 CFR 19 • Radiation protection requirements in 10 CFR 20 • Audit program.
Emergency Procedures	• Emergency/contingency plans

ALARA – as low as is reasonably achievable
CFR – Code of Federal Regulations
NRC – US Nuclear Regulatory Commission
RSO – Radiation Safety Officer
SOP – standard operating procedure

8.2 Refresher Training

Workers or individuals frequenting restricted areas will be provided an abbreviated refresher training course annually or whenever there is a significant change in duties, process, regulations, or the terms of the radioactive materials license. The instructor (RSO or RSO designee) will:

- Provide to each worker a written or oral test, with questions directly relevant to the principles of radiation safety and health protection at the site and as covered in the training course.
- Review the test results with each worker; and
- Discuss any wrong answers to test questions with the worker until he or she understands the correct answer.

Workers who fail the test (achieve a score below 70 percent) will be retested after receiving additional training. Tests and results will be maintained on site. Retraining will include relevant information that has become available during the past year, a review of issues regarding safety that have arisen during the year, changes in regulations and license conditions, exposure trends, and other current topics.

8.3 Task-Specific Training

Workers or individuals involved with licensed material or activities as a part of their job will receive task-specific training. Task-specific information may include:

- Authorized and supervised users;
- Worker-specific process tasks;
- Shipping of radioactive material;
- Applicable regulations and license conditions;
- Areas where radioactive material is used and stored;
- Appropriate response to spills, emergencies, or other unsafe conditions;
- Emergency procedures;
- Survey programs;
- Waste management; and
- Instrumentation.

8.4 Trainer Qualifications

The RSO or RSO designee will perform the initial and refresher radiation training.

9 Facilities and Equipment

This section describes the process, structures, and emission control systems for each stage of the Demonstration Project. Additional detail for all processes is provided in Appendix C.

9.1 Process Description

A bulk exploration sample of approximately 1,000 short tons, averaging 10.1% total REO (TREO), was extracted from the Bear Lodge property to support the Demonstration Project. The Demonstration Project involves the physical processing of this already extracted exploration sample followed by chemical processing to produce a pure TREO(Th) concentrate followed by the separation of neodymium/praseodymium oxide and other rare earth concentrate streams.

The Demonstration Plant will consist of the following process stages:

1. Physical upgrade (PUG): comminution and screening of the extracted exploration sample containing source material.

1. Primary processing (PP): primary hydrometallurgical processing of the comminuted exploration sample to produce a highly pure TREO(Th) concentrate (the precursor), which separates out a significant portion of the natural radioactivity contained in the exploration sample.

2. Thorium-cerium separation (TCS): removal of radioactivity, mainly thorium and its decay products, together with cerium, which is not currently considered to be a marketable REO product. An innovative technology allows the effectively complete removal of the source material. It allows for significant recycling of process streams and reduces the production of waste significantly.

3. Neodymium/praseodymium separation (NPS) and refining of REE groups including high purity neodymium/praseodymium oxide (the primary product), a lanthanum, cerium concentrate, a samarium, europium, gadolinium (SEG) concentrate, and a heavy rare earth elements (HREE) concentrate. The innovative technology applies multifunctional separators in a network for the recycling of valuable product streams to optimize the product quality and yield. The network is controlled by proprietary software combining real-time monitoring data of critical process streams with unique process simulation software.

The process will produce these primary products and byproducts and implement extensive materials recycling to reduce waste as much as possible.

9.1.1 Physical Upgrading (PUG)

The PUG stage is designed to use a combination of crushing and screening to reduce the grain size of the exploration sample (Table 4) and physically liberate the rare earth-bearing fines for processing in the Demonstration Plant. Following delivery of exploration sample to the site, PUG processing will occur in the PUG/Sample Storage Facility over a period of approximately two weeks at a processing rate of approximately 100 tons per day. The final comminuted product will be temporarily stored in super sacks within the covered PUG/Sample Storage Facility before being transported to the Main

Process Facility building. The process for preparation of the super sack with the comminuted sample is as follows:

- The comminuted sample will be fed into a bag filler, which consists of a collection hopper, enclosed screw conveyor, and dustless distribution pipe.
- Super sacks are to be placed on a platform scale and filled to approximately ¾ short ton each.
- The filled 1 cubic meter super sack, which has a 6-mil polyethylene liner, is then closed and moved with a forklift to a storage location within the PUG/Sample Storage Facility. Dust collection hoppers with a bag house will eliminate particulates from the PUG process.
- During Demonstration Plant operations, the filled and stored supersacks will be transported by a forklift to the Main Process Facility (approximately twice per day) at a feed rate of up to 3.0 short tons per day and emptied into the Primary Process feed hopper (section 9.1.2) via a standalone bag breaker system to begin rare earth element separation. Bag breaker system will have local dust collection to capture any residual dust from discharging the sample.

9.1.2 Primary Processing (PP)

PP includes primary hydrometallurgical processing of the comminuted and homogenized sample to produce a TREO(Th) concentrate, which is an intermediate product with a purity of >97 weight percent TREO(Th). The primary processing (PP) consists of three main processes: 1) a leach circuit, including the wash of the leached residue, 2) selective REE precipitation, including the wash, drying, and calcining of the precipitate, and 3) recovery of acids and water from the barren leach solution. PP will occur in the Main Process Facility.

9.1.3 Thorium-Cerium Separation (TCS)

In the TCS stage, the TREO(Th) concentrate, the intermediate product of the PP, is further refined to a REE raffinate, effectively free of thorium and depleted in cerium. The TCS process consists of digestion of the TREO(Th) concentrate, a solvent extraction (SX) cycle including extraction of thorium and cerium from aqueous phase to organic phase, strip of the organic phase by precipitation strip, and wash of the organic phase. The SX cycle produces REE-bearing, non-radioactive raffinate for further separation of specific REEs and thorium/cerium-bearing radioactive waste that is treated in the solid waste treatment process. TCS will occur in the Main Process Facility.

9.1.4 Neodymium/Praseodymium Separation (NPS)

In the NPS stage, the effectively thorium-free and cerium-depleted extraction raffinate from the SX process in TCS is processed further in subsequent SX cycles to separate:

- Raffinate mainly containing HREE, and samarium, europium, and gadolinium (SEG) in SX_A
- Raffinate mainly containing SEG in SX_B1
- Raffinate mainly containing lanthanum, cerium, and metal impurities in SX_B2
- Highly pure raffinate containing neodymium and praseodymium in SX_B3

From the four different raffinates, solid products of mixed REEs are produced by precipitation dependent on the product specifications. NPS will occur in the Main Process Facility.

9.1.5 Chemical Recycling and Waste Facilities

In the waste treatment process, all waste and wastewater streams are combined and neutralized for disposal. There will be no discharge of wastewater.

The produced solid waste streams are:

- Washed leach residue from the PP containing the non-dissolved fraction of the source material and most of the radium originating from the exploration sample which is immobilized in the leach residue via coprecipitation.
- Thorium-bearing oxalate from the precipitation strip of the TCS process containing all remaining residual thorium originating from the exploration sample.

The produced wastewater streams are:

- Strongly acidic metal chloride concentrate from the PP acid recovery plant containing the mobilized, but not precipitated, uranium, protactinium, and actinium fraction of the exploration sample.
- Acidic bleed streams from the precipitation strip and wash of the TCS process.

All four streams are considered as radioactive waste streams.

Within a mixing tank, the radioactive wastewater stream forms a hydrous ferric oxide sludge during neutralization with burnt lime and the radioactivity concentration is reduced below the feed concentration due to the increased mass from neutralization. The bleed streams are neutralized by burnt lime to form calcium precipitates.

The solid waste streams are neutralized and immobilized by burnt lime to a pH range of 6-9 and transferred using a belt filter to a pug mill where they are recombined with the liquid waste streams in a batched process. The total tailings consist of neutralized solids and wastewater from the PP stage combined with the neutralized solids and wastewater from the TCS stage. Bentonite is added to the total tailings if needed to adsorb excess liquid. The bentonite will be purchased in bags and stored on-site in the PUG/Sample Storage building. An initial order/purchase of 1,000 pounds of bentonite will be made at the start of the operations period and will then be ordered as needed. The total tailings waste, which contains nearly 100% of the radioactive material, is transferred to a roll-off bin and stored prior to periodic waste shipments to a licensed disposal facility.

The organic process material used in both TCS and NPS stages will be recycled within the process. If a process upset condition occurs, the organic will be transferred into a portable tanker trailer within the restricted area. The organic will be analyzed for recycle or disposal. The organic waste of the TCS may contain a small concentration of thorium and will be conditioned with a hydrocarbon adsorber and mixed with the other radioactive waste streams and disposed together as solid radioactive waste at a licensed disposal facility. The non-radioactive organic waste from NPS will be disposed of separately at a local hydrocarbon treatment facility.

Chemical recycling will occur in several process stages identified in the process flow diagrams provided in Appendix C. Waste facilities are indicated in the facility process layout also provided in Appendix C.

Table 4. Summary of process feed material use, delivery, and storage

Process Feed Material	Use	Delivery Schedule	Storage Location	Total Cumulative Mass[a] [short tons (metric tons)]	Maximum Mass [b] [short tons]
Exploration sample	PUG feed material	20-day period prior to operations	PUG/Sample Storage Facility	1,000 (907)	N/A
Hydrochloric acid	PP digestion	Every 14 days	Chemical Containment Area	300 (272)	31
Oxalic acid	REO extraction	Every 21 days (bags)	Chemical Containment Area	400 (350)	30
Sulfuric acid	REO precipitation	Once (tote) prior to operations	Chemical Containment Area	2 (2)	2
Nitric acid	REO leach to soluble rare earth nitrates	Every 14 days	Chemical Containment Area	600 (544)	47.9
Ammonia water	pH control	Every 14 days	Chemical Containment Area	150 (136)	35.4
Lime	pH control	Once prior to operations	Equipment Shed	80 (73)	80
Organic reactants	Rare earth separation	Every 4 months depending on organic recycle efficiency	Chemical Containment Area	200 (181)	83

[a] Total cumulative mass for one year of operation.
[b] Maximum mass stored at the site at any one time during operations.
NPS – neodymium/praseodymium separation
PUG – physical upgrade
PP – primary process
REO – rare earth oxide
TCS – thorium/cerium separation

9.2 Structures and Emission Control

The restricted area (Figure 5) will be graded appropriately and bermed to prevent the discharge of water potentially contacting licensed material.

Outside the restricted area but within the site boundary, auxiliary facilities will include the parking area, office trailer, laydown yard, stormwater collection system, and site fence. The office trailer will be located on the northwest side of the property and will house administration, security office, fire management, first aid, safety training, and sign-in/out facilities. This building will host the offices for administrative and technical personnel and the lunchroom/restrooms for employees and visitors. An outdoor laydown area will be built (Figure 5) to receive and store large pieces of equipment and bulk supplies. This laydown area will only be used during construction. Equipment and supplies stored in the laydown area will be disposed in a process consistent with section 4.13.2 of the *Environmental Report* (RER 2022). Site grading will direct stormwater to a collection area within the site boundary for sampling and appropriate disposition.

9.2.1 PUG/Sample Storage Facility

The PUG/Sample Storage Facility will be used to receive and store the exploration sample prior to crushing, and will house the jaw crusher, cone crusher, and coarse vibrating screen units while onsite. The final comminuted product will be stored in super sacks within the covered PUG/Sample Storage Facility. The existing 120ft x 55ft pole barn will require minor modifications to accommodate the crushing and screening equipment. In addition to the comminuted product, the pole barn will serve as a storage for bentonite, lime, and other materials and equipment needed for the operations period.

The interior of the PUG/Sample Storage Facility will be a basic shell to house small portable equipment, with sufficient capacity to accommodate the entire sample and a loading/staging area south of the building. All areas within the PUG/Sample Storage Facility that have the potential to contact licensed material will be designed to drain to an internal collection point to prevent environmental discharge. The south side of the PUG/Sample Storage Facility is open to the environment; therefore, any air emissions will come from ground level on the south side (Figure 5).

Dust and particulate emissions will be generated during PUG processing. The PUG/Sample Storage Facility will include local emission controls for the PUG process equipment (Table 5). Process controls will be used throughout PUG processing to prevent release of particulates, including dust collection installed at each transfer point reporting to a bag house with the dust redeposited with the final PUG product. During processing, a temporary screen or curtain will be installed across the open southern side of the PUG/Sample Storage Facility to further limit particulate emissions. Additionally, the dustless bag loading system used to transfer comminuted sample to super sacks will have a local emission control system. General design and operational information of emission control equipment can be found in Table 5. Additional details of the emission control equipment are included in the Air Quality Permit Application provided as Appendix I to the *Environmental Report* (RER 2022). During processing, the south side of the PUG/Sample Storage Facility will be monitored for radioactive gaseous and particulate releases as described in section 10.7.

After the PUG process is complete and the sample is stored in super sacks, normal ventilation of the building will limit workplace airborne levels of radioactive particulates and gas at the PUG/Sample Storage Facility. Passive monitoring will continue as described in section 10.7.

9.2.2 Main Process Facility

The Main Process Facility (see detailed facility process layout in Appendix C) will house the process units, which will be built on modular, self-contained skids using multiple levels of steel platforms with sufficient primary containment for localized spills. The existing building will require a 30ft x 30ft expansion at the northwest section due to some process equipment being taller than the existing Main Process Facility. This expansion will contain rare earth separation equipment along with process tanks and pumps. Access points will be built-in throughout the process for operation and maintenance needs. The overall facility design will minimize the possibility of contamination and facilitate decommissioning.

All areas within the Main Process Facility that have the potential to contact licensed material will be designed to drain to the facility sump, the interior surfaces of which will be sealed to prevent environmental discharge. Any releases to the building floor will be sampled, treated, and properly disposed of in accordance with site SOPs. There will be no underground piping used in the Demonstration Project. The facility design will emphasize use of nonporous materials and minimize length and direction changes in ventilation systems. Process controls, including level indicators and alarms will be used throughout the facility to indicate release of liquid. Spills will be handled in accordance with spill response and emergency response plans.

Within the Main Process Facility, restrooms and safety facilities such as eyewash and shower will be available. The analytical laboratory area will house the equipment required to analyze process and environmental samples. The electrical control room (ECR) will include digital and manual process controls and access to the electrical, ventilation, and safety support systems. The existing 30ft x 12ft ECR will require modifications, including being stripped of all existing equipment and retrofitted to accommodate all electrical equipment needed to provide power and controls to the processing facility.

The Main Process Facility is designed to be a zero-emission facility. All process emissions will be collected and neutralized in appropriate scrubber systems before discharge (Table 5). The scrubbers supporting various processes in the Main Process Facility are diagramed in Appendix C and summarized in Table 5. The Main Process Facility scrubber and bulk chemical storage scrubber will be located in the designated scrubber area, which will be a 10ft x 10ft area on the south side of the processing facility. Details of scrubber equipment can be found in the air quality permit application provided as Appendix I to the Environmental Report (RER 2022).

Within the Main Process Facility, all process equipment other than the calciner will be vented through the main scrubber system. The calciner will have its own, dedicated local scrubber system. The building heating, ventilation, air conditioning (HVAC) system will also have a high-efficiency particulate air filtration system. The emission point for the Main Process Facility scrubber will be on the south side of the building (Figure 5). The general, high-efficiency particulate air filtered ventilation system for the Main Process Facility, indicated in the Auxiliary Plant on the east side of the processing facility in Figure 5, is not anticipated to have any potential radiological effluent releases or monitoring. The Auxiliary Plant area is a newly constructed 28ft x 20ft building designated for support equipment such as the cooling tower, boiler, and process air system. Additional details regarding design and operational information for emission control equipment in the Main Process Facility can be found in Air Quality Permit Application in Appendix I to the *Environmental Report* (RER 2022). Emission points will be monitored for radioactive gaseous and particulate releases as described in section 10.7.

9.2.3 Chemical Containment Area

The Chemical Containment Area (CCA) is a chemical storage area within an existing 80ft x 50ft concrete containment structure that previously housed two large tanks. It will be modified and retrofitted to accommodate seven process chemical tanks (see Figure 7). Modifications to the existing area include the removal of two existing tank foundations, construction of seven new tank foundations, coating of interior concrete walls to protect the concrete from chemical spills, construction of an all-weather canopy to keep most of the snow and rain out, and the installation of piping, pumps and appurtenances associated with filling and emptying the bulk storage tanks.

The CCA will be used as a secondary containment for process feed chemicals that will be used during operation. A process chemicals summary is provided in Table 4. The State of Wyoming requires that secondary containment storage facilities of process chemicals provide a capacity of 110% of the largest single tank. The largest tank in the chemical containment area will be 12,200 gallons, therefore a capacity of 13,420 gallons is required to meet these regulations. The total secondary containment volume provided by the existing chemical containment is approximately 180,000 gallons, making the existing containment more than sufficient for the project. Double lined piping will be installed to transfer process chemicals into the Main Process Facility.

The CCA will not be enclosed and will only have an all-weather canopy. The ammonia water will have a separate ventilation system. Ventilation piping for the other chemical storage tanks will be routed to the Main Process Facility scrubber located in the Scrubber Area next to the Main Process Facility building (Figure 2). This is summarized in Table 5 and additional details on the scrubber system can be found in the WDEQ-approved air quality permit application [Appendix I to the *Environmental Report* (RER 2022)].

9.2.4 Clean Room

The Clean Room will be a newly constructed building, which will serve as the controlled access point for personnel entering and leaving the restricted area (Figure 5). It will have a men's and women's locker room for operators to scan in and out of the restricted area at the beginning and end of their shifts. The Clean Room will also house all portable radiological monitoring instruments, SOPs, and in-use records as well as change rooms for workers.

9.2.5 Maintenance/Equipment Shed

The Maintenance/Equipment Shed will house miscellaneous support supplies and equipment as well as the burnt lime used for pH control.

Table 5. Summary of air emission controls

Building	Air Emission Control System	Notes
PUG/Sample Storage Facility	PUG equipment baghouse	Dust collection from PUG processing and super sack loading
Main Process Facility	Main Process Facility scrubber	Caustic soda scrubber system will collect from vents from PP, TCS, NPS equipment as well as the Chemical Containment Area. Venting rate up to 200 actual cubic feet per minute at 80-150 °F
	PP feed hopper dust collection system	Bag breaker and dustless screw feeder will be used to limit emissions from sample feed to PP reactor
	Calciner scrubber	Vent from PP calciner will be scrubbed through activated carbon canister
	TCS feed hopper dust collection system	Used to limit emissions from TREO(Th) feed to TCS reactor
	HVAC system	Capacity to provide 3-6 air exchanges per hour with high-efficiency particulate air filtration
Chemical Containment Area	Ammonium hydroxide bulk storage tank	Vendor-supplied standalone scrubber
	Building ventilation	Ventilation of Chemical Containment Area will route through Main Process Facility scrubber

°F – degrees Fahrenheit
HVAC – heating, ventilation, and air conditioning
NPS – neodymium/praseodymium separation
PP – primary process
PUG – physical upgrade
TCS – thorium/cerium separation
TREO(Th) – total rare earth oxide with thorium concentrate

9.2.6 Accident Control in Facilities

To mitigate the risk of accidents within the facilities during operation, the Demonstration Project process will be evaluated for safe operations during normal and off normal/upset conditions as part of a formal Hazard and Operability Analysis (HAZOP). The HAZOP examines the process at the individual equipment level as well as the subsystem and system levels and evaluates the safety requirements for normal and off-normal operations. The output of the HAZOP includes input to safety and operating procedures as well as specific process control hardware and software requirements.

For all operating scenarios, the HAZOP identifies all alarms, interlocks (hardware and software), as well as failure status (loss of power state for valves, equipment, etc.) for all equipment. The HAZOP will identify and examine accident scenarios and ensure that the design of the process and control systems mitigate any potential release of radioactive or other chemicals.

This HAZOP process will be incorporated into the control philosophy for safe plant operations. Further details of the types of safety control elements used for the various types of process equipment are provided in Appendix E.

10 Radiation Protection Program

The RPP will be designed in accordance with the requirements of 10 CFR 20 Subpart B and will include limiting potential radiological doses to workers and the public at the Demonstration Project to levels that at minimum comply with the requirements of 10 CFR 20 Subpart C and Subpart D, and that are ALARA in accordance with 10 CFR 20.1101(b). Consistent with 10 CFR 20.1201(e), RER will also limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity.

Consistent with their sequence in NUREG-1556, Volume 12, the elements of the RPP are described in the following subsections.

10.1 Audit and Review

This section describes RER's ALARA program, a request for performance-based licensing, and review and audit processes.

10.1.1 ALARA Program

ALARA policy statement: RER will support, maintain and enforce a company policy of keeping radiological doses to site workers and the public as far below applicable regulatory limits as is reasonably achievable, taking into account the state of technology, economics of improvements in relation to the state of technology; and economics of improvements in relation to benefits to public health and safety and the recovery of rare earth minerals for use in technologies important to the public interest.

Implementation of this ALARA policy will be a formal component of the RPP based on the requirements of 10 CFR 20.1101(b), and the fundamental principles and practices recommended in Regulatory Guide 8.10 *Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As is Reasonably Achievable* (NRC 2016). RER management will support the ALARA policy, monitor its performance via related information and assessments as provided by the RSO, and advocate improvements based on recommendations of the RSO and third party ALARA program audits.

Specific elements of the ALARA program will include:

- ALARA action levels for evaluation of process and radiation protection practices will be established at 10% of any applicable radiation dose limit.
- The ALARA action level for declared pregnant workers will be a measured dose of 50 mrem, or 10% of the dose equivalent limit to the embryo/fetus during the entire pregnancy. If a measured dose to a declared pregnant worker exceeds 17 mrem on a quarterly measurement, which could result in 50 mrem over a 9-month pregnancy duration, the worker's job function will be evaluated for potential dose reduction and adjusted accordingly.
- An administrative action level for radon concentration in workplace air will be established at 25% of the 10 CFR 20 Appendix B derived air concentration value corrected for NRC's recommended equilibrium fraction of 0.5 for indoor facilities (NRC 2019). If passive facility monitoring indicates radon concentrations exceeding this action level, the process and ventilation systems will be evaluated for potential adjustments.
- Facility design including grading, drainage collection systems, use of nonporous materials and minimizing length and direction changes in ventilation systems.
- Informing all workers and site personnel of the company's ALARA policy/program.
- Continual internal monitoring and evaluation of the effectiveness of the RPP and ALARA programs by the RSO and radiation protection staff, including assessments of ways to further reduce exposures.
- Assignment of well-defined responsibilities for the implementation of elements of the RPP by properly trained staff.
- Appropriate training and instruction commensurate with the potential for radiological exposures for all site workers and visitors (see section 8).
- The RSO will have the authority to enforce safe facility operations, including halting any operation deemed to be unsafe or not ALARA.
- Modifications to operations and maintenance procedures, along with equipment and facilities, will be made where this will substantially reduce radiological exposures at reasonable cost.
- Routine occupational exposure monitoring in work areas consisting of a rotating schedule of mobile units during operations to establish occupational exposure potential.
- Pre-operational and routine operational surveys for contamination control and to locate any potential buildup of radioactive material or changes in external dose rates.

10.1.2 Performance-Based Licensing

RER is requesting a performance-based license which will allow it to perform qualifying actions without further environmental review by the NRC. These qualifying actions include changes, tests, and experiments as defined in 10 CFR 50.59 and must meet the following criteria:

- No significant change in the types or significant increase in the amounts of any effluents that may be released offsite;
- No significant increase in individual or cumulative occupational radiation exposure;
- No significant construction impacts; and

- No significant increase in the potential for or consequences from radiological impacts.

The SERP will evaluate and determine whether proposed actions meet these qualifying criteria.

10.1.3 Review

RER will review the content and implementation of the RPP at least annually to ensure the RPP:

- Is commensurate with the scope and extent of licensed activities;
- Is compliant with NRC and DOT regulations (as applicable), and the terms and conditions of the license;
- Maintains occupational doses and doses to members of the public ALARA; and
- Is documented, and appropriate records are maintained for the duration required by the regulations (see section 10.10).

10.1.4 Audit Program

A third-party audit will be conducted once during the year of operation of the Demonstration Plant by an independent organization. The qualifications of auditor(s) will be equivalent to those of the RSO. In addition, they will be experienced in the operational aspects of radiation protection practices specific to the licensed activities at the facilities. The RSO will not be an auditor but will facilitate the audit and provide needed information.

In accordance with 10 CFR 20.1101(c), the objectives of the third-party audit program will be to evaluate:

- Efforts to maintain doses to levels which are ALARA;
- Compliance with NRC and DOT regulations and license conditions;
- The ability to identify and correct deficiencies in the RPP;
- Overall management of the RPP including senior management's role and commitment;
- Implementation of the radiation monitoring program; and
- Whether operating procedures that can potentially affect the use of radiative materials or occupational dose have been developed, documented, implemented, and maintained to demonstrate compliance with 10 CFR 20.1101(a).

A written report of the RPP audit will be sent to the RER Technical Specialist. The report will be consistent with Appendix G of NUREG–1556, Volume 12 (NRC 2000).

10.2 Radiation Monitoring Instruments and Calibration

10.2.1 Instruments

RER will use instruments that meet the specifications of instruments used to monitor radiation in Appendix H in NUREG–1556, Volume 12 (NRC 2000). Table 6 provides a list of instruments, or their equivalents, that will be used for the radiological survey/monitoring program. RER will modify the inventory of radiation survey instruments, as necessary.

Table 6. Proposed radiation monitoring instruments and sources

Instrument Type	Use	Make/Model Example [a]	Number of Units [a]	Estimated Sensitivity [b]
TLD or OSL dosimeters from a NVLAP-approved provider	External dose monitoring (personnel)	Landauer OSL	1 per worker per quarter	1 mrem
Track etch detectors	Radon monitoring (passive)	Radonova	10 paired detectors (with/without radon-220 filter)	1.4E-10 µCi mL^{-1} over two months
Mobile, continuous electrostatic collection alpha spectroscopy	Radon monitoring (real-time)	Durridge RAD7	1	1E-10 µCi mL^{-1}
Exposure rate meter	General area gamma radiation surveys Surveys of packages/waste containers Personnel and facility contamination measurements	Ludlum Model 19	2	1 µR hr^{-1}
Sodium iodide detector	General area gamma radiation surveys Personnel and facility contamination measurements	Ludlum Model 44-10 with Ludlum Model 2221	2 meter/detector pairs	Scanning MDCs (MARSSIM 2000, Table 6.7): 2.8 pCi g^{-1} for Ra-226 in equilibrium with all decay products 1.8 pCi g^{-1} for Th-232 in equilibrium with all decay products 80 pCi g^{-1} for natural uranium
Alpha scintillator detector	Surveys of packages/waste containers	Ludlum Model 43-5 with Ludlum Model 2241	2 meter/detector pairs	Scanning MDC (Table 8): 721 dpm 100 cm^{-2} alpha
Alpha scintillator with thick plastic beta scintillator	Surveys of packages/waste containers Personnel and facility contamination measurements	Ludlum Model 43-93 with Ludlum Model 2360	2 meter/detector pairs (plus spare detector)	Static MDC (Table 8): 74 dpm 100 cm^{-2} alpha 1111 dpm 100 cm^{-2} beta Scanning MDC (Table 8): 214 dpm 100 cm^{-2} alpha 4938 dpm 100 cm^{-2} beta
Pancake Geiger-Mueller detector (unshielded) with detachable dose filter and exposure rate readout	Surveys of packages/waste containers Personnel and facility contamination measurements	Ludlum Model 44-9 with Ludlum Model 12 and Dose Filter	2 meter/detector pairs (plus spare detector)	Static MDC (Table 8): 3333 dpm 100 cm^{-2} total Dose rate with detachable dose filter: 0.01 mrad/hr
Pancake Geiger-Mueller detector (shielded)	Personnel and facility contamination measurements	Ludlum Model 44-40 with Ludlum Model 12	2 meter/detector pairs	Static MDC (Table 8): 2234 dpm 100 cm^{-2} total
Benchtop sample counter	Surveys of packages/waste containers Air sampling	Ludlum Model 3030	2	Static MDC (Table 8): 17 dpm 100 cm^{-2} alpha 264 dpm 100 cm^{-2} beta
Breathing zone monitor (lapel sampler)	Air sampling (personnel)	Escort Elf lapel sampler	3	N/A
Mobile, continuous air sampling system	Air sampling (facility)	Hi-Q Environmental Products MRV-0523CV-HMF (115 VAC)	1	N/A

Instrument Type	Use	Make/Model Example [a]	Number of Units [a]	Estimated Sensitivity [b]
Alpha, beta, and gamma NIST traceable standard sources	Function checking equipment	Eckert & Ziegler / Ludlum polonium-210, technitium-99, and cesium-137 sources	1 each	N/A
Air flow calibrators	Function checking equipment	Zeon International	1 per system	N/A

[a] Instrument make/model and number of units are estimates for planning purposes. RER will modify the inventory of instruments, as necessary.
[b] Estimated sensitivity values are based on manufacturer specifications for example units and the MDC equations presented in **Table 8**.

cpm – counts per minute
dpm – decays per minute
dpm 100 cm^{-2} – decays per minute per 100 square centimeters
MDC – minimum detectable concentration
mrem – millirem
μCi mL^{-1} – microcuries per milliliter
μR hr^{-1} – micro-Roentgen per hour
NIST – National Institute of Standards and Technology
NVLAP – National Voluntary Laboratory Accreditation Provider
OSL – optically-stimulated luminescent dosimeter
pCi g-1 – picocuries per gram
pCi L^{-1} – picocuries per liter
RER – Rare Element Resources, Inc.
TLD – thermoluminescent dosimeter

10.2.2 Calibration

A vendor that the NRC or an Agreement State has licensed to perform instrument calibration will calibrate the portable instruments for radiation protection before first use, at least annually thereafter, and after any repair. Ongoing operational checks will supplement the calibrations.

10.2.3 Surface Contamination Detection Capability

10.2.3.1 Minimum Detectable Concentrations

The radionuclide-weighted surface contamination detection capability, or minimum detectable concentration (MDC), for radiation survey instruments will be calculated if the sensitivity of a counting system is unknown. Example MDC calculations (Table 8) and example values for relevant parameters (defined in Table 7) are provided below.

Table 7. Definitions of variables and constants for minimum detectable concentration calculations

Variable	Units	Definition
C_b	counts	Background counts
T_b	minutes	Background count time (1 minute unless otherwise specified)
$R_b = \frac{C_b}{T_b}$	cpm	Background count rate
C_g	counts	Sample counts
T_g	minutes	Sample count time (1 minute unless otherwise specified)
$R_g = \frac{C_g}{g}$	cpm	Sample count rate
$R_n = R_g - R_b$	cpm	Net count rate
d'	unitless	1.96 - target index of sensitivity for Type I error 10%, Type II error 25% (MARSSIM 2000, Table 6.5)
i	seconds	1 second - scan observation interval based on approximate scan speed of 1 detector width per second and estimated target area equal to detector field of view
$MDCR = d' \times C_b \times \frac{60}{i}$	cpm	Minimum detectable count rate (scanning) calculated for anticipated background level (counts during observation interval)
$\varepsilon_{total} = \varepsilon_{instrument} \times \varepsilon_{surface}$	cpm dpm^{-1}	Total efficiency calculated as the product of instrument and source efficiency (NRC 2020, Section 4), see calculations below
$2pi\ emission\ rate$	dpm	Source emission rate (2 pi geometry) provided by the NIST-traceable source certificate
$\varepsilon_{sureyor}$	unitless	0.71 – recommended conservative value for inexperienced surveyor ($\sqrt{p} = \sqrt{0.5}$) from guidance (NRC 2020, Section 6.2.2)
MDC	dpm 100 cm^{-2}	Minimum detectable concentration, see calculations below

cm - centimeters
cpm – counts per minute
dpm – decays per minute

Static MDC

An MDC for static counts will be calculated using the following equation (NRC 2020, Eq. 3.11):

$$MDC = \frac{2.71 + 3.29 \times \sqrt{R_b \times T_g \times \left(1 + \frac{T_g}{T_b}\right)}}{T_g \times \varepsilon_{total} \times \frac{probe\ area\ \text{cm}^2}{100\ \text{cm}^2}}$$

Scan MDC

An MDC for scanning surfaces will be calculated using the following equation (NRC 2020, Eq.6.4):

$$MDC_{scan} = \frac{d' \times \sqrt{C_b} \times \frac{60}{i}}{\varepsilon_{sureyor} \times \varepsilon_{instrument} \times \varepsilon_{surface} \times \frac{probe\ area\ \text{cm}^2}{100\ \text{cm}^2}}$$

Table 8. Example MDC calculations

Type	Instrument [a]	Measurement	$\varepsilon_{instrument}$	$\varepsilon_{surface}$ [b]	R_b [c]	MDC (dpm 100 cm^{-2})
Alpha scintillator	43-5 and 2241	Scanning alpha	0.26	0.25	3	721
Alpha/beta scintillator	43-93 with 2360	Static alpha	0.4	0.25	1	74
		Scanning alpha	0.4	0.25	1	214
		Static beta	0.3	0.25	300	1111
		Scanning beta	0.3	0.25	300	4938
Pancake Geiger-Mueller	44-9 with 12	Static all	0.3	0.25	60	3333
	44-40 with 12	Static all	0.3	0.25	25	2234
Benchtop sample counter	3030	Removable alpha	0.64	0.25	0	17
		Removable beta	0.54	0.25	50	264

[a] See instrument list (Table 6).
[b] The following surface efficiency values will be used (NRC 2020, pp. 4-4):
$\boldsymbol{\varepsilon_{surface}} = \mathbf{0.5}$ for beta emitters of maximum beta energy > 0.4 MeV
$\boldsymbol{\varepsilon_{surface}} = \mathbf{0.25}$ for alpha emitters and beta emitters of maximum beta energy between 0.15 MeV and 0.4 MeV
[c] Background count rate (counts per minute) estimated using manufacturer specifications for sensitivity or expected values.
dpm 100 cm^{-2} – decays per minute per 100 square centimeters
MDC – minimum detectable concentration
$\boldsymbol{\varepsilon_{instrument}}$ – instrument efficiency
R_b – background count rate
$\boldsymbol{\varepsilon_{surface}}$ – surface efficiency

The MDC equations above consider a correction for probe area as recommended in NRC guidance (MARSSIM 2000, Eq. 6-10). The scan MDC calculation will be adjusted to account for equipment with different surface areas in SOPs if needed.

Assumptions used in determining the MDC will be incorporated into the RPP to ensure that measurements satisfy data quality objectives for the program of interest. Details such as scan speed and distance from the source will be incorporated into activity-specific SOPs and into on-the-job training for radiation protection staff. Radiation protection staff will be trained to recognize changes in observed or documented results which may indicate that measurements are failing to meet data quality objectives, and RSO or designee review will be incorporated into document review and periodic audits of the RPP implementation.

10.2.3.2 Instrument Efficiency

Operationally, instrument efficiency will be calculated by conducting counts of the NIST-traceable sources described in Table 9.

Table 9. Radioactive sources

Source Type	Radionuclide	Energy Notes	Dimensions [a]
Alpha	Polonium-210	5.3 MeV α	Circular 4.7 cm diameter 17.3 cm^2 area 0.32 cm thick
Beta	Technitium-99	0.11 MeV mean β^-	Circular 4.7 cm diameter 17.3 cm^2 area 0.076 cm thick
Gamma	Cesium-137	0.19 MeV mean β^- 0.66 MeV γ from barium-137m	Circular 4.7 cm diameter 17.3 cm^2 area

[a] Source dimensions are estimates for planning and sensitivity estimating purposes. Inventory may be modified as necessary for operations.
cm – centimeter
MeV – mega electron volts

Instrument efficiency will be calculated as follows:

$$\varepsilon_{instrument} = \frac{R_n}{2pi\ emission\ rate}$$

In all cases, sources used for determining instrument efficiency will be smaller than the active area of the probe, so an area correction will not be required because the fraction of the surface emissions that are subtended by the probe area is 100% (NRC 2020, pp. 4-2).

The sources used for determining instrument efficiency (Table 9) have emission energies similar to those of the radionuclides of interest as follows:

Thorium-232 series alpha energies vary between 3.8 mega electron volts (MeV) and 8.8 MeV and have an average, emission weighted alpha energy of 5.6 MeV per decay, assuming secular equilibrium (see Table 10).

Table 10. Emission-weighted alpha decay energy for thorium-232 series

Isotope	Alpha energy (MeV)	Emission fraction	Weighted emission energy (MeV)
Thorium-232	3.95	22%	0.86
	4.01	78%	3.14
	Subtotal	100%	3.99
Thorium-228	5.34	26%	1.39
	5.42	73%	3.98
	Subtotal	99%	5.37
Radium-224	5.45	5%	0.28
	5.69	95%	5.40
	Subtotal	100%	5.67
Radon-220	6.29	100%	6.28
Polonium-216	6.78	100%	6.78
Bismuth-212	6.05	25%	1.52
	6.09	10%	0.59

	Subtotal	35%	2.11
Polonium-212	8.87	100%	8.87
Thorium series		**6.3 alphas per decay**	**5.58 average energy**

Note: emission energies and abundances are from primary alpha emissions, NuDat 3.0
MeV – mega electron volts

Uranium-238 (U-238) series alpha energies vary between 4.2 MeV and 7.7 MeV and have an average, emission weighted alpha energy of 5.4 MeV per decay, assuming secular equilibrium (see Table 11)

Table 11. Emission-weighted alpha decay energy for uranium-238 series

Isotope	Alpha energy (MeV)	Emission fraction	Weighted emission energy (MeV)
Uranium-238	4.15	21%	0.87
	4.20	79%	3.32
	Subtotal	100%	4.19
Uranium-234	4.77	71%	3.41
	4.72	28%	1.34
	Subtotal	100%	4.75
Thorium-230	4.69	76%	3.58
	4.62	23%	1.08
	Subtotal	100%	4.66
Radium-226	4.78	94%	4.49
	4.60	6%	0.28
	Subtotal	100%	4.77
Radon-222	5.49	100%	5.48
Polonium-218	6.00	100%	6.00
Polonium-214	7.69	100%	7.69
Polonium-210	5.30	100%	5.30
Uranium series		**8 alphas per decay**	**5.36 average energy**

Note: emission energies and abundances are from primary alpha emissions, NuDat 3.0
MeV – mega electron volts

Thorium-232 series beta energies up to 2.3 MeV β_{max} (bismuth-212) and a weighted average maximum energy of 0.81 MeV (see Table 12).

Table 12. Emission-weighted maximum beta decay energy for thorium-232 series

Isotope	β_{max} energy (MeV)	Emission fraction	Weighted emission energy (MeV)
Radium-228	0.04	100%	0.04
Actinium-228	0.98	7%	0.07
	1.01	7%	0.07
	1.12	3%	0.04
	1.17	32%	0.37
	1.74	12%	0.21
	2.08	8%	0.17
	Subtotal	69%	0.92
Lead-212	0.16	5%	0.01
	0.33	85%	0.28
	0.57	10%	0.06
	Subtotal	100%	0.35
Bismuth-212	1.59	8%	0.13
	2.25	48%	1.09
	Subtotal	56%	1.21
Thallium-208	1.28	25%	0.32
	1.52	21%	0.32
	1.80	50%	0.90
	Subtotal	96%	1.54

Isotope	β_{max} energy (MeV)	Emission fraction	Weighted emission energy (MeV)
Thorium series			**0.81 weighted average maximum energy**

Note: emission energies and abundances are from primary beta emissions (Johnson and Birky 2012, Tables 8.8 and 8.10)
MeV – mega electron volts

Uranium-238 series beta energies up to 3.3 MeV β_{max} (bismuth-214) and a weighted average maximum energy of 0.73 MeV (see Table 13).

Table 13. Emission-weighted maximum beta decay energy for uranium-238 series

Isotope	β_{max} energy (MeV)	Emission fraction	Weighted emission energy (MeV)
Thorium-234	0.08	3%	0.00
	0.10	6%	0.01
	0.10	19%	0.02
	0.19	73%	0.14
	Subtotal	100%	0.16
Protactinium-234 metastable		99%	2.25
Lead-214	0.67	48%	0.32
	0.73	43%	0.31
	1.03	6%	0.06
	Subtotal	97%	0.70
Bismuth-214	1.42	8%	0.12
	1.51	18%	0.26
	1.54	18%	0.28
	3.27	18%	0.58
	Subtotal	62%	1.24
Lead-210	0.02	80%	0.01
	0.06	20%	0.01
	Subtotal	100%	0.03
Bismuth-210	1.16	100%	1.16
Uranium series			**0.73 weighted average maximum energy**

Note: emission energies and abundances are from primary beta emissions (Johnson and Birky 2012, Tables 8.8 and 8.10)
MeV – mega electron volts

Therefore, the manufacturer-reported efficiency for plutonium-239 alpha (emission-weighted energy of 5.1 MeV) and technetium-99 beta (0.29 MeV), which are generally lower than the values in the above tables, will conservatively approximate the instrument efficiency for uranium and thorium series emissions. Example radionuclide-weighted values for $\varepsilon_{instrument}$ are provided in Table 14.

Table 14. Example values for instrument efficiency

Instrument [a]	Measurement	Example $\varepsilon_{instrument}$	Justification
43-5 with 2241	Static/scanning alpha	0.26	Based on 4-pi efficiency of 13% from Ludlum for Pu-239
43-93 with 2360	Static/scanning alpha	0.4	Based on 4-pi efficiency of 20% from Ludlum for Pu-239
	Static/scanning beta	0.3	Based on 4-pi efficiency of 15% from Ludlum for Tc-99 (conservatively assumes 0% backscatter)
44-9 with 12	Static alpha/beta/gamma	0.3	Based on 4-pi efficiency of 15% from Ludlum for Pu-239
44-40 with 12	Static alpha/beta/gamma	0.3	Based on 4-pi efficiency of 15% from Ludlum for Pu-239
3030	Removable alpha	0.64	Based on 4-pi efficiency of 32% from Ludlum for Th-230

Instrument [a]	Measurement	Example $\varepsilon_{instrument}$	Justification
	Removable beta	0.54	Based on 4-pi efficiency of 27% from Ludlum for Tc-99 (conservatively assumes 0% backscatter)

[a] See instrument list in **Table 6**.
Pu-239 – plutonium-239
Tc-99 – technetium-99
Th-230 – thorium-230

10.2.3.3 Dose Rate Limit

Note 6 in NUREG-1556, Vol. 12, Table M-2, "Acceptable Surface Contamination Levels for Equipment," requires that "the average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad h^{-1} at 1 cm and 1.0 mrad h^{-1} at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber." Table 16 provides the results of conservative, empirical dose rate estimate for the two most energetic beta emitters in the thorium-232 and uranium-238 series for the Demonstration Project. NRC has previously determined (NRC 2015) that the beta/gamma surface activity limits in Table M-2 are more restrictive for U-238 series radionuclides than the note 6 dose rate limits, which means that the dose rate limits in note 6 will be met if the beta-gamma emitter surface activity limits are met.

Using the following equation (Johnson 2017, Eq, 6.33b) with variables defined in Table 15:

$$\dot{D}_\beta = 3.6 \times 10^{-2} \times C_a \times \bar{E} \times \mu_{\beta,t} \times e^{(-\mu_{\beta,a} \times d)} \times e^{(-\mu_{\beta,t} \times 0.007)}$$

the average and maximum radiation levels in Table 16 associated with surface contamination resulting from beta-gamma emitters meeting the surface criteria in Table 17 will not exceed 0.2 mrad h^{-1} (average) or 1.0 mrad h^{-1} (maximum) measured through not more than 7 mg cm^{-2} of total absorber. Therefore, demonstrating compliance with the surface criteria in Table 17 will be sufficient to ensure compliance with the note 6 dose rate limit.

Table 15. Definition of variables and constants for beta dose rate calculation

Variable	Units	Definition
$\dot{D}_\beta$	mrad h^{-1}	dose rate to the basal cells of the skin at a depth of 7 mg cm^{-2}
3.6×10^{-2}	constant	Constant calculated as: $0.5\ (\beta^-\ \text{directed upward}) \times 1.25\ (25\%\ \text{scattered upward}) \times \frac{1.6 \times 10^{-13}\ \text{J}}{\text{MeV}} \times \frac{3600\ \text{s}}{\text{h}} \times \frac{10^6\ \text{g mGy}}{\text{J}} \times \frac{100\ \text{mrad}}{\text{mGy}}$
C_a	Bq cm^{-2}	Surface area concentration of beta contamination, calculated as: $\frac{5000\ \text{dpm}}{100\ \text{cm}^2} \times \frac{\text{Bq}}{60\ \text{dpm}} = 0.83\frac{\text{Bq}}{\text{cm}^2}$ average from Table 17 $\frac{15000\ \text{dpm}}{100\ \text{cm}^2} \times \frac{\text{Bq}}{60\ \text{dpm}} = 2.5\frac{\text{Bq}}{\text{cm}^2}$ maximum from Table 17
E_{max} and $\bar{E}$	MeV	Maximum (Johnson and Birky 2012, Tables 8.8 and 8.10) and average (NuDat 3.0) beta energy of the emission: U-238 series: bismuth-214 and protactinium-234 Th-232 series: bismuth-212 and actinium-228
$\mu_{\beta,t}$	cm^2 g^{-1}	Beta absorption coefficient for tissue (Johnson 2017, Eq. 6.21): $\mu_{\beta,t} = 18.6 \times (E_{max} - 0.036)^{-1.37}$
$e^{(-\mu_{\beta,a} \times d)}$	unitless	Correction for beta absorption in air calculated using: the beta absorption coefficient for air (Johnson 2017, Eq. 6.20): $\mu_{\beta,a} = 16 \times (E_{max} - 0.036)^{-1.4}$ the density thickness of air (27°C) between a planar source and dose point:

		$$d = \frac{1.29 \times 10^{-3}\mathrm{g}}{\mathrm{cm}^3} \times \left(\frac{273}{300}\right) \times 1\ \mathrm{cm} = 1.2 \times 10^{-3}\,\frac{\mathrm{g}}{\mathrm{cm}^2}$$
$e^{(-\mu_{\beta,t} \times 0.007)}$	unitless	Correction for beta absorption in tissue calculated using a tissue depth of 0.007 g cm^{-2}

Table 16. Estimated beta skin dose rate for most energetic emissions

Nuclide	C_a	E_{max}	$\bar{E}$	$\mu_{\beta,t}$	$\mu_{\beta,a}$	$e^{(-\mu_{\beta,t} \times 0.007)}$	$e^{(-\mu_{\beta,a} \times d)}$	$\dot{D}_\beta$
Pa-234m	0.83	2.28	0.82	6.146	5.160	0.958	0.994	0.14
Bi-214	0.83	3.27	1.27	3.725	3.094	0.974	0.996	0.14
Bi-212	0.83	2.25	0.83	6.276	5.272	0.957	0.994	0.15
Ac-228	0.83	2.08	0.75	6.985	5.881	0.952	0.993	0.15
Pa-234m	2.50	2.28	0.82	6.146	5.160	0.958	0.994	0.43
Bi-214	2.50	3.27	1.27	3.725	3.094	0.974	0.996	0.21
Bi-212	2.50	2.25	0.83	6.276	5.272	0.957	0.994	0.45
Ac-228	2.50	2.08	0.75	6.985	5.881	0.952	0.993	0.44

Ac-228 – actinium-228
Bi-212/214 – bismuth-212/bismuth-214
Pa-234m – protactinium-234 metastable

10.3 Material Receipt and Accountability

RER will develop, implement, and maintain SOPs for ensuring the continual accountability of license materials.

Physical inventories will be conducted at intervals not to exceed six months, to account for all radioactive source materials received and possessed under this license.

The exploration sample will become licensed radioactive material during the PUG stage and will remain licensed through the Demonstration Plant processes until shipped as a radioactive waste. Small, sealed sources and x-ray fluorescence analyzers could potentially be used at the onsite analytical laboratory, along with minor amounts of radioactive chemicals for use as matrix spikes or radiotracers. These materials (Table 6) may qualify as exempt small quantities that do not require licensing. Nuclear density gauges containing sealed sources could also be used in process facilities as flow meters or particle size monitors. Non-exempt sealed sources or other small quantities of radioactive materials, if used at the facility for such ancillary purposes, will be obtained under separate radioactive materials license application(s) for such sources, if needed.

10.4 Occupational Dose

RER will monitor individuals in accordance with the guidance in section 8.10.4 of NUREG–1556, Volume 12 (NRC 2000). Any personnel onsite for 5 or more days annually will be given a personal OSL dosimeter to monitor external doses received. The proposed 5-day threshold is based on estimated external dose rate of the most limiting external dose scenario for the Demonstration Project (i.e., standing 1 meter away from a wall of storage containing exploration sample held in super sacks). For personnel onsite for fewer than 5 days annually, external doses are unlikely to exceed 10 mrem (see Table 18, footnote a. for additional information regarding external dose potential).

RER will maintain for inspection by the NRC documentation demonstrating that unmonitored individuals, if any, are not likely to receive radiation doses in excess of the limits in 10 CFR 20.1502. Proposed monitoring for occupational dose assessment is described in Table 18.

A policy and procedures for declared pregnant workers will be maintained consistent with 10 CFR 20.1208 and 10 CFR 20.1502. External dose will be monitored for all workers via personal OSL dosimeters, which meets the monitoring requirements in 10 CFR 20.1502. While there are no anticipated changes to work situation for declared pregnant workers, measured external exposure rates from routine occupational surveys may be used to perform a prospective evaluation of occupational dose to the embryo/fetus during the worker's pregnancy.

10.5 Public Dose

Prospective public dose evaluations for the Demonstration Project [provided as Appendix F to the *Environmental Report* (RER 2022)] indicate that public doses from licensed activities are not likely to exceed the public dose limits in 10 CFR 20.1301. During operations, compliance will be shown with the annual dose limit in 10 CFR 20.1301 consistent with 10 CFR 20.1302 and NUREG 1736 section 3.20.1302 (NRC 2001). Public dose will be evaluated according to the method specified 10 CFR 20.1302(b)(1), "demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit." Airborne effluents (particulates and radon) from the Demonstration Plant facilities will be monitored and the dose received by the member of the public receiving the highest dose from the licensed activity will be calculated.

Based on available meteorological data and assumed occupancy, it is anticipated that members of the public in the nearest neighborhood (Figure 6) will be the critical group. The occupancy of other members of the public, such as delivery personnel, is expected to be small compared to the critical group.

Proposed monitoring for public dose assessment is described in Table 18.

10.6 Safe Use of Radionuclides and Emergency Procedures

RER will 1) develop and document procedures for the safe use, security, and emergencies before the generation or receipt of licensed material; and 2) implement and maintain SOPs and emergency procedures.

Procedures will be revised only if the changes 1) are reviewed and approved in writing by the SERP; 2) comply with NRC regulations and the license; 3) do not degrade the effectiveness of the program; and 4) relevant RER personnel are provided training in the revised procedures prior to their implementation.

10.6.1 Minimization of Contamination

Section 9 provides detailed descriptions of how the facility design, processes, and operational procedures will minimize contamination of the facility and potential releases of contaminants to the environment, in accordance with the requirements of 10 CFR 20.1406 and 10 CFR 20.1701. Routine contamination surveys are described in Table 18.

10.6.2 Radiation Work Permits

RER will prepare a written Radiation Work Permit (RWP) under the supervision of the RSO for any activity when the potential for exposure to radioactive material exists and for which no SOP already exists. The RWP will describe the following:

- Scope of the task to be performed;
- Potential radiological and physical hazards that may be encountered;
- Precautions necessary to maintain radiation exposures ALARA;
- Any necessary radiological surveys, monitoring, or sampling;
- Any appropriate task-specific training;
- Appropriate personal protective equipment (PPE) for the task;
- Documentation of any survey, monitoring, or sampling results; and
- Identification of personnel who will perform the task.

Examples of tasks that may require a RWP include:

- Maintenance on equipment, *e.g.*, pumps and piping, in the vicinity of unshielded sources of unusually high gamma radiation emissions.
- Maintenance on airborne effluent scrubbers, bag houses, or other pollution control equipment that may contain radioactive material.
- Other work as directed by the RSO to ensure that doses are kept ALARA.

The RSO (or RSO designee) will review, approve, and sign the RWP before the start of a task. Any facility worker may identify the need for an RWP, but it will be prepared by qualified radiation safety staff for review and approval by the RSO.

10.6.3 Posting Program

Entrances to the restricted area will be posted conspicuously with standard yellow and magenta signs including the words "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL," to provide general compliance with 10 CFR 20.1902(e). Some areas within the restricted area, *e.g.*, containerized waste storage areas, may need to be posted as "airborne radioactivity areas" or "radiation areas" as defined in 10 CFR 20.1003 and as required by 10 CFR 20.1902. Routine radiological surveys and measurements will determine if these special postings are required.

10.6.4 Quality Assurance/Quality Control

Prior to operations, RER will establish a quality assurance (QA) program applicable to the Demonstration Project consistent with recommendations in Regulatory Guide 4.15 *Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment* (NRC 2007). The purpose of the program is to ensure that all radiological and non-radiological measurements that support the radiological monitoring program are reasonably valid and of a defined quality. This program is needed to 1) identify deficiencies in sampling and measurement processes and report them to germane, responsible personnel such that they may take corrective action and 2) obtain a measure of confidence in the results of the monitoring program to assure NRC and the public that the results are valid.

The QA program will contain the following elements of Regulatory Guide 4.15 (NRC 2007):

- Organizational structure, responsibilities, and qualifications of both management and operational personnel;
- Qualifications of personnel;
- SOPs used in the monitoring programs;
- Records of samples, from collection to offsite shipment for analysis;
- Records of quality control (QC) of the sample analyses, including results of QC blanks, duplicates, and cross-checks performed by other laboratories;
- Calibration and operation of equipment used in obtaining samples, measuring radiation, etc.;
- Data verification and validation procedures; and
- Data and calculations used to determine concentrations of radioactive materials, radiation doses due to occupational exposure, etc.

QA procedures will be defined for the following:

- External Monitoring Program
- Airborne Radiation Monitoring Program
- Contamination Control Program
- Airborne Effluent Program
- Management Control Program

In general, the QC requirements for a specific activity will be incorporated into its respective SOP.

The elements of QA/QC regarding the radioanalytical methods of section 6 of Regulatory Guide 4.15 (NRC 2007) will be addressed in facility SOPs, provided the data are being used to support the programs listed above. Contract analytical laboratories will be given the requirements of Regulatory Guide 4.15 as part of the selection process. Selection of the contract laboratory will be based partially on its ability to develop and implement the QA/QC requirements of Regulatory Guide 4.15.

10.7 Radiological Surveys and Monitoring

Radiological surveys and monitoring will be important components of the RPP, in accordance with the requirements of 10 CFR 20 Subpart F. RER will survey all facilities and maintain contamination levels in accordance with the survey frequencies and contamination levels in Appendix M to NUREG–1556, Volume 12 (NRC 2000). A plan has been proposed to monitor work areas with a rotating schedule of mobile units during operations (Table 18) to establish occupational exposure potential and allow flexibility to adapt monitoring and control systems to optimize function. Additional monitoring requirements are discussed in the WDEQ air quality permit [Appendix I to the *Environmental Report* (RER 2022)].

Pre-operational and routine operational surveys will also be implemented for contamination control and to locate any potential buildup of radioactive material or changes in external dose rates. As recommended by Regulatory Guide 8.25 (NRC 1982), airflow patterns and the locations of ventilation air inlets and exhausts and sources of airborne radioactive materials will be noted in planning operational monitoring and in the event of any ventilation changes. Additional discussion of process control systems is provided in Appendix E.

Components of the radiological survey and monitoring program are identified in Table 18.

10.7.1 Acceptable Surface Contamination Levels

The proposed acceptable surface contamination levels are the most restrictive surface contamination values listed in Table M-2 of Appendix M to NUREG–1556, Volume 12 (NRC 2000), which are consistent with the “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material” (NRC 1987b). The acceptable surface contamination levels in Table 17 will apply for personnel monitoring, surveys of unrestricted areas, and releasing equipment and items for unrestricted use. If different values or derived values for mixtures of radionuclides are considered, a request will be submitted for NRC review.

For surveys of surfaces in restricted areas, alpha values will be compared to the levels in Table 17, which are based on NRC guidance (NRC 2002a, Section 2.5) for an achievable ALARA level and are considered low enough to ensure little contribution to airborne radioactivity (10^{-3} μCi cm^{-2} or 220,000 dpm 100 cm^{-2}).

The values in Table 17 will be used as ALARA action levels for all surveys for surface contamination. Processes, instrumentation, and survey procedures will be evaluated for possible changes if these values are exceeded.

Table 17. Proposed acceptable surface contamination levels

Use	Value	Average	Maximum	Removable
Personnel monitoring, surveys of unrestricted areas, and releasing equipment and items for unrestricted use	Alpha surface radioactivity (dpm 100 cm^{-2})	100	300	20
	Beta surface radioactivity (dpm 100 cm^{-2})	5,000	15,000	1,000
Surveys of restricted areas	Alpha surface radioactivity (dpm 100 cm^{-2})	220,000	660,000	44,000

Note: It will be conservatively assumed that all measured alpha radiation is attributable to radionuclides in the most restrictive category of Table M-2 of Appendix M to NUREG–1556, Volume 12 (NRC 2000).

dpm 100 cm^{-2} – decays per minute per 100 square centimeters

10.8 Maintenance

RER expects the maintenance of facilities and repair of process equipment to be integral to completing the Demonstration Project, ensuring radiation protection, and keeping doses ALARA. Maintenance itself, however, can lead to routine or non-routine exposures to sources of radioactivity. RER will develop and implement SOPs for routine maintenance activities. Non-routine maintenance, or any non-routine activity not covered by an SOP and where there is the potential for exposure to licensed materials above a control limit, will require an RWP, as described in section 10.6.2. RER expects to review and identify the need for maintenance, or the effectiveness of maintenance performed with respect to radiation safety during routine reviews, audits, and/or NRC inspections.

10.9 Transport of Radioactive Materials

Transport of licensed radioactive materials beyond the restricted area will comply with applicable DOT and NRC regulations. NRC transportation regulations (10 CFR 71) apply specifically to packaging requirements for licensed material to be transported outside of licensed facilities, while the DOT regulates such shipments while they are in transit and sets standards for labeling and smaller quantity packages. Procedures to meet these regulations and all facility NRC license requirements will include the use of NRC-approved packaging/containment for shipments, contamination surveys of packages/transport vehicles, and proper package labeling, vehicle placarding, and material manifests. Vehicles used to transport materials to or from the Demonstration Plant will not access the restricted area; therefore, no decontamination will be needed provided the applicable DOT and NRC regulations for transportation of radioactive materials are met.

Table 18. Proposed routine radiological surveys and monitoring

Building	PUG/Sample Storage Facility	Main Process Facility	Other Facilities
Ambient Radiation Level Surveys	• Monthly exposure rate measurements near stored sample (Figure 5)	• Monthly exposure rate measurements in radioactive material process areas (Figure 5)	• Monthly exposure rate measurements in waste storage area (location identified in Attachment 1 to Appendix C). • Exposure rate measurements around restricted area fence boundary monthly during operations and quarterly during construction and decommissioning
Occupational External Dose Monitoring	• All personnel onsite for ≥ 5 days [a] will be issued a personal dosimeter	• All personnel onsite for ≥ 5 days [a] will be issued a personal dosimeter	• All personnel onsite for ≥ 5 days [a] will be issued a personal dosimeter
Contamination Surveys	• Surveys before and after PUG processing, including: 1) indoor/outdoor gamma radiation surveys, 2) scanning and swipes for removable and total alpha and/or beta contamination	• Daily [e] surveys of process areas, including: 1) indoor/ outdoor gamma radiation surveys, 2) scanning and swipes for removable and total alpha and/or beta contamination	• Routine personnel contamination surveys (at a minimum hands and feet) for all personnel leaving the restricted area performed at one location identified on Figure 5 [f] • Monthly surveys of office and gate areas
Unrestricted Release Surveys	• Release surveys [b] for equipment demobilization and maintenance	• Release surveys [b] for equipment demobilization and maintenance	• Surveys of packages/waste containers to meet DOT regulations
Occupational Air Monitoring	• Breathing zone monitoring for representative worker during PUG processing • Passive radon [d] track etch monitoring for project duration (Figure 5)	• Weekly breathing zone monitoring for representative workers [c] • Mobile, continuous area air sampling (8-hour sample duration) rotating weekly through radioactive material process areas [c] • Passive radon [d] track etch monitoring for project duration (Figure 5)	N/A
Airborne Effluent Release Monitoring	• Mobile, continuous area air sampling outside of south side of building during PUG processing for emissions/public dose assessment • Real-time, continuous radon [d] monitoring at open end of facility during PUG processing	• Weekly, isokinetic stack monitoring for radon [d] from each scrubber stack for emissions/public dose assessment • Semi-annual particulate emission evaluation for stack by a third party for emissions/public dose assessment	• Passive radon [d] track etch and OSL dosimeter monitoring at restricted area fence over project duration for public dose assessment (Figure 6)

[a] Personnel onsite for less than 5 days are unlikely to receive an external dose exceeding 10 mrem based on the estimated external dose rate for a worker standing 1 meter away from a "wall" of stored exploration sample in super sacks, which is the most limiting external dose scenario for the Demonstration Project. The conservatively estimated external dose rate to this individual is 0.58 mrem hr^{-1}. 100% occupancy for 5 working days (40 hours) could result in an external dose of 23 mrem, however no more than 25% occupancy is considered realistic for the PUG/Sample Storage facility, which is open to the elements, does not have any office space, and will not have a routine use other than sample storage. Note: Any activity when the potential for exposure to radioactive material exists and for which no SOP already exists will be covered by a radiation work permit with appropriate dose monitoring.

[b] Radioactivity levels on surfaces for unrestricted release will meet the levels listed in Table M-2 of Appendix M to NUREG–1556, Volume 12, which are consistent with the "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" (NRC 1987a).

[c] Occupational air monitoring in the Main Process Facility will be used to establish exposure potential. After exposure potential is established, frequency of sample collection may be reduced to monthly.

[d] Radon monitoring will have the ability to discriminate between radon-220 and radon-222. NRC's recommended equilibrium fractions of 0.5 for indoor exposures and 0.7 for outdoor exposures will be used (NRC 2019). A radon track etch and OSL dosimeter will be installed at the Met station indicated in Figure **6**. Results from this location will be subtracted as a background value for public dose assessment.

[e] Frequency of contamination surveys is consistent with NUREG 1156, Volume 12, Appendix M, Table M-1 (NRC, 2000). However, expected contamination levels are low since processing occurs in a closed system with ventilation controls.

[f] An SOP, training, and signage within the restricted area will be used to direct all personnel to perform a contamination survey before exiting the restricted area.

DOT – US Department of Transportation
PUG – physical upgrade
SOP – standard operating procedure

10.10 Recordkeeping and Reporting

10.10.1 Records

Records will be maintained in accordance with the applicable requirements of 10 CFR 20 Subpart L, including the following:

- Current RPP and all provisions (including SOPs);
- Results of internal reviews, external audits, and inspections of the RPP, including any NRC-approved changes that may have resulted from such evaluations;
- Records of surveys, workplace/environmental monitoring and sampling, and instrument calibrations;
- Records of all surveys and monitoring, with associated calculations and modeling, used to estimate radiation doses to workers and members of the public;
- Records of all measurements, monitoring, and calculations of radiological effluent releases;
- Records of occupational doses to individual workers for the current year and cumulative dose histories including prior exposures;
- Records of any doses exceeding regulatory limits due to planned special exposures or responses to accidental spills or releases; and
- Records of waste disposal, including materials shipped offsite for disposal at an approved facility.

In general, RER will summarize most of this information in annual reports and retain hard copy and electronic records, *e.g.*, raw data, field notes, and modeling runs. These records will be maintained for no less than three years or until license termination, as specified in 10 CFR 20 Subpart L.

10.10.2 Reporting

Reporting will be performed in accordance with applicable requirements of 10 CFR 20 Subpart M and 10 CFR 40.60. RER also will prepare an effluent monitoring report as required by the WDEQ.

11 Waste Management

RER will use the model waste procedures and guidelines published in Appendix P to NUREG–1556, Volume 12 (NRC 2000). Detail on waste generation and quantities is provided in section 9.1.5 and Appendix C. Waste handling and shipment is described in the *Environmental Report* (RER 2022), section 4.13.

12 Fees

This information is provided on NRC Form 313 (Appendix A).

13 Certification

This information is provided on NRC Form 313 (Appendix A).

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Figures

Figure 1. Demonstration Project boundary near Upton, Wyoming

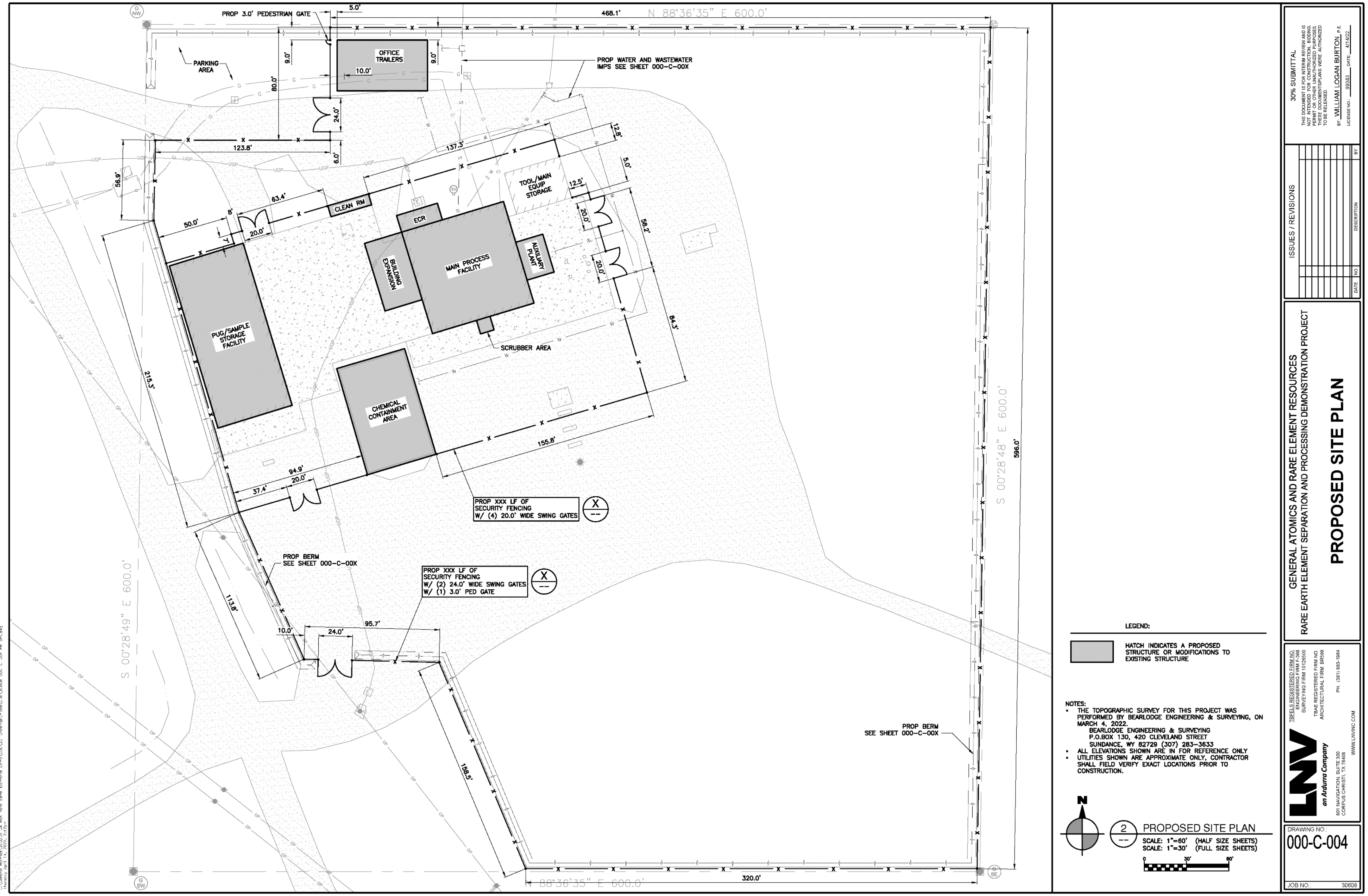

Figure 2. Proposed Site Plan for the Demonstration Project

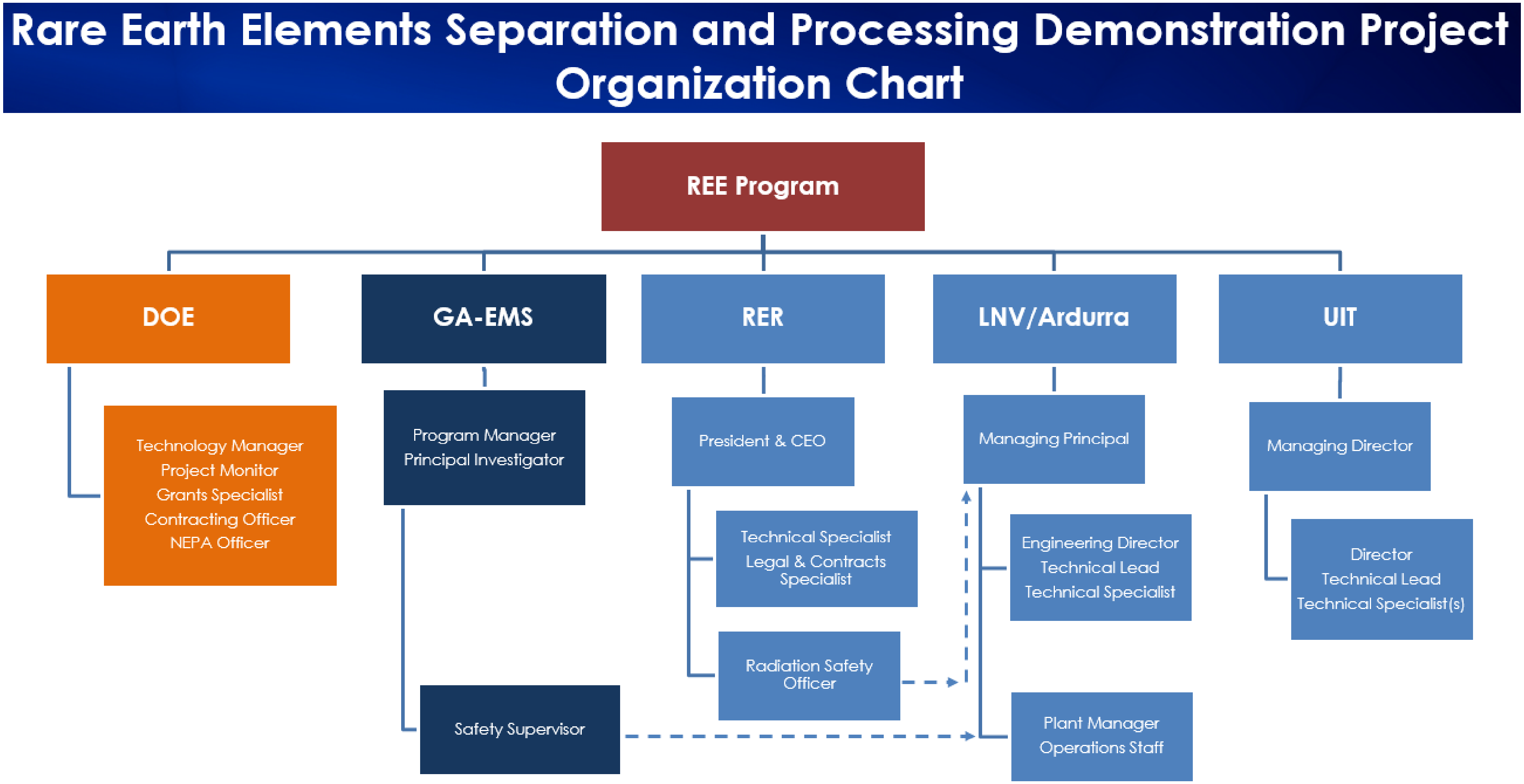

Figure 3. Demonstration Project team organization chart

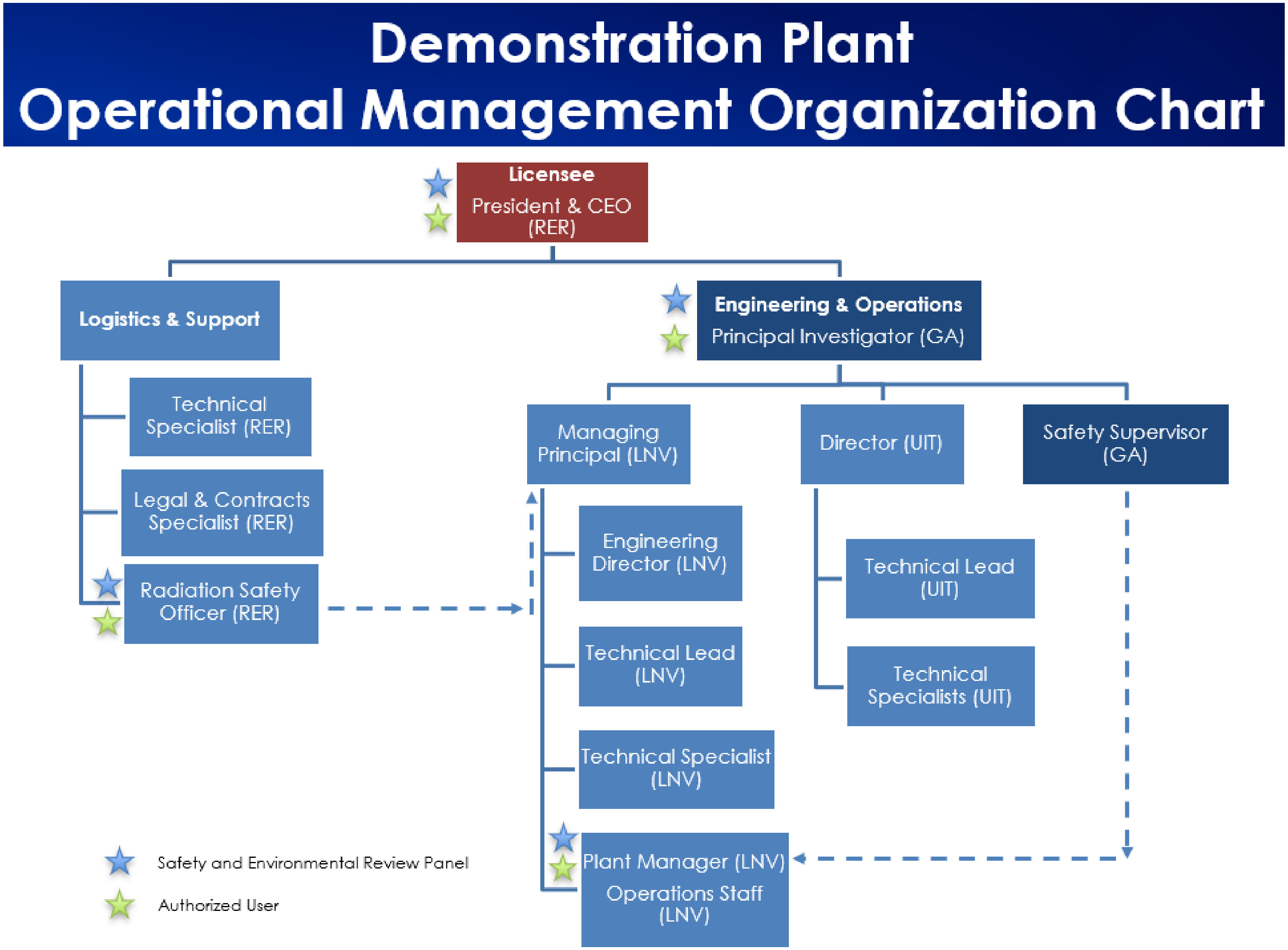

Figure 4. Demonstration Plant operational management organization chart

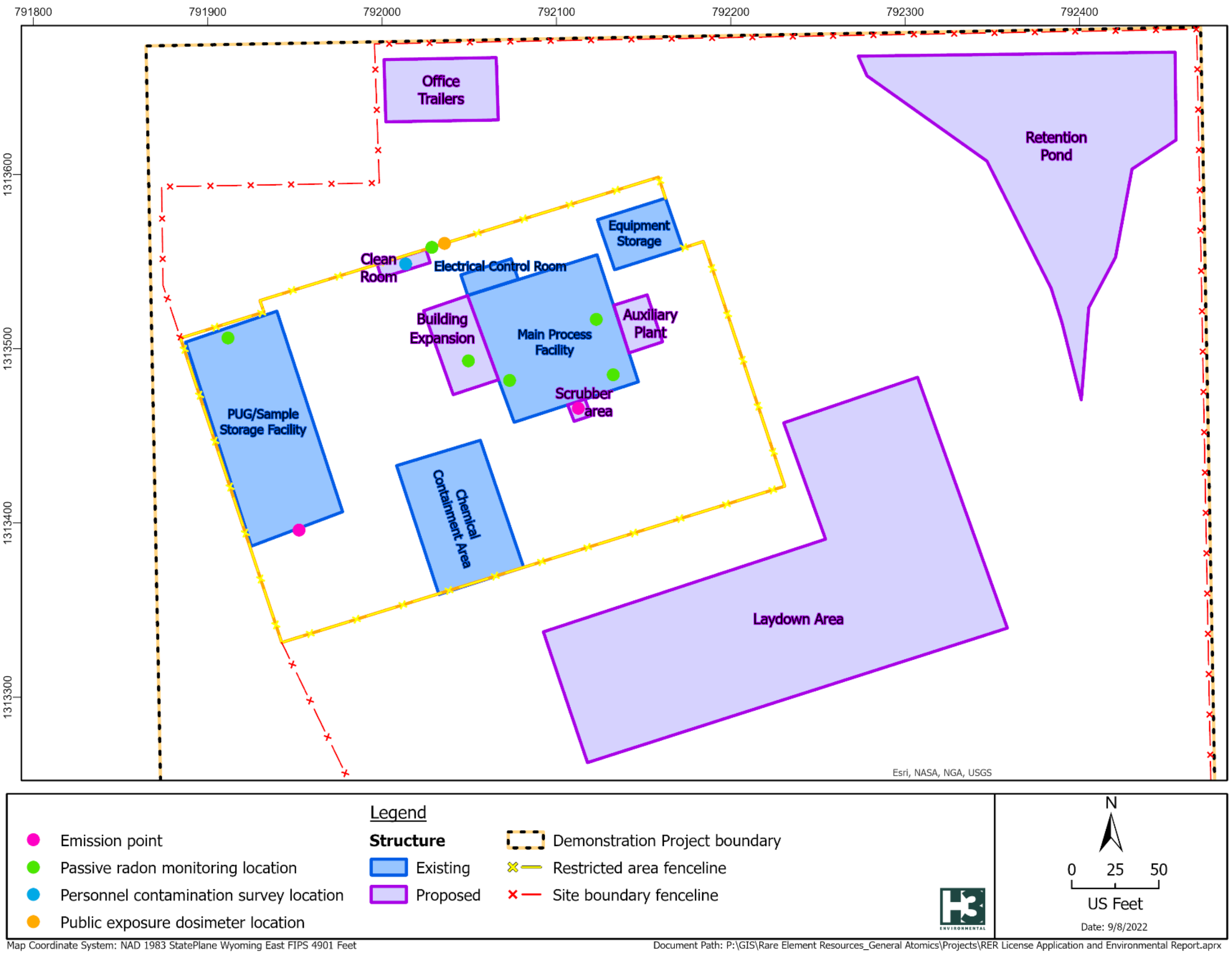

Figure 5. Demonstration Project restricted area map

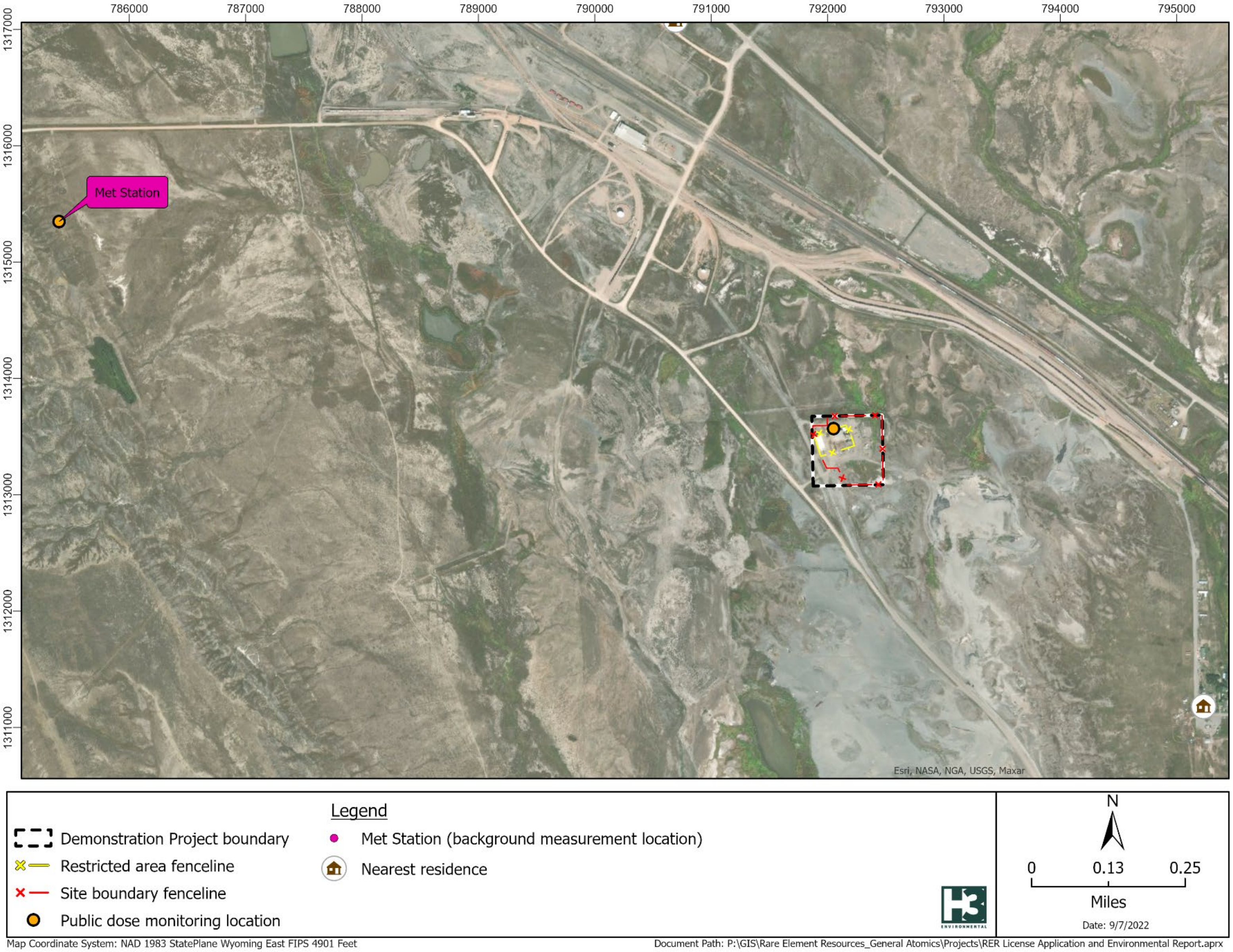

Figure 6. Public dose monitoring

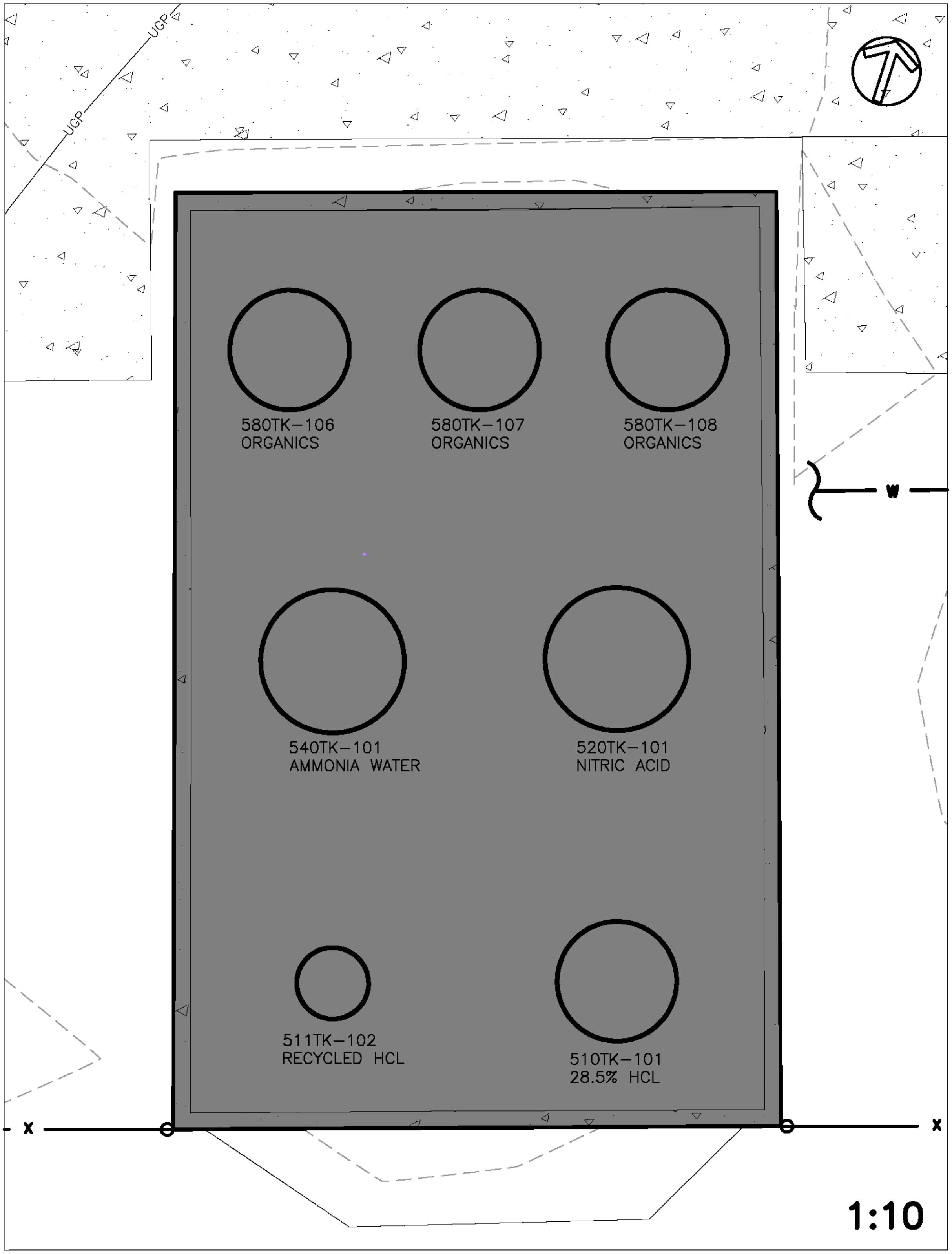

Figure 7. Chemical Tank Layout

Appendix A: NRC Form 313

NRC FORM 313 (01-2020)
10 CFR 30, 32, 33, 34, 35, 36, 37, 39, and 40

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR MATERIALS LICENSE

APPROVED BY OMB: NO. 3150-0120 **EXPIRES: 01/31/2023**

Estimated burden per response to comply with this mandatory collection request: 4.3 hours. Submittal of the application is necessary to determine that the applicant is qualified and that adequate procedures exist to protect the public health and safety. Send comments regarding burden estimate to the Information Services Branch (T-6 A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0120), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

INSTRUCTIONS: SEE THE CURRENT VOLUMES OF THE NUREG-1556 TECHNICAL REPORT SERIES ("CONSOLIDATED GUIDANCE ABOUT MATERIALS LICENSES") FOR DETAILED INSTRUCTIONS FOR COMPLETING THIS FORM: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1556/. SEND TWO COPIES OF THE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

MATERIALS SAFETY LICENSING BRANCH
DIVISION OF MATERIAL SAFETY, STATE, TRIBAL AND RULEMAKING PROGRAMS
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

ALABAMA, CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, FLORIDA, GEORGIA, KENTUCKY, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, NORTH CAROLINA, PENNSYLVANIA, PUERTO RICO, RHODE ISLAND, SOUTH CAROLINA, TENNESSEE, VERMONT, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA,

SEND APPLICATIONS TO:

LICENSING ASSISTANCE TEAM
DIVISION OF NUCLEAR MATERIALS SAFETY
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
2100 RENAISSANCE BOULEVARD, SUITE 100
KING OF PRUSSIA, PA 19406-2713

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND APPLICATIONS TO:

MATERIALS LICENSING BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

IF YOU ARE LOCATED IN:

ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, HAWAII, IDAHO, KANSAS, LOUISIANA, MISSISSIPPI, MONTANA, NEBRASKA, NEVADA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, OREGON, PACIFIC TRUST TERRITORIES, SOUTH DAKOTA, TEXAS, UTAH, WASHINGTON, OR WYOMING,

SEND APPLICATIONS TO:

NUCLEAR MATERIALS LICENSING BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
1600 E. LAMAR BOULEVARD
ARLINGTON, TX 76011-4511

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

- [x] A. NEW LICENSE
- [ ] B. AMENDMENT TO LICENSE NUMBER ______
- [ ] C. RENEWAL OF LICENSE NUMBER ______

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include zip code)*

Rare Element Resources, Inc.
P.O. Box 271049
Littleton, Colorado 80127

3. ADDRESS WHERE LICENSED MATERIALS WILL BE USED OR POSSESSED

131 Buffalo Creek Road
Upton, Weston County, Wyoming 82730
(SE1/4 NW1/4 Section 34
Township 48 North Range 65 West)

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Randall Scott

BUSINESS TELEPHONE NUMBER	BUSINESS CELLULAR TELEPHONE NUMBER
720-278-2460	303-521-5810

BUSINESS E-MAIL ADDRESS
rscott@rareelementresources.com

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL
   a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.
6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.
7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING AND EXPERIENCE.
8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.
9. FACILITIES AND EQUIPMENT.
10. RADIATION SAFETY PROGRAM.
11. WASTE MANAGEMENT.
12. LICENSE FEES (Fees required only for new applications, with few exceptions*)
    (See 10 CFR 170 and Section 170.31)
    ***Amendments/Renewals that increase the scope of the existing license to a new or higher fee category will require a fee.**

FEE CATEGORY: 2(A)(2)(f) AMOUNT ENCLOSED: $ 0.00

PER THE DEBT COLLECTION IMPROVEMENT ACT OF 1996 (PUBLIC LAW 104-134), YOU ARE REQUIRED TO PROVIDE YOUR TAXPAYER IDENTIFICATION NUMBER. PROVIDE THIS INFORMATION BY COMPLETING NRC FORM 531: https://www.nrc.gov/reading-rm/doc-collections/forms/nrc531info.html.

13. CERTIFICATION. *(Must be completed by applicant) THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.*

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 37, 39, AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.
WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER -- TYPED/PRINTED NAME AND TITLE	SIGNATURE	DATE
Randall Scott President & Chief Executive Officer	Randall J Scott	4/25/22

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			$		
APPROVED BY				DATE	

Appendix B: Decommissioning Funding Plan

RARE EARTH ELEMENT SEPARATION AND PROCESSING DEMONSTRATION PROJECT
RARE ELEMENT RESOURCES

DECOMMISSIONING FUNDING PLAN

Submitted to the US Nuclear Regulatory Commission

Rare Element Resources

SEPTEMBER 2022

Table of Contents

List of Tables

List of Attachments

Acronyms and Abbreviations

BLS	US Bureau of Labor Statistics
CPI	Consumer Price Index
DFP	decommissioning funding plan
DOE	US Department of Energy
DOT	US Department of Transportation
FOA	Funding Opportunity Announcement
GA	General Atomics
HREE	heavy rare earth elements
LLW	low-level radioactive waste
LNV	LNV, an Ardurra Group, Inc. company
M&E	materials and equipment
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NPS	neodymium/praseodymium separation
NRC	US Nuclear Regulatory Commission
PP	primary processing
PUG	physical upgrade
REE	rare earth element
REO	rare earth oxide
RER	Rare Element Resources, Inc.
SEG	samarium/europium/gadolinium
TCS	thorium/cerium separation
TREO(Th)	total rare earth oxide with thorium concentrate
UIT	Umwelt-und Ingenieurtechnik GmbH Dresden
US	United States
WCS	Waste Control Specialists, LLC

1 Facility Description

Rare Element Resources, Inc. (RER) is proposing to conduct a Rare Earth Element (REE) Separation and Processing Demonstration Project (Demonstration Project) in northeastern Wyoming in collaboration with General Atomics (GA), GA's European affiliate Umwelt-und Ingenieurtechnik GmbH Dresden (UIT) and engineering and construction subcontractor LNV, an Ardurra Group, Inc. company (LNV). RER, GA, UIT, and LNV are collectively referred to in this document as the Team.

The Demonstration Project is being developed as a 50% commercial / 50% government-funded cooperative agreement between the Team and the US Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy under DOE's Critical Materials Funding Opportunity Announcement (FOA) with a total project budget of $43.8 million. The Demonstration Project includes the engineering, construction, and operation of a REE separation and processing Demonstration Plant.

The Demonstration Project proposes to demonstrate the domestic production of neodymium-praseodymium and other rare earth oxides (REOs). Approximately 1,000 tons of exploration sample removed previously from the Bear Lodge project in Wyoming are available for processing. The Team plans to design, construct, and operate a demonstration-scale hydrometallurgical, separation, and refining plant at a processing rate of up to 3 tons of feed material per day as a research and development scale-up. The Demonstration Plant is planned to operate for approximately one year.

This decommissioning funding plan (DFP) presents RER's detailed, site-specific cost estimate for decommissioning associated with the Demonstration Project. Additionally, this DFP describes the method for assuring funds for decommissioning, describes the means for adjusting both the cost estimate and funding level over the life of the facility, and contains the certification of financial assurance and financial instrument provided as financial assurance.

This DFP follows the format established in NUREG-1757, Volume 3, Revision 1, Appendix A *Standard Format and Content of Financial Assurance Mechanisms for Decommissioning* (NRC 2012) and incorporates the relevant content of *Interim Staff Guidance on Decommissioning Funding Plans for Materials Licensees* (NRC 2012). The methods used to estimate the decommissioning cost of the Demonstration Project are consistent with appropriate US Nuclear Regulatory Commission (NRC) guidance (NRC 2012, 2019) and are conservative.

1.1 NRC License

RER is requesting a new NRC license for source material produced incidental to the processing of REE (RER 2022).

1.2 Types and Quantities of Materials Authorized Under the License

As described in section 5 of the license application, RER is requesting to possess source material. The source material will be uranium and thorium in their natural isotopic abundance with combined concentrations greater than 0.05 percent by weight contained in a REO mineral exploration sample. The weight of the exploration sample is approximately 1,000 short tons (RER 2022).

1.3 Description of How Licensed Materials are Used

A description of facilities and equipment is provided in section 9 of the license application (RER 2022). A detailed description and process flow diagrams are provided in Appendix C.

The Demonstration Plant will consist of the following process stages:

1. Physical upgrade (PUG): comminution and screening of the extracted exploration sample containing source material.
2. Primary processing (PP): primary hydrometallurgical processing of the comminuted exploration sample to produce a highly pure TREO(Th) concentrate (the precursor), which separates out a significant portion of the natural radioactivity contained in the exploration sample.
3. Thorium-cerium separation (TCS): removal of radioactivity, mainly thorium and its decay products, together with cerium, which is not currently considered to be a marketable REO product. An innovative technology allows the effectively complete removal of the source material. It allows for significant recycling of process streams and reduces the production of waste significantly.
4. Neodymium/praseodymium separation (NPS) and refining of REE groups including high purity neodymium/praseodymium oxide (the primary product), a lanthanum, cerium concentrate, a samarium, europium, gadolinium (SEG) concentrate, and a heavy rare earth elements (HREE) concentrate. The innovative technology applies multifunctional separators in a network for the recycling of valuable product streams to optimize the product quality and yield. The network is controlled by proprietary software combining real-time monitoring data of critical process streams with unique process simulation software.

1.4 Demonstration Plant Description

1.4.1 Location

The physical location of operations is provided as item 3 on NRC Form 313 (Appendix A)

1.4.2 Structures

Structures associated with the Demonstration Project are detailed in section 9 of the license application (RER 2022). Structures within the license restricted area include:

- PUG/Sample Storage Facility
- Main Process Facility (including Building Expansion, Auxiliary Plant, and Electrical Control Room)
- Maintenance/Equipment Shed
- Chemical Containment Area
- Clean Room

The surface areas of structures are indicated in Attachment 1, Table A.3.3 (floor/foundations and roof/ceilings) and Table A.3.4 (walls).

Outside of the restricted area but within the site boundary, auxiliary facilities will include the office trailer, employee parking, laydown yard, stormwater collection system, and site fence. These facilities are assumed to be non-impacted and are not considered further in this DFP.

1.4.3 Components

Process components of the Demonstration Plant that may contact licensed material, e.g., tanks, reactors, agitators, conveyors, are located primarily within the PUG/Sample Storage Facility and Main Process Facility. Components are identified by a unit number associated with significant steps in the process. The general categories of facility components are:

- Equipment for the PUG stage will be supplied by the PUG contractor. All PUG activities will be completed, and all equipment decontaminated and demobilized consistent with RPP and applicable SOPs (unrestricted release) from the site early in the operational period or will be disposed of with tailings as low-level waste. Therefore, PUG components are not considered here[1].
- 100-series equipment is associated with the PP stage.
- 200-series equipment is associated with the TCS stage.
- 300-series equipment is associated with the NPS stage.
- 400-series is reserved for final product containers, which will be shipped according to sale agreement and are not included in the decommissioning cost estimate.
- 500-series equipment is associated with raw process feeds. These raw materials will have no contact with licensed material; therefore, 500-series items are not included in the decommissioning cost estimate.
- 600-series equipment is associated with building ventilation and scrubber systems.
- 700-series equipment is associated with waste management.

A comprehensive list of items, dimensions, and generic materials is provided in Attachment 1, Table A.3.5.

1.5 Quantities of Materials or Waste Accumulated Before Shipping or Disposal

Waste categories include tailings and other dry radioactive waste, non-hazardous industrial waste, and organic waste. The approximate onsite waste inventory at closure is 150 cubic yards of tailings[2].

1.6 Contaminated Material that will Require Remediation

Decommissioning of the Demonstration Plant will include the survey and release of structures and components (materials and equipment [M&E]) as well as disposition of some materials as low-level radioactive waste (LLW).

1.6.1 Structures

All indoor facilities within the Demonstration Plant restricted area are anticipated to be impacted by source material processing, handling and storage; thus, all indoor building surfaces are considered impacted. To

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[1] No environmental impacts are anticipated from this demobilization and there will be no change to the PUG/Sample Storage Facility after equipment is demobilized. There are no other anticipated uses of this building other than sample storage and incidental storage of bentonite, lime, and other materials/equipment needed for the operations period.

[2] Calculated based on an estimated total tailings mass of 2448 short tons (February 2022 mass balance) and an estimated tailings density of 1.4 short tons per cubic yard. This estimate assumes the final month's tailings volume is 150 cubic yards (200 tons). A total of up to 6.19 short tons per day (up to 2,400 short tons for the project) of treated and neutralized tailings will be disposed of at a licensed waste disposal facility at a rate of approximately 1 roll-off bin per week (approximately 30 short tons or 29 cubic yards per week). A bentonite water adsorber will be added if needed to eliminate standing water.

estimate the cost, the structures of the Demonstration Plant are classified as Class 1 or 2 based on guidelines in *Multi-Agency Radiation Survey and Site Investigation Manual* [(MARSSIM 2000)], where:

- Class 1 areas have a high potential for radiological contamination or are known to have radiological contamination present.
- Class 2 areas have a potential for residual radioactivity above background but likely below any release level. Class 2 areas in this DFP are assumed to be facility surfaces where radioactive material or sources were processed, stored, or inadvertently transferred to, but the potential of contamination has been determined to be low.

This cost estimate assumes that all building floors within the restricted area and all interior walls below 6 feet within the restricted area are Class 1. Building ceilings and walls above 6 feet are Class 2. For this decommissioning cost estimate, all structures are assumed to be releasable, and no structures are disposed as LLW.

1.6.2 Materials and Equipment

It is anticipated that radiological decontamination, demolition, and disposition will be applied to all facility components and equipment within the restricted area except for 400- and 500- series items (see section 1.4.3). To estimate the cost, M&E are classified as impacted based on guidelines in *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* [(MARSAME 2009). M&E that can be adequately decontaminated and surveyed will be evaluated for release for unconditional use (unrestricted release). Items with inaccessible surfaces and porous materials such as conveyor belts, filter media, and some grinding components are expected to be disposed of as LLW. For this decommissioning cost estimate, M&E assumed to be LLW include pumps, agitators, and filters except for 300- series items (see section 1.4.3). The total estimated waste volume from M&E is 1490 cubic feet (55 cubic yards).

2 Estimated Decommissioning Costs

The cost estimate for decommissioning totals $917,193. Table 1 is a breakdown of the total decommissioning costs consistent with Attachment 1, Table A.3.18.

The following subsections describe the processes and assumptions used to estimate the cost associated with the removal of structures and equipment and radiological final status surveys. Parametric cost models are applied to representatively sized structures and equipment. In Attachment 1, the parametric cost is applied to the total number of structure units as shown in Table A.3.3, Table A.3.4, and Table A.3.5. The costs for labor, equipment, and materials are deconstructed and summed according to reporting categories specified in NUREG-1757, Volume 3, Revision 1. Details and calculations are shown in Attachment 1, and a complete list of the cost estimate tables is provided in Table 2.

Table 1. Decommissioning costs

Task/Component	Attachment 1 Table	Report Section	Base Year Cost 2022	Percentage of Total
Labor: Planning, Preparation, and Project Management	Table A.3.13	2.1.1	$255,384	34.8%
Labor: Decontamination and Dismantling	Table A.3.7	2.1.2	$47,665	6.5%
Labor: Restoration of Facility Grounds	Excluded	2.1.3	--	--
Labor: Final Radiation Survey	Table A.3.9	2.1.4	$51,326	7.0%

Labor: Site Stabilization and Long-Term Surveillance	Excluded	2.1.5	--	--
Packing Material Costs	Table A.3.14.	2.2.1	$35,700	4.9%
Shipping Costs	Table A.3.14.	2.2.1	$49,568	6.8%
Waste Disposal Costs	Table A.3.14.	2.2.1	$191,912	26.2%
Equipment/Supply Costs	Table A.3.15	2.2.2	$94,545	12.9%
Laboratory Costs	Table A.3.16	2.2.3	$7,654	1.0%
Miscellaneous Costs	Excluded	2.2.4	--	--
Subtotal			$733,754	100%
25% Contingency		2.3	$183,439	
TOTAL DECOMMISSIONING COST ESTIMATE			**$917,193**	

Table 2. List of detailed cost estimate tables in Attachment 1

Attachment 1 Table	Title/Description
Table A.3.3	Structure Surface Areas and Proposed MARSSIM Class - Floor/Foundations and Roof/Ceilings
Table A.3.4	Structure Surface Areas and Proposed MARSSIM Class - Walls
Table A.3.5.	Number and Dimensions of Facility Components
Table A.3.6	Planning, Preparation and Project Management (Work Hours)
Table A.3.7.1.	Material and Equipment Disposition and Free Release
Table A.3.7.	Summary Decontamination or Dismantling of Radioactive Facility Components
Table A.3.9.1.	Class I Building Surveys
Table A.3.9.2.	Class II Building Surveys
Table A.3.9.	Final Radiation Survey
Table A.3.11	Total Workdays by Labor Category
Table A.3.12.	Worker Unit Labor Rates Base Year
Table A.3.13.	Total Labor Costs by Major Decommissioning Task
Table A.3.14.1.	Waste Control Specialists, Andrews County, TX, Disposal Costs
Table A.3.14.2.	Owner Operator Independent Drivers Association (OOIDA) Cost of Truck Operations
Table A.3.14.	Packaging, Shipping, and Disposal of Radioactive Wastes (excluding Labor costs)
Table A.3.15	Equipment/Supply Costs (excluding containers)
Table A.3.16	Laboratory Costs
Table A.3.18.	Total Decommissioning Costs

2.1 Labor Costs

The summary of labor costs presented in Table A.3.13 is based on total workdays (Table A.3.11) and worker unit cost schedule (Table A.3.12). The following subsections identify labor components.

2.1.1 Planning and Preparation

The summary of planning and preparation costs is presented in Table A.3.6. These costs account for the labor required to prepare and submit documentation to regulatory agencies, including the decommissioning plan and work plans. Other labor costs accounted for in this table include procurement of special equipment, staff training, an initial characterization of the radiological condition of the facility, and overall project management.

2.1.2 Decontamination or Dismantling of Radioactive Facility Components

Details are presented in Table A.3.7. which identifies the process for the disposition of M&E for unrestricted release and disposal. The work sequence for the disposition of equipment for unrestricted release is described in Table A.3.7.1.

2.1.3 Restoration of Contaminated Areas on Facility Grounds

This DFP assumes all areas will meet the criteria for total and removable surface activity that satisfy unrestricted release and no further decontamination will be necessary. Therefore, Table A.3.8 has been excluded.

2.1.4 Final Radiation Surveys

Table A.3.9 summarizes final radiation surveys of buildings and is subdivided by MARSSIM class.

2.1.4.1 MARSSIM Class 1 Buildings

Final Radiation Survey – the sequence of Class 1 work and assumptions are described in Table A.3.9.1.

2.1.4.2 MARSSIM Class 2 Buildings

Final Radiation Survey – the sequence of Class 2 work and assumptions are described in Table A.3.9.2.

2.1.5 Site Stabilization and Long-Term Surveillance

As described in the key assumptions below, this estimate assumes decommissioning will occur immediately after the cessation of facility operations. No long-term surveillance costs are anticipated and Table A.3.10 has been excluded.

2.2 Nonlabor Costs

The following subsections identify nonlabor components.

2.2.1 Packaging, Shipping, and Disposal of Radioactive Wastes

Table A.3.14 summarizes packaging, shipping, and disposal costs. LLW resulting from decommissioning operations will be processed at the site, loaded into shipping containers, and transported by truck to the Waste Control Specialists, LLC (WCS) facility in Andrews County, TX. The distance between Upton, Wyoming and Andrews County, TX is estimated at 981 miles. All waste will be transported and disposed of in Type A B-12 containers. Table A.3.14.1 and Table A.3.14.2 present detailed cost estimates relating to waste packaging, transportation, and disposal.

2.2.2 Equipment and Supply Costs (Excluding Containers)

Table A.3.15 summarizes equipment and supply costs for all decommissioning efforts.

2.2.3 Laboratory Costs

Table A.3.16 summarizes laboratory costs for all decommissioning efforts.

2.2.4 Miscellaneous Costs

There are no other miscellaneous costs, and Table A.3.17 has been excluded.

2.3 Contingency Factor

A 25 percent contingency factor ($183,439) is added to the total decommissioning cost estimate in accordance with 10 CFR 40.36 to account for uncertainty in contamination levels, waste disposal costs, and other costs associated with decommissioning.

3 Key Assumptions

The following assumptions are recommended in NUREG-1757, Volume 3, Revision 1 (NRC 2012).

- Decommissioning will occur immediately after the cessation of facility operations. Surveillance costs for an interim period are unnecessary.
- Inventories of materials and waste at the time of decommissioning will be in amounts that are consistent with quantities of historically licensed material and uses of radioactive material.
- Third-party contractor(s) will decommission the facility.
- This DFP does not take credit for any salvage value that might be realized from the sale of potential assets (e.g., recovered materials or decontaminated equipment) during or after decommissioning.

General assumptions relating to waste packaging, transport, and disposal are:

- Most of the M&E removed from the restricted area is expected to be meet criteria for unrestricted release and can be salvaged. Exceptions include items with inaccessible surfaces and porous materials such as conveyor belts and filter media and some grinding components.
- Disposal facility is WCS in Andrews County, Texas.
- Disposal rates are based on the cost per cubic foot in NUREG-1307, Revision 18 *Report on Waste Burial Charges* (NRC 2020). All surcharges are calculated from NUREG-1307, Revision 18 with no application of shipment or container surcharges.

Specific assumptions related to decontamination, decommissioning, and final radiological surveys are included in Attachment 1.

4 Adjustments to the Cost Estimate

Pursuant to 10 CFR 40.36, this cost estimate must be adjusted at least every 3 years over the life of the facility, or at the time of license amendments or renewals. However, the total operational period of the Demonstration Project is expected to be less than three years, so cost adjustments are not anticipated.

For completeness, this section provides a description of the means that will be used to adjust the site-specific cost estimate and associated levels of periodically over the life of the facility if the 3-year period is reached. Costs have been divided into categories based on the list provided in NUREG-1757, Volume 3, Revision 1, Appendix A, section A.3.2. The adjustment for each cost category is described in Table 3.

Table 3. Adjustments to the cost estimate

Component	Commitment (on a 3-year basis)
Inflation	The cost estimate will be updated to account for inflation.
Changes in labor costs	The method for adjusting labor rates will be to compare labor classifications to the BLS *Occupational Employment Statistics* web page (BLS 2021b) for the State of Wyoming to the wages used.
Changes in equipment and supply costs	The method for adjusting costs of equipment and supplies will be to use the CPI located on the BLS web page (BLS 2021a). The rate of change in the CPI for the period between cost adjustments will be used as a multiplier to adjust previous equipment and supply cost estimates to current cost estimates.
Changes in facility conditions or operations	The cost estimate will be updated to account for: • Leaks or spills • Increased waste inventory • Facility modifications • Changes in authorized possession limits • Use of a settling pond
Changes in expected decommissioning procedures	The cost estimate will be updated to account for: • Newly detected soil or groundwater contamination • Increased disposal costs • Actual remediation costs that exceed the decommissioning cost estimate • Onsite disposal

BLS – US Bureau of Labor Statistics
CPI – Consumer Price Index
US – United States

5 Certification of Financial Assurance

RER presently intends to use a surety bond in conjunction with a Standby Trust as the method to provide reasonable financial assurance that decommissioning funding will be available at the time of decommissioning the facility. At least six (6) months prior to the receipt of licensed material in quantities and form requiring decommissioning funding, RER will provide the NRC with the draft financial assurance instrument it intends to execute. Upon finalization of the specific funding instrument to be used and at least thirty (30) days prior to the commencement of operations, RER will provide the NRC the signed and executed documentation. RER will not obtain radioactive material until the NRC reviews and approves the executed financial assurance instrument and certification of financial assurance. The surety bond will provide assurance that decommissioning costs will be paid if RER is unexpectedly unable to meet its obligations at the time of decommissioning. Funds drawn from the surety bond will be placed directly into a Standby Trust that names the NRC as its beneficiary.

6 Recordkeeping

In accordance with 10 CFR 40.36(f), RER will retain records of information that could have a material effect on the ultimate costs of decommissioning until the license terminates. These records will include information regarding:

1. Spills or other contamination that cause contaminants to remain following cleanup efforts;
2. As built drawings of structures, equipment, and modifications thereto where radioactive contamination exists (e.g., from the use or storage of such materials);
3. Original and modified cost estimates of decommissioning; and
4. Original and modified decommissioning funding instruments and supporting documentation.

7 References

BLS. 2021a. "CPI Inflation Calculator." U.S. Bureau of Labor Statistics. https://www.bls.gov/data/inflation_calculator.htm.

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RER. April 2022. *Application for Source Material Possession License.* Rare Element Resources, Inc. .

Attachment 1: Detailed Cost Estimate Tables

Table A.3.3. Structure Surface Areas and Proposed MARSSIM Class - Floor/Foundations and Roof/Ceilings

Facility	Description	Restricted Area	MARSSIM Class Floor	Floor (ft^2)	Material	MARSSIM Class Roof/ Ceiling	Roof/ Ceilings (ft^2)	Material	Notes
DP	PUG/Sample Storage Facility	Yes	I	6426	Concrete	II	6426	Metal	
DP	Main Process Facility	Yes	I	5625	Concrete	II	5625	Metal	
DP	Main Process Facility Building Expansion	Yes	I	1400	Concrete	II	1400	Metal	
DP	Main Process Facility Auxiliary Plant	Yes	I	560	Concrete	N/A	0	N/A	Platform
DP	Electrical Control Room	Yes	I	360	Concrete	II	360	Metal	
DP	Maintenance/Equipment Shed	Yes	I	1230	Concrete	II	1230	Metal	
DP	Chemical Containment Area	Yes	I	3900	Concrete	II	3900	Canvas	
DP	Clean Room	Yes	I	240	Concrete	II	240	Metal	
DP	Office Trailer	No	N/A	N/A	Metal	N/A	N/A	Metal	Out of scope (outside of restricted area)
DP	Laydown Yard	No	N/A	N/A	Gravel	N/A	N/A	N/A	Out of scope (outside of restricted area)

Note: Sourced directly from LNV Inc, General Atomics Rare Earth Demonstration Plant Proposed Site Plan.
DP - Demonstration Plant
ft^2 - square feet
MARSSIM - Multi-Agency Radiation Survey and Site Investigation Manual

Table A.3.4. Structure Surface Areas and Proposed MARSSIM Class – Walls

Facility	Description	Restricted Area	Wall Height (ft)	Total Wall Surface Area (ft^2)	MARSSIM Class Floor + Wall < 6ft	Wall Surface Area < 6ft (ft^2)	MARSSIM Class Wall > 6ft	Wall Surface Area >6ft (ft^2)	Material	Notes
DP	PUG/Sample Storage Facility	Yes	25	8650	I	2076	II	6574	Metal	
DP	Main Process Facility	Yes	24	7200	I	1800	II	5400	Metal	
DP	Main Process Facility Building Expansion	Yes	55	8580	I	936	II	7644	Metal	
DP	Main Process Facility Auxiliary Plant	Yes	6	1536	N/A	0	N/A	0	Metal	Platform
DP	Electrical Control Room	Yes	12	1008	I	504	II	504	Metal	
DP	Maintenance/Equipment Shed	Yes	14	1988	I	852	II	1136	Metal	
DP	Chemical Containment Area	Yes	6	1536	I	1536	II	0	Concrete	
DP	Clean Room	Yes	10	760	I	456	II	304	Metal	
DP	Office Trailer	No	12	N/A	N/A	N/A	N/A	N/A	Metal	Out of scope
DP	Laydown Yard	No	N/A	N/A	N/A	N/A	N/A	N/A	Gravel	Out of scope

Note: Sourced directly from LNV Inc, General Atomics Rare Earth Demonstration Plant Proposed Site Plan.
DP - Demonstration Plant
ft - feet
ft^2 - square feet
MARSSIM - Multi-Agency Radiation Survey and Site Investigation Manual

Table A.3.5. Number and Dimensions of Facility Components

Item ID	DFP Category	Decommissioning Method	Quantity	Length (ft)	Height (ft)	Width (ft)	Diameter (ft)	Linear Feet (ft)	Generic Shape	Surface Area (ft^2)	Volume (ft^3)
110A-R101	Agitator	Disposed - LLW	1		7		2		Cylinder		22
110A-R102	Agitator	Disposed - LLW	1		7		2		Cylinder		22
120A-R101	Agitator	Disposed - LLW	1		2		2		Cylinder		6
120A-R102A	Agitator	Disposed - LLW	1		2.5		2		Cylinder		8
120A-R102B	Agitator	Disposed - LLW	1		2.5		2		Cylinder		8
120A-R102C	Agitator	Disposed - LLW	1		2.5		2		Cylinder		8
120A-R102D	Agitator	Disposed - LLW	1		2.5		2		Cylinder		8
150A-TK101	Agitator	Disposed - LLW	1		3.5		2		Cylinder		11
170A-R101	Agitator	Disposed - LLW	1		2.5		2		Cylinder		8
170A-TK101	Agitator	Disposed - LLW	1		2.5		2		Cylinder		8
170A-R102	Agitator	Disposed - LLW	1		1		2		Cylinder		3
210A-R101	Agitator	Disposed - LLW	1		1		2		Cylinder		3
230A-TK101	Agitator	Disposed - LLW	1		1.75		2		Cylinder		5
230A-TK102a	Agitator	Disposed - LLW	1		1.5		2		Cylinder		5
230A-TK103a	Agitator	Disposed - LLW	1		1.5		2		Cylinder		5
130BF-101	Filter	Disposed - LLW	1	16.5	5	4			Rectangle		330
170FP-101	Filter	Disposed - LLW	1	20	5	4			Rectangle		400
230BF-101	Filter	Disposed - LLW	1	16.5	5	4			Rectangle		330
110P-R101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
110P-R102	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
110P-TK101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
110P-TK103A	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
110P-TK103B	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
120P-R101A	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
120P-R101B	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
120P-R101C	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
120P-R102	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
130P-BF101A	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
130P-BF101B	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
150P-TK101	Pump	Disposed - LLW	1	3	2	3			Rectangle		18
150P-TK102	Pump	Disposed - LLW	1	3	2	3			Rectangle		18
170P-E101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
170P-R101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
170P-R102	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
170P-RC101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
170P-S101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8

Item ID	DFP Category	Decommissioning Method	Quantity	Length (ft)	Height (ft)	Width (ft)	Diameter (ft)	Linear Feet (ft)	Generic Shape	Surface Area (ft^2)	Volume (ft^3)
170P-TK101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
170P-TK102	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
210P-R101A	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
210P-R101B	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
210P-TK101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
220P-TK101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
220P-TK102	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
230P-BF101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
230P-TK101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
230P-TK102a	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
230P-TK102b	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
230P-TK103a	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
230P-TK103b	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
240P-MS101a	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
240P-TK101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
700P-R101	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
700P-R102	Pump	Disposed - LLW	1	2	2	2			Rectangle		8
313A-TK101	Agitator	Unrestricted Release	1		1.75		2		Cylinder	17	
313A-TK102a	Agitator	Unrestricted Release	1		1.25		1.5		Cylinder	9	
313A-TK103a	Agitator	Unrestricted Release	1		1.25		1.5		Cylinder	9	
325A-TK102a	Agitator	Unrestricted Release	1		3		2		Cylinder	25	
325A-TK102b	Agitator	Unrestricted Release	1		3		2		Cylinder	25	
335A-TK101A	Agitator	Unrestricted Release	1		5		2		Cylinder	38	
335A-TK101B	Agitator	Unrestricted Release	1		5		2		Cylinder	38	
335A-TK101C	Agitator	Unrestricted Release	1		5		2		Cylinder	38	
335A-TK101D	Agitator	Unrestricted Release	1		5		2		Cylinder	38	
335A-TK102	Agitator	Unrestricted Release	1		4		2		Cylinder	31	
341A-TK101	Agitator	Unrestricted Release	1		5		2		Cylinder	38	
351A-TK101	Agitator	Unrestricted Release	1		1.5		2		Cylinder	16	
365A-R101A	Agitator	Unrestricted Release	1		1		2		Cylinder	13	
365A-R101B	Agitator	Unrestricted Release	1		1		2		Cylinder	13	
365A-R101C	Agitator	Unrestricted Release	1		1		2		Cylinder	13	
365A-R101D	Agitator	Unrestricted Release	1		1		2		Cylinder	13	
365A-TK101	Agitator	Unrestricted Release	1		1.5		2		Cylinder	16	
313BF-101	Filter	Unrestricted Release	1	16.5	5	4			Rectangle	337	
325FP-101	Filter	Unrestricted Release	1	2	0.1	2			Rectangle	9	
335FP-101	Filter	Unrestricted Release	1	2	0.1	2			Rectangle	9	

Item ID	DFP Category	Decommissioning Method	Quantity	Length (ft)	Height (ft)	Width (ft)	Diameter (ft)	Linear Feet (ft)	Generic Shape	Surface Area (ft^2)	Volume (ft^3)
365BF-101	Filter	Unrestricted Release	1	16.5	5	4			Rectangle	337	
110CF-101	Misc.	Unrestricted Release	1	10	3	3			Rectangle	138	
150CF-101	Misc.	Unrestricted Release	1	7.5	2.25	3.5			Rectangle	102	
140RK-101	Misc.	Unrestricted Release	1	20	5	4			Rectangle	400	
220MS-101	Misc.	Unrestricted Release	1	10	6	5			Rectangle	280	
220MS-102	Misc.	Unrestricted Release	1	10	6	5			Rectangle	280	
240MS-101	Misc.	Unrestricted Release	1	10	6	5			Rectangle	280	
311C-101	Misc.	Unrestricted Release	1		23		0.5		Cylinder	37	
314MS-101	Misc.	Unrestricted Release	1	10	6	5			Rectangle	280	
321C-101	Misc.	Unrestricted Release	1		23		0.5		Cylinder	37	
323C-101	Misc.	Unrestricted Release	1		11.5		0.33		Cylinder	12	
331C-101	Misc.	Unrestricted Release	1		36		1		Cylinder	115	
333C-101	Misc.	Unrestricted Release	1		16		0.8		Cylinder	41	
341C-101	Misc.	Unrestricted Release	1		42.5		1.3		Cylinder	176	
343C-101	Misc.	Unrestricted Release	1		20		1.15		Cylinder	74	
351C-101	Misc.	Unrestricted Release	1		40		1		Cylinder	127	
353C-101	Misc.	Unrestricted Release	1		16		0.8		Cylinder	41	
361C-101	Misc.	Unrestricted Release	1		30		0.65		Cylinder	62	
363C-101	Misc.	Unrestricted Release	1		15.5		0.65		Cylinder	32	
700M-101	Misc.	Unrestricted Release	1	10	4	4			Rectangle	192	
311P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
311P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
313P-BF101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
313P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
313P-TK102A	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
313P-TK102B	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
313P-TK103A	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
313P-TK103B	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
314P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
321P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
321P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
325P-RO101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
325P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
325P-TK102A/B	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
331P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
331P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
333P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	

Item ID	DFP Category	Decommissioning Method	Quantity	Length (ft)	Height (ft)	Width (ft)	Diameter (ft)	Linear Feet (ft)	Generic Shape	Surface Area (ft^2)	Volume (ft^3)
335P-RO101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
335P-R101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
335P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
335P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
341P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
341P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
351P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
351P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
353P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
361P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
361P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
363P-TK101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
365P-R101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
365P-RO101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
365P-BF101	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
365P-TK102	Pump	Unrestricted Release	1	2	2	2			Rectangle	24	
110FH-101	Tank	Unrestricted Release	1	4	4	4			Rectangle	96	
110R-101	Tank	Unrestricted Release	1		14		6		Cylinder	320	
110R-102	Tank	Unrestricted Release	1		14		6		Cylinder	320	
110TK-101	Tank	Unrestricted Release	1		14.5		6		Cylinder	330	
110TK-102	Tank	Unrestricted Release	1		14.5		6		Cylinder	330	
110TK-103	Tank	Unrestricted Release	1		14.5		6		Cylinder	330	
120R-101	Tank	Unrestricted Release	1	4	4	4			Rectangle	96	
120R-102	Tank	Unrestricted Release	1	10	4.5	5			Rectangle	235	
150TK-101	Tank	Unrestricted Release	1		7		5		Cylinder	149	
150TK-102A	Tank	Unrestricted Release	1		7		5		Cylinder	149	
150TK-102B	Tank	Unrestricted Release	1		7		5		Cylinder	149	
150FH-101	Tank	Unrestricted Release	1	4	4	4			Rectangle	96	
170R-101	Tank	Unrestricted Release	1		5		3.5		Cylinder	74	
170TK-101	Tank	Unrestricted Release	1		5		3.5		Cylinder	74	
170R-102	Tank	Unrestricted Release	1		2		6		Cylinder	94	
170TK-102	Tank	Unrestricted Release	1		5		3.5		Cylinder	74	
210FH-101	Tank	Unrestricted Release	1	2	2	2			Rectangle	24	
210R-101	Tank	Unrestricted Release	1		5.5		4		Cylinder	94	
210TK-101	Tank	Unrestricted Release	1		8.5		5		Cylinder	173	
220TK-101	Tank	Unrestricted Release	1		3.5		4		Cylinder	69	
220TK-102	Tank	Unrestricted Release	1		4		3		Cylinder	52	

Item ID	DFP Category	Decommissioning Method	Quantity	Length (ft)	Height (ft)	Width (ft)	Diameter (ft)	Linear Feet (ft)	Generic Shape	Surface Area (ft^2)	Volume (ft^3)
230TK-101	Tank	Unrestricted Release	1		3.5		4		Cylinder	69	
230TK-102a	Tank	Unrestricted Release	1		3		5		Cylinder	86	
230TK-102b	Tank	Unrestricted Release	1		8		1.5		Cylinder	41	
230TK-103a	Tank	Unrestricted Release	1		3		5		Cylinder	86	
230TK-103b	Tank	Unrestricted Release	1		8		1.5		Cylinder	41	
240TK-101	Tank	Unrestricted Release	1		4		2		Cylinder	31	
311TK-101	Tank	Unrestricted Release	1		8		4		Cylinder	126	
311TK-102	Tank	Unrestricted Release	1		3		3		Cylinder	42	
313TK-101	Tank	Unrestricted Release	1		3.5		4		Cylinder	69	
313TK-102a	Tank	Unrestricted Release	1		2.5		1.5		Cylinder	15	
313TK-102b	Tank	Unrestricted Release	1		5		1		Cylinder	17	
313TK-103a	Tank	Unrestricted Release	1		2.5		1.5		Cylinder	15	
313TK-103b	Tank	Unrestricted Release	1		5		1		Cylinder	17	
314TK-101	Tank	Unrestricted Release	1		6		2		Cylinder	44	
321TK-101	Tank	Unrestricted Release	1		8		4		Cylinder	126	
321TK-102	Tank	Unrestricted Release	1		3.5		5		Cylinder	94	
323TK-101	Tank	Unrestricted Release	1		3		3		Cylinder	42	
325TK-101	Tank	Unrestricted Release	1		3.5		3		Cylinder	47	
325TK-102a	Tank	Unrestricted Release	1		6		2		Cylinder	44	
325TK-102b	Tank	Unrestricted Release	1		6		2		Cylinder	44	
331TK-101	Tank	Unrestricted Release	1		10		4		Cylinder	151	
331TK-102	Tank	Unrestricted Release	1		10		4		Cylinder	151	
333TK-101	Tank	Unrestricted Release	1		10		4		Cylinder	151	
335TK-101	Tank	Unrestricted Release	1		10		4		Cylinder	151	
335TK-102	Tank	Unrestricted Release	1		8		4		Cylinder	126	
335R-101	Tank	Unrestricted Release	1	5	4	3			Rectangle	94	
341TK-101	Tank	Unrestricted Release	1		10		4		Cylinder	151	
341TK-102	Tank	Unrestricted Release	1		10		4		Cylinder	151	
343TK-101	Tank	Unrestricted Release	1		10		4		Cylinder	151	
351TK-101	Tank	Unrestricted Release	1		3		3		Cylinder	42	
351TK-102	Tank	Unrestricted Release	1		10		4		Cylinder	151	
353TK-101	Tank	Unrestricted Release	1		10		4		Cylinder	151	
361TK-101	Tank	Unrestricted Release	1		8		4		Cylinder	126	
361TK-102	Tank	Unrestricted Release	1		3		3		Cylinder	42	
363TK-101	Tank	Unrestricted Release	1		3		3		Cylinder	42	
365R-101	Tank	Unrestricted Release	1	4	2	2			Rectangle	40	
365TK-101	Tank	Unrestricted Release	1		3		3		Cylinder	42	

Item ID	DFP Category	Decommissioning Method	Quantity	Length (ft)	Height (ft)	Width (ft)	Diameter (ft)	Linear Feet (ft)	Generic Shape	Surface Area (ft^2)	Volume (ft^3)
601	Tank	Unrestricted Release	1	31	9	9			Rectangle	1278	
602	Tank	Unrestricted Release	1	7	2	2			Rectangle	64	
603	Tank	Unrestricted Release	1		3		1		Cylinder	11	
604	Tank	Unrestricted Release	1		3		1		Cylinder	11	
605	Tank	Unrestricted Release	1		3		1		Cylinder	11	
606	Tank	Unrestricted Release	1		5		1		Cylinder	17	
607	Tank	Unrestricted Release	1		5		1		Cylinder	17	
700TK-101	Tank	Unrestricted Release	1		3		3		Cylinder	42	
700R-102	Tank	Unrestricted Release	1		10		6		Cylinder	245	
730R-101	Tank	Unrestricted Release	1		10		6		Cylinder	245	

Note: Surface area and volume are calculated based on component dimensions and generic shape.
DFP - Decommissioning Funding Plan
ft - feet
ft^2 - square feet
ft^3 - cubic feet
LLW - low level waste

Table A.3.6. Planning, preparation, and project management

Activity	Program Manager	Radiological Safety Officer/CHP	RCT Supervisor	Ops Super/ Foreman	PM Admin Assistant	Training Assistant	RCT
Preparation of documentation for regulatory agencies	80	120	40	40	80		
Submittal of Decommissioning Plan to NRC when required	80	160	40	40	20		
Development of work plans	20	160	40	20	40		
Procurement of special equipment	10	0	10	20	10		
Staff training	20	20	20	20	20	80	
Initial characterization of radiological condition of facility	20	50	50	50	20		200
Project management	260	1040		260	260	260	
TOTAL HOURS	490	1550	200	450	450	340	200
TOTAL COST	$46,913	$133,176	$17,184	$25,466	$13,388	$10,115	$9,136

CHP - certified health physicist
NRC - U.S. Nuclear Regulatory Commission
Ops - operations
PM - program manager
RCT - radiation control technician

Table A.3.7.1. Parametric 1 – Material and Equipment Disposition and Free Release

Cost Estimate Model

Parameter Number: 1 **Parameter Name:** Structure,Tank, Equipment Disposition and Free Release
Cost Unit: Cubic Foot **Developed By:**
Checked By:

Work Difficulty Factors
Work Break: 1 **Respiratory Protect.:** 1
Accessibility: 1 **Protective Clothing:** 1

Work Sequence:
1) Pressure wash tank, conveyor, or misc. item surface and collect wash water in Baker tank.
2) Rig itemfor lifting and staging to sizing area.
3) Shear anchor bolts or struts associated with item footings.
4) Lift item and relocate to sizing area.
5) Using Excavator/shear, cut and size tank into pieces allowing surface contamination surveys.
6) As necessary, utilize hand tools for structure or equipment disassembly.
7) RCTs perform free release survey on inner surfaces.
8) RCTs survey containers and prepare shipping info.
9) Free release tank sections available for industrial waste disposal.

Assumptions
1) Applicable to all structures, tanks, conveyors, and silos. Does not apply to conveyor belts.
2) Assume reference tank surface area is 5000 ft$^{2.}$ Equivalent to 465 m^2.
3) Adequate work staging area is available.
4) Radiological scanning surveys will be performed at an average of 1 m^2/2 min
5) Total removal and sizing time = 10 hours
6) Total survey time = 930 minutes =15.5 hr
7) Assume after washing and sizing, tanks are acceptable for unrestricted release or industrial waste disposal.

LABOR	Raw Hours	Effective Hours	Rate	Cost	Comments:
Laborer (2)	51	51.00	$ 27.89	$ 1,422.39	
Ops Super/Foreman	24	24.00	$ 56.59	$ 1,358.16	
Radiation Control Technician (2)	51	51.00	$ 45.68	$ 2,329.68	
Crane Operator	10	10.00	$ 48.25	$ 482.50	
Excavator Operator	12	12.00	$ 46.73	$ 560.76	
Container/Forklift Truck Driver	51	51.00	$ 46.73	$ 2,383.23	
	============	========	=========	==========	
Subtotal:	199	199	--	$ 8,536.72	

EQUIPMENT	Units	Rate	Cost	Comments:
Manlift	25.50	$ 7.95	$ 202.84	
Forklift	25.50	$ 11.36	$ 289.77	
Shear Mechanisms	12.00	$ 6.82	$ 81.82	
Cat 300 Excavator	12.00	$ 45.45	$ 545.45	
Pressure Washer	4.00	$ 1.70	$ 6.82	
100 gallon Baker Tanks	20.00	$ 1.70	$ 34.09	
Radiological Survey Equipment - RCT	51.00	$ 22.50	$ 1,147.50	
	========	=========	==========	
Subtotal:	--	--	$ 2,308.30	

MATERIALS	Units	Rate/unit	Cost	Comments:
Diesel Fuel	16	$ 6.39	$ 102.24	
Level D Worker-Day	24.875	$ 18.75	$ 466.41	
Liquid waste sample - RCRA metals, gross alpha and beta	0.05	$ 1,200.00	$ 60.00	Note should result in 1 sample over all application
	========	=========	==========	
Subtotal:	--	--	$ 628.65	

TOTAL:	$ 11,473.66	**per 5000 ft^2**
	$ 2.29	**per ft^2**

Deconstructed Labor

51	131	Laborer (2)
24	62	Ops Super/Foreman
51	131	Radiation Control Technician (2)
10	26	Crane Operator
12	31	Excavator Operator
51	131	Container/Forklift Truck Driver

Deconstructed Equipment

26	66	Manlift
26	66	Forklift
12	31	Shear Mechanisms
12	31	Cat 300 Excavator
4	10	Pressure Washer
20	51	100 gallon Baker Tanks
51	131	Radiological Survey Equipment - RCT

Decontructed Materials

16	41	Diesel Fuel
25	64	Level D Worker-Day
0.05	0	Liquid waste sample - RCRA metals, gross alpha and beta

Table A.3.7. Summary Decontamination or Dismantling of Radioactive Facility Components

Component	Total Units	Unit	Parametric Cost	Total Cost
Tanks	5628	ft^2	$ 2.29	$ 12,914
300 series components	5562	ft^2	$ 2.29	$ 12,764
Misc. Items	1672	ft^2	$ 2.29	$ 3,837
Pumps, Agitators, Filters	1490	ft^3	$ 2.29	$ 3,418
			Total $	$ 32,933

Component	Quantity	Unit	Method	Laborer	Ops Super/ Foreman	RCT	Crane Operator	Excavator Operator	Container/ Forklift Truck Driver
Tanks, Conveyors, Misc. Items	12862	ft^2	Unrestricted Release	131	62	131	26	31	131
Pumps, Agitators, Filters	1490	ft^3	Disposed - LLW	160	80	160	40	80	80
			Total Hours	291	142	291	66	111	211
			Total $	$8,121	$8,021	$13,302	$3,171	$5,181	$9,869

ft^2 - square feet
ft^3 - cubic feet
LLW - low level waste
Ops - operations
RCT - radiation control technician

Table A.3.9.1. Parametric 2 - Class I Building Surveys

Cost Estimate Model DRAFT

Parameter Number:	2	**Parameter Name:**	Class I Building Survey Areas
Cost Unit:	Sq. Foot	**Developed By:**	
		Checked By:	

Work Difficulty Factors

Work Break:	1.083	**Respiratory Protect.:**	1
Accessibility:	1	**Protective Clothing:**	1

Work Sequence:
1) Identify and mark all MARSSIM Class I building survey surfaces. Clear loose obstructions.
2) Laborer vacuum/clean floors and surfaces in survey unit.
3) Initialize radiological survey equipment, function test, background, etc.
4) Perform large area radiological surveys.
5) Collect and analyze 20 static and removable contamination measurements on systematic grid.
6) Perform hand surveys for difficult access surfaces.
7) Process and dump data to survey report database.

Assumptions
1) Work is performed in level D PPE.
2) All building contents and equipment have been emptied from survey areas. Applies to licensed floor areas and walls to a height of 6' above floor surface.
3) Assume all areas will meet unrestricted release criteria for total and removable contamination. No further decon necessary.
4) All floor coverings including tile, vinyl, carpet, etc. have been removed. Survey surface area 10 m x 10 m floors; four walls to height of 2 m.
5) Total survey unit area of 100 m^2 (1076 ft^2) assume residential use.
6) Surveys will be performed for alpha and beta-gamma emitting radionuclides, with primary indexing to thorium-232 + D, and uranium-238+D.
7) Assume that MARSSIM based characterization survey will meet requirements of final status survey.
8) Detector area is 10 cm x 50 cm.
9) Assumes large area survey system - Area of 500 cm^2, scanning speed 3 cm/s. 500 cm^2 covered in 3.3 sec.
10) 1 m^2 covered in 66 sec. Total survey coverage time 90 min.
11) Removable contamination swipes will be collected during survey; locations based on large area detection scanning results.
12) 10 % of surfaces (10 m^2) will require hand scanning at 1 m^2/2 min.
13) Total automated scan time = 100/1.1 = 90 min. Total hand scanning time = 10 x 2 = 20 min
14) Static and removable contamination survey require 0.5 hr.

LABOR	Raw Hours	Effective Hours	Rate	Cost	Comments:
RCT (automated scanning)	4	4.00	$ 45.68	$ 182.72	
RCT Supervisor	2	2.00	$ 85.92	$ 171.84	
Laborer	4	4.00	$ 27.89	$ 111.56	
Container/Forklift Truck Driver	4	4.00	$ 46.73	$ 186.92	
RCT (Hand scanning and swipe counting)	2	2.00	$ 45.68	$ 91.36	
Radiological Safety Officer/CHP (reporting)	3	3.00	$ 85.92	$ 257.76	
	=======	========	========	=========	
Subtotal:	19	19	--	$ 1,002.16	

EQUIPMENT	Units	Rate	Cost	Comments:
Manlift	4.00	$ 7.95	$ 31.82	
Large Area Radiation Detection System	4.00	$ 250.00	$ 1,000.00	
Radiological Survey Equipment - RCT	8.00	$ 22.50	$ 180.00	
Subtotal:	--	--	$ 1,211.82	

MATERIALS	Units	Rate/unit	Cost	Comments:
Miscellaneous Radiological Survey Supplies Class 1	1	$ 312.50	$ 312.50	
Diesel Fuel	1	$ 6.39	$ 6.39	
	========	========	=========	
Subtotal:	--	--	$ 318.89	

TOTAL:	$ 2,532.87	**per 1076 ft2**
	$ 2.35	**per ft^2**

Deconstructed Labor

4	104	RCT (automated scanning)
2	52	RCT Supervisor
4	104	Laborer
4	104	Container/Forklift Truck Driver
2	52	RCT (Hand scanning and swipe counting)
3	78	Radiological Safety Officer/CHP (reporting)

Deconstructed Equipment

4	104	Manlift
4	104	Large Area Radiation Detection System
8	207	Radiological Survey Equipment - RCT

Decontructed Materials

1	26	Miscellaneous Radiological Survey Supplies Class 1
1	26	Diesel Fuel

Table A.3.9.2. Parametric 3 - Class II Building Surveys

Cost Estimate Model DRAFT

Parameter Number:	3	**Parameter Name:**	Class II Building Survey Areas
Cost Unit:	Sq. Foot	**Developed By:**	
		Checked By:	

Work Difficulty Factors

Work Break:	1.083	**Respiratory Protect.:**	1
Accessibility:	1	**Protective Clothing:**	1

Work Sequence:

1) Identify and mark all MARSSIM Class II building survey surfaces. Clear loose obstructions.
2) Laborer vacuum/clean floors and surfaces in survey unit.
3) Initialize radiological survey equipment, function test, background, etc.
4) Perform large area radiological surveys.
5) Collect and analyze 20 static and removable contamination measurements on systematic grid.
6) Perform hand surveys for difficult access surfaces.
7) Process and dump data to survey report database.

Assumptions

1) Work is performed in level D PPE.
2) All building contents and equipment have been emptied from survey areas. Applies to licensed walls and ceilings 2m and greater above floor surface.
3) Assume all areas will meet unrestricted release criteria for total and removable contamination. No further decon necessary.
4) All wall coverings including paneling, wallpaper, etc. have been removed. Survey surface area 10 m x 10 m ceiling; four walls from 2 m above ground surface to 10 m at ceiling level.
5) Total survey unit area of 100 m^2 (1076 ft^2) assume residential use with 25% scan coverage=269 ft2.
6) Surveys will be performed for alpha and beta-gamma emitting radionuclides, with primary indexing to thorium-232 + D, and uranium-238+D.
7) Assume that MARSSIM based characterization survey will meet requirements of final status survey.
8) Detector area is 10 cm x 50 cm.
9) Assumes large area survey system - Area of 500 cm^2, scanning speed 3 cm/s. 500 cm^2 covered in 3.3 sec.
10) 1 m^2 covered in 66 sec. Total survey coverage time 22.5 min.
11) Removable contamination swipes will be collected during survey; locations based on large area detection scanning results.
12) Total automated scan time = 100/1.1 = 90 min.
13) Static and removable contamination survey require 0.5 hr.

LABOR	Raw Hours	Effective Hours	Rate	Cost	Comments:
RCT (automated scanning)	2	2.00	$ 45.68	$ 91.36	
RCT Supervisor	2	2.00	$ 85.92	$ 171.84	
Laborer	2	2.00	$ 27.89	$ 55.78	
Container/Forklift Truck Driver	2	2.00	$ 46.73	$ 93.46	
RCT (Hand scanning and swipe counting)	1	1.00	$ 45.68	$ 45.68	
Radiological Safety Officer/RCT (reporting)	3	3.00	$ 85.92	$ 257.76	
	========	========	========	=========	
Subtotal:	12	12	--	$ 715.88	

EQUIPMENT	Units	Rate	Cost	Comments:
Manlift	4.00	$ 7.95	$ 31.82	
Large Area Radiation Detection System	4.00	$ 250.00	$ 1,000.00	
Radiological Survey Equipment - RCT	4.00	$ 22.50	$ 90.00	
	========	========	=========	
Subtotal:	--	--	$ 1,121.82	

MATERIALS	Units	Rate/unit	Cost	Comments:
Miscellaneous Radiological Survey Supplies Class 2	1	$ 125.00	$ 125.00	
Diesel Fuel	1	$ 6.39	$ 6.39	
Subtotal:	--	--	$ 131.39	

TOTAL:	$ 1,969.09	**per 1076 ft^2**
	$ 1.83	**per ft^2**

Deconstructed Labor

2	76	RCT (automated scanning)
2	76	RCT Supervisor
2	76	Laborer
2	76	Container/Forklift Truck Driver
1	38	RCT (Hand scanning and swipe counting)
3	114	Radiological Safety Officer/CHP (reporting)

Deconstructed Equipment

4	151	Manlift
4	151	Large Area Radiation Detection System
4	151	Radiological Survey Equipment - RCT

Decontructed Materials

1	38	Miscellaneous Radiological Survey Supplies Class 2
1	38	Diesel Fuel

Table A.3.9. Final Radiation Survey

Building Surface Type	Total Units	Unit	Parametric Cost	Total Cost
Class I Floors	19741	ft^2	$ 2.26	$ 44,615
Class I Walls	8160	ft^2	$ 2.26	$ 18,442
Class II Walls and Ceilings	40743	ft^2	$ 1.78	$ 72,523
			Total	$ 135,579

Building Surface Type	Total Units	Unit	Laborer	RCT Supervisor	RCT	RSO/CHP	Container/ Forklift Truck Driver
Class I Floors and Walls		ft^2	104	52	156	78	104
Class II Walls and Ceilings		ft^2	76	76	114	78	104
		Total hours	179	128	269	156	207
		Total $	$5,005	$10,963	$12,296	$13,368	$9,694

CHP - certified health physicist
ft^2 - square feet
RCT - radiation control technician
RSO - radiation safety officer

Table A.3.11. Total Workdays by Labor Category

Task	Program Manager	PM Admin Assistant	Training Assistant	Laborer	Ops Super/ Foreman	Crane Operator	Excavator Operator	Container/ Forklift Truck Driver	RCT	RCT Supervisor	RSO/CHP
Planning and preparation (A.3.6)	490	450	340	0	450	0	0	0	200	200	1550
Summary Decontamination, Dismantling and Free Release of Facility Components (A.3.7)	0	0	0	291	142	66	111	211	291	0	0
Restoration of contaminated areas on facility grounds (A.3.8)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Final Radiation Survey (A.3.9)	0	0	0	179	0	0	0	207	269	128	156
Site stabilization/surveillance (A.3.10)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Note: All values in above table are in hours.

Task	Program Manager	PM Admin Assistant	Training Assistant	Laborer	Ops Super/ Foreman	Crane Operator	Excavator Operator	Container/ Forklift Truck Driver	RCT	RCT Supervisor	RSO/CHP
Planning and preparation (A.3.6)[1]	61	56	43	0	56	0	0	0	25	25	194
Summary Decontamination, Dismantling and Free Release of Facility Components (A.3.7)[2]	0	0	0	36	18	8	14	26	36	0	0
Restoration of contaminated areas on facility grounds (A.3.8)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Final Radiation Survey (A.3.9)[2]	0	0	0	22	0	0	0	26	34	16	19
Site stabilization/surveillance (A.3.10)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Note: All values in above table are in hours.
[1] Planning and preparation basis 8 hours per day.
[2] Field work basis 8 hours per day.
CHP - certified health physicist

Ops - operations
PM - program manager
RCT - radiation control technician
RSO - radiation safety officer

Table A.3.12. Worker Unit Labor Rates Base Year

		REF 2022 BASE				
		YEAR-0 HOURLY RATE				
Resource Title	**Labor Type**	**Yr-0 Rate Direct**	**SCA Fringe** $4.60	**W-2 Fringe** 28.0%	**DL OH** 20.0%	**Yr0 Rate Burdened**
Program Manager	W-2	$62.33	$0.00	$17.45	$15.96	$95.74
PM Admin Assistant	W-2	$19.37	$0.00	$5.42	$4.96	$29.75
Training Assistant	W-2	$19.37	$0.00	$5.42	$4.96	$29.75
Laborer	SCA	$18.64	$4.60	$0.00	$4.65	$27.89
Ops Super/Foreman	W-2	$36.84	$0.00	$10.32	$9.43	$56.59
Crane Operator	SCA	$35.61	$4.60	$0.00	$8.04	$48.25
Excavator Operator	SCA	$34.34	$4.60	$0.00	$7.79	$46.73
Container/Forklift Truck Driver	SCA	$34.34	$4.60	$0.00	$7.79	$46.73
RCT	SCA	$33.47	$4.60	$0.00	$7.61	$45.68
RCT Supervisor	W-2	$55.94	$0.00	$15.66	$14.32	$85.92
Radiological Safety Officer/CHP	W-2	$55.94	$0.00	$15.66	$14.32	$85.92
Mechanic	W-2	$25.01	$0.00	$7.00	$6.40	$38.42
Equipment Maint Supervisor	W-2	$31.86	$0.00	$8.92	$8.16	$48.94
ESH&Q Manager	W-2	$48.05	$0.00	$13.45	$12.30	$73.80
Fuel Truck Operator	SCA	$23.57	$4.60	$0.00	$5.63	$33.80
Engr & Construction Manager	W-2	$62.33	$0.00	$17.45	$15.96	$95.74
Ops Mgr Admin Assistant	W-2	$23.19	$0.00	$6.49	$5.94	$35.62
Waste Mgmt Coordinator	W-2	$26.14	$0.00	$7.32	$6.69	$40.15
Waste Supervisor	W-2	$26.14	$0.00	$7.32	$6.69	$40.15

Table A.3.12. Worker Unit Labor Rates Base Year (*continued*)

Labor Cost Component	Program Manager	PM Admin Assistant	Training Assistant	Laborer	Ops Super/ Foreman	Crane Operator	Excavator Operator	Container/ Forklift Truck Driver	RCT	RCT Supervisor	RSO/ CHP
Salary & Fringe ($/year)	$165,947	$51,571	$51,571	$48,339	$98,083	$83,637	$80,995	$80,995	$79,186	$148,935	$148,935
Overhead Rate (%) Direct Labor	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Total Cost per year	$199,137	$61,885	$61,885	$58,007	$117,699	$100,364	$97,194	$97,194	$95,023	$178,722	$178,722
Total Cost per Work Day[1]	$766	$238	$238	$223	$453	$386	$374	$374	$365	$687	$687

Note: Rates sourced directly from independent contractors, the U.S. Bureau of Labor Statistics Wyoming State Occupational Employment and Wage Estimates, and the Health Physics Society 2019 salary survey.
[1] Based on 260 workdays per year.
Ops – operations
PM – program manager
RCT – radiation control technician
RSO – radiation safety officer

Table A.3.13. Total Labor Costs by Major Decommissioning Task

Task	Program Manager	PM Admin Assistant	Training Assistant	Laborer	Ops Super/ Foreman	Crane Operator	Excavator Operator	Container/ Forklift Truck Driver	RCT	RCT Supervisor	RSO/CHP
Planning and preparation (A.3.6)[1]	$46,912	$13,389	$10,116	$0	$25,464	$0	$0	$0	$9,137	$17,185	$133,182
Summary Decontamination, Dismantling and Free Release of Facility Components (A.3.7)[2]	$0	$0	$0	$8,121	$8,020	$3,171	$5,181	$9,869	$13,303	$0	$0
Restoration of contaminated areas on facility grounds (A.3.8)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Final Radiation Survey (A.3.9)[2]	$0	$0	$0	$5,005	$0	$0	$0	$9,693	$12,297	$10,963	$13,368
Site stabilization/surveillance (A.3.10)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

[1] Planning and preparation basis 8 hours per day.
[2] Field work basis 10 hours per day.
CHP - certified health physicist
Ops - operations
PM - program manager
RCT - radiation control technician
RSO - radiation safety officer

Table A.3.14.1. Waste Control Specialist, Andrews County, TX, Disposal Costs

Waste Type	Disposal Volume (ft^3)	Proposed # Containers	Proposed # Shipments	Base WCS Rate ($/$ft^3$)	Curie Inventory Charge ($0.05 per mCi) ($/ft^3)	Total Base Cost and Surcharges ($/$ft^3$)
Pumps, Agitators, Filters	1490	17	5	$100.00	$3.50	$103.50
Total	1490					

Note: Rates sourced from Section 336.1310 of Title 30 of the Texas Administrative Code. All waste is Class A LLW.
ft^3 - cubic feet
LLW - low level waste
mCi - millicurie
WCS - Waste Control Specialists

Table A.3.14.2. Owner Operator Independent Drivers Association (OOIDA) Cost of Truck Operations

April 2022 Wyoming Diesel 5.11 gallon
Average Truck Mileage 6 mi/gal

Cost of Operations *(based on 100,000 miles a year)*

In the example below, the drivers income is based on 30% of the Total Cost of Operation.

	ANNUAL COSTS	MONTHLY COSTS	CENTS PER MILE
Total Miles Driven Annually	**100,000**		
FIXED COSTS			
Truck Payment	$16,000.00	$1,333.33	0.160
Trailer Payment	$0.00	$0.00	0.000
Collision/Comp Insur.	$5,700.00	$475.00	0.057
Bobtail Insur.	$704.00	$58.67	0.007
Cargo Insur.	$0.00	$0.00	0.000
Health Insur.	$2,643.00	$220.25	0.026
Licenses	$1,574.00	$131.17	0.016
Permits	$454.00	$37.83	0.005
Accounting Svcs	$541.00	$45.08	0.005
Return on Investment	$0.00	$0.00	0.000
Total Fixed Costs:	**$27,616.00**	**$2,301.33**	**0.276**
VARIABLE COSTS			
Tractor Fuel	$85,166.67	$7,097.22	0.852
Reefer Fuel	$0.00	$0.00	0.000
Tractor/Trailer Tires	$2,300.00	$191.67	0.023
Maintenance	$4,676.00	$389.67	0.047
Repair	$5,615.00	$467.92	0.056
Truck Wash	$701.00	$58.42	0.007
Telephone	$1,534.00	$127.83	0.015
Lodging	$788.00	$65.67	0.008
Meals	$5,177.00	$431.42	0.052
Loading/Unloading Charges	$0.00	$0.00	0.000
Tolls	$1,276.00	$106.33	0.013
Legal Fees	$0.00	$0.00	0.000
Fines	$0.00	$0.00	0.000
Cargo Claims	$0.00	$0.00	0.000
Scale Fees	$0.00	$0.00	0.000
Workman's Compensation	$0.00	$0.00	0.000
Taxes(Road, Use, Fuel, Fed)	$1,755.00	$146.25	0.018
Miscellaneous Expenses	$500.00	$41.67	0.005
Total Variable Costs:	**$109,489**	**$9,124.06**	**1.095**
Total Vehicle Costs:	**$137,105**	**$11,425.39**	**1.371**
Drivers Income:	**$58,759**	**$4,896.60**	**0.588**
Total Cost of Operation:	**$195,864**	**$16,321.98**	**1.959**

**In the example above note this driver has total expenses per mile of $0.88 cents a mile. If he's hauling 98 cents per mile freight, he's clearing 10 cents a mile which translatates into an annual wage of $9,362.*

Table A.3.14. Packing, Shipping, and Disposal of Radioactive Wastes (excluding Labor costs)

(a) Packing Material Costs

Waste Type [1]	Original Volume (ft^3)	Processed Volume (ft^3)	Number of Containers	Type of Container [2]	Unit Cost of Container	Total Packaging Costs
Pumps, Agitators, Filters	1490	1490	17	Type A - B25 IP-1/88 ft^2	$ 2,100.00	$ 35,700.00
Total	1490	1490	17	-	$ 2,100.00	$ 35,700.00

[1] All waste is Class A LLW
[2] Assume maximum loading to B25 container is 88
ft^2 - square feet
ft^3 - cubic feet
LLW - low level waste

(b) Shipping Costs

Waste Type	Number of Truckloads[1]	Unit Cost ($/mile/ truckload)	Surchages ($/mile)[2]	Overweight charges ($/mile)	Distance Shipped (miles)	Total Shipping Costs
Conveyor Belts, Filters, Agitators, Motors	5	$1.96	$0.20		981	$ 10,567.83
Onsite Tailings (Based on WCS quoted $195/ton)					981	$ 39,000.00
Total	5	-	-	-	981	$ 49,567.83

Note: The distance from Upton, WY to Andrews County, TX is 981 miles.
[1] Assume 4 containers per truckload.
[2] 10% premium assumed for LLW transport.
LLW - low level waste

(c) Waste Disposal Costs

Waste Type	Disposal Volume (ft^3)[1]	Unit Cost ($/$ft^3$)	Surcharges ($/$ft^3$)[1]	Total Disposal Costs
Conveyor Belts, Filters, Agitators, Motors	1632	$100.00	$3.50	$ 168,912.00
Onsite Tailings (Based on WCS quoted $115/ton)				$ 23,000.00
Total	1632	-	-	$ 191,912.00

[1] Disposal volume is based on total B-25 container volume of 96 ft^3.
ft^3 - cubic feet

Table A.3.15. Equipment/Supply Costs (Excluding Containers)

				REF 2022 BASE $ YEAR-0 RATE				
Equipment Title	**Qty**	**Rate Unit**	**Rate**	**MOB/DEMO 25.0%**	**Rate Burdened**	**HR Rate Burdened**	**Tot Units**	**Tot $**
Cat 300 Excavator	1	Mo	$8,000.00	$2,000.00	$10,000.00	$45.45	31	$1,403
Cat 960 Loader	1	Mo	$4,000.00	$1,000.00	$5,000.00	$22.73		$0
8-ton forklift	1	Mo	$4,000.00	$1,000.00	$5,000.00	$22.73		$0
Forklift	1	Mo	$2,000.00	$500.00	$2,500.00	$11.36	66	$745
Manlift	1	Mo	$1,400.00	$350.00	$1,750.00	$7.95	321	$2,552
Shear Mechanisms	1	Mo	$1,200.00	$300.00	$1,500.00	$6.82	31	$210
Grappler Mechanisms	1	Mo	$800.00	$200.00	$1,000.00	$4.55		$0
Dump Truck	1	Mo	$1,200.00	$300.00	$1,500.00	$6.82		$0
Low Boy Trailer	1	Mo	$1,000.00	$250.00	$1,250.00	$5.68		$0
Closed Haul Trailer	1	Mo	$1,500.00	$375.00	$1,875.00	$8.52		$0
Torch Cutting System	1	Mo	$600.00	$150.00	$750.00	$3.41		$0
Grease/Maintenance Truck	1	Mo	$1,000.00	$250.00	$1,250.00	$5.68		$0
Pressure Washer	1	Mo	$300.00	$75.00	$375.00	$1.70	10	$18
100-gallon Baker Tanks	1	Mo	$300.00	$75.00	$375.00	$1.70	51	$88
Radiological Survey Equipment Package - RCT	1	Hr	$18.00	$4.50	$22.50	$22.50	490	$11,027
Large Area Radiation Detection System	1	Hr	$200.00	$50.00	$250.00	$250.00	255	$63,796
Level C Person-Day	1	Ea	$125.00	$31.25	$156.25	NA		$0
Level D Person-Day	1	Ea	$15.00	$3.75	$18.75	NA	64	$1,200
Diesel Fuel	1	Gal	$5.11	$1.28	$6.39	NA	105	$671
Miscellaneous Radiological Survey Supplies Class 1	1	Ea	$250.00	$62.50	$312.50	NA	26	$8,103
Miscellaneous Radiological Survey Supplies Class 2	1	Ea	$100.00	$25.00	$125.00	NA	38	$4,733

Note: Waste containers priced in A.3.14.

Table A.3.16. Laboratory Costs

Laboratory Analyses	Qty	Rate Unit	Rate	MOB/DEMO NA	Rate Burdened	HR Rate Burdened	Tot Units	Tot $
Liquid waste sample - RCRA metals & VOA, gross alpha and beta	1	Ea	$1,200.00	$0.00	$1,200.00	NA	0	$154
Full waste profile sample for disposal site	1	Ea	$7,500.00	$0.00	$7,500.00	NA	1	$7,500

HR - hourly rate
RCRA - Resource Conservation and Recovery Act
VOA - volatile organic compound

Table A.3.18. Total Decommissioning Costs

Task/Component	Base Year Cost 2022	Percentage of Total
Planning, Preparation and Project Management (A.3.6)	$ 255,384	34.8%
Summary Decontamination, Dismantling and Free Release of Facility Components (A.3.7)	$ 47,665	6.5%
Restoration of Facility Grounds (A.3.8)	n/a	n/a
Final Radiation Survey Labor (A.3.9)	$ 51,326	7.0%
Site Stabilization and Long-term surveillance (A.3.10)	n/a	n/a
Packing Material Costs (A.3.14(a))	$ 35,700	4.9%
Shipping Costs (A.3.14(b))	$ 49,568	6.8%
Waste Disposal Costs (A.3.14(c))	$ 191,912	26.2%
Equipment/Supply Costs (A.3.15)	$ 94,545	12.9%
Laboratory Costs (A.3.16)	$ 7,654	1.0%
Miscellaneous Costs (A.3.17)	n/a	n/a
Subtotal	$ 733,754	100%
25% Contingency	$ 183,439	-
TOTAL DECOMMISSIONING COST ESTIMATE	$ 917,193	100%

Appendix C: Detailed Process Description and Diagrams

CONFIDENTIAL – WITHOLD FROM PUBLIC DOMAIN UNDER 10 CFR 2.390

Appendix D: Authorized User Resumes

- President & CEO: Randall Scott
- Plant Manager: Dante Leal
- Principal Investigator: Benjamin Russ, Ph.D.
- RSO: Michael Schierman, CHP

RANDALL J. SCOTT
PRESIDENT AND CEO

RELEVANCE

Mr. Scott is President and CEO of Rare Element Resources and has led the company and the development of the Bear Lodge Rare Earth Projcet since 2011. He has extensive experience in domestic and international mine/project development including project management, financing, engineering, permitting, feasibility studies, and operations.

EDUCATION

- Masters in Business Administration- University of Arizona
- BS Metallurgical Engineering- Colorado School of Mines

EXPERIENCE

Years of Experience – 45 Years

Rare Element Resources, Ltd, Denver, Colorado (2011-2020)

President, CEO and Director

- Responsible for all aspects of Company strategy, finance, and management, including development of the Bear Lodge Rare Earth Project

Thompson Creek Metals Company Inc, Denver, Colorado (2010-2011)

Vice President, Corporate Responsibility and Strategy

- Responsible for developing and executing company-wide focus on sustainability, environmental and safety performance
- Implemented company-wide strategy management system

Scott Home and Land Real Estate Team, Denver, Colorado (2002-2009)

- Principle and founder of Real Estate Group

Cyprus Amax Minerals Company and RAG American Coal (former Cyprus Coal) Denver, Colorado and Phoenix, Arizona (1989-2001)

Various senior executive positions in domestic and international coal and metal operations, project development, economic and feasibility studies

Pincock Allen & Holt, Denver, Colorado (1979-1989)

Executive Vice President and Director

- Managed multi-disciplinary consulting projects for mineral companies, financial institutions, and government agencies

PATENTS / AWARDS

- Rare Element Reources has filed patents pending on the development of its proprietary rare earth processing technology

CITIZENSHIP

- USA

LNV
engineers | architects | surveyors

Dante Leal

Graduate Engineer

Education:

Bachelor of Science, Mechanical Engineering, Texas A&M University – Corpus Christi, 2018

Mr. Leal has three years of experience providing civil and mechanical engineering services. His LNV career began as a graduate engineer in 2018 upon graduation and he is currently working towards obtaining his engineer-in-training license. His experience includes water and wastewater treatment, pump design, project management and construction observation. He is experienced in CAD, ArcGIS, and EPA SSOAP technologies.

Project Experience

Transportation:

City of Corpus Christi – Holly Road - Paul Jones to Rodd Field

Mr. Leal providing civil support services for full engineering design and surveying services to improve 2-lane rural road to 5-lane urban arterial street in the City of Corpus Christi. Scope includes street, ADA pedestrian, cycle tracks, storm water, water, wastewater, street lighting, signalization, signage, pavement marking, traffic control and ROW acquisition.

Texas Department of Transportation – New Harbor Bridge Project

Mr. Leal provided construction observation support services for the construction of the New Harbor Bridge Project. The project is set to replace the existing 70-year-old Harbor Bridge with a new cable stayed style bridge that will be the longest of its kind in North America. The bridge is set to have a height of 538ft at the main towers, 1,661ft long and have a water clearance height of 205ft.

Wastewater:

City of Corpus Christi – Oso Water Reclamation Plant Headworks and Lift Station Improvements

Mr. Leal providing civil support services for the design, bidding and construction phase services of the New Influent Lift Station, Headworks Facility and Odor Control System at the Oso Water Reclamation Plant. The New Influent Lift Station Include six 150 HP variable speed pumps rated at 11.5 MGD providing an initial firm capacity of 60 MGD and an ultimate firm capacity of 80 MGD. The new 98 MGD capacity Headworks will be equipped with four mechanically-cleaned, stair-type screens made out of Type 316 SS with a ¼-inch bar spacing, four Eutek Headcell® vortex grit removal system, two Eutek Teacup and two Hydrogritter® Classifiers. The new odor control system will include a 6800 cfm Biotower system and 5400 cfm In-ground Biofilter capable of treating a combined air flow of 12,200 cfm and high hydrogen sulfide concentrations at a removal efficiency rate of 99%.

City of Corpus Christi – Oso Water Reclamation Plant Breakpoint Chlorination Decommissioning and Process Upgrades

Mr. Leal is providing civil and mechanical support services for the design, bidding and construction phase services of the New Bioreactors, Chemical Facilities, Solids Handling Building, Aeration Blower House, and Clarifiers. The upgrades will include installing a new fine buddle aeration system and converting the existing aeration basins to Bioreactors, state of the art turbo blowers and reduce the total consumption of chemicals needed to treat the effluent wastewater. Additionally, a third Bioreactor will be added will be constructed and add the 98MGD capacity of the Oso Water Reclamation Plant.

Pipeline Analysis (City of Tyler, Texas) – Wastewater Hydraulic Model
Mr. Leal is providing civil support services for a calibrated hydraulic model of the City's wastewater collection system. Documented results, recommendations and opinions of probable costs for improvements. The City has approximately 650 miles of gravity lines ranging in size from 6-inches to 54-inches, 20 lift stations and 8,800 manholes. The hydraulic model will equip the City with the tools for analyzing and identifying system conveyance capacities, bottlenecks, and potential overflow locations. The model will facilitate system analysis, aid in the development of system improvements, produce informational maps/exhibits and will help predict the system's response to future improvements. The project will provide a wastewater flow capacity evaluation, overflow management, infiltration/inflow modeling, system deficiency identification, TCEQ and EPA Compliance, CIP development/costs, new system design and future needs analysis.

DR. BENJAMIN RUSS
SENIOR ENGINEER/PRGRAM MANAGER

RELEVANCE

Dr. Russ has his Ph.D. in Chemical Engineering and has been Center Head for the Advanced Technologies Group, working on developing advanced systems for energy storage and utilization. He has 17 years of experience in materials science and chemical engineering. His work includes development the closed loop demonstration of the hydrogen production processes, novel radioisotope production processes, high power laser-matter interactions studies and systems development and development of field emission display devices.

EDUCATION

- Ph.D., Chemical Engineering, University of California, San Diego, 1997
- M.S., Chemical Engineering, University of California, San Diego, 1996
- B.S., Chemical Engineering, University of California, Davis, 1993

EXPERIENCE

General Atomics, San Diego, CA 2004 – Present

Senior Engineer and Project Manager (2004 – present)

- **Program Manager** for the Concepts and Technology Development Group, responsible for managing and performing R&D programs, including high power laser-matter interaction studies and system development, industrial electrostatic separation process development, and composite materials development.
- **Center Head** for Advanced Technologies Group, responsible for managing the IFT Characterization Facility as well as internal R&D programs. These programs include development of ultra-high resolution 3D printing technologies, leading to sub-micron features in both plastics and metals as well as the development of robotic automation for high precision assembly tasks.
- **Center Head** for the Energy Process Group, responsible for managing multi-million dollar programs for medical isotope development and large scale energy storage and utilization, including Nuclear and Solar Hydrogen and solar thermal heat storage projects.
- **Technical lead** Developing the Selective Gaseous Extraction process for 99Mo production. Coordinating fuel development process, target development and project execution for in-reactor experiments. Development of new processes for isotopes including medical and industrial applications, such as 223Ra, 226Ra, 239Pu and 227Ac.
- **Technical lead** Developing the Sulfur-Iodine Hydrogen Production demonstration for the Nuclear Hydrogen Initiative. Designed and scaled up laboratory processes to a fully integrated pilot-plant demonstration.
- **Staff Engineer** Developing the extractive distillation processes for the Sulfur-Iodine Thermochemical hydrogen production system.

EU Joint Research Centre, Institute for Reference Materials and Measurements, Geel, Belgium, 1993 – 1994

SELECTED RELEVANT PUBLICATIONS

- 12 publications in scientific journals and conference proceedings

PATENTS / AWARDS

- 19 issued US patents

CITIZENSHIP

- United State

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April 2022

Michael Schierman, CHP
Principal Health Physicist
Mike.schierman@h3enviro.com
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Mobile (505) 301-5312

Education

Colorado State University, MS Health Physics
1994

University Nevada-Las Vegas, BS Biological Science
1991

Experience

H3 Environmental, Principal Health Physicist Albuquerque, NM, April-2020 – Present

A founding member of the H3 Environmental with over 27 years of experience in health physics as it applies to uranium mill license applications, characterization and remediation of radioactively contaminated sites, and radiological dose evaluation. Manages day-to day business and serves as technical subject matter expert.

Environmental Restoration Group, Senior Health Physicist, Albuquerque, NM, January 2006 – July 2020
Functioned as a senior health physics and project manager. Duties included business development, project management of large, complex radiologically contaminated sites, development of license applications and environmental reports, developing and implementing radiation protection programs, radiological dose assessments, final status survey design and implementation, and managing a staff of 5-8 technical personnel. Served as radiation safety officer on 1 NRC and 2 agreement state licenses.

Umetco Minerals Corporation, Radiation Safety Officer, Uravan, CO, May 1994 – December 2005
Radiation Safety Officer and Environmental Manager at a former uranium milling site in Uravan Colorado. The site has a radioactive material licensed issued by the state of Colorado and is also on the National Priorities List (NPL). Duties included developing implementing the radiation protection and environmental monitoring program, decommissioning over 100 mill buildings, and remediation of the site.

The Dow Chemical Company, Remediation Leader, Grand Junction, CO, January 2000 – December 2005
Functioned as the remediation leader for two sites, one in Pittsburg CA, the other in Ft Saskatchewan Alberta. The responsibilities included managing scope, schedule, and budgets for remediation project occurring and petrochemical processing sites. Oversight of multidisciplinary consultants and interaction with regulatory agencies was a significant part of the job.

Certifications and Skills

Certifications: American Board of Health Physics, 2007

Skills: Microsoft Office Suite, RESRAD family, PRG calculator, CAP88, ProUCL, JMP statistical package, MILDOS, Visual Sample Plan

Professional Affiliations: Health Physics Society, national and local chapters.

Appendix E: Process Control Safety Interlock Philosophy Overview

1. Process Control Safety & Interlock Philosophy

a. Scope of Automation

Automation for the new Facility control system may include, but not be limited to the following:

i. Monitor run status of all running pumps.
ii. Monitor levels in all tanks, reactors, columns, mixers, etc.
iii. Adjust (manually or automatically) all VFD (variable frequency drives) speed rates based on process conditions or operator-specified parameters. Process variables monitored and controlled may be:
  - Flowrates
  - Tank, reactor, column, mixer, etc. levels as required.
  - Tank, reactor, column, mixer, etc. temperatures as required.
  - Tank, reactor, column, mixer, etc. analytical requirements as required.
  - Controlling process variable shall be determined on process demands compared to operator-specified setpoints.
iv. Valve status on critical process valves.
v. Monitor all alarm points and shutdown pumps as required when adverse process or motor/pump health conditions are detected.
vi. Display all relevant process data and enable auto/manual control of the system from SCADA HMI.
vii. Automatically record process data in the historical database, and display trending information when requested.
viii. Monitor process analytical equipment and record the data in the historical database, and display trending information when requested.

b. Safeties and Interlocks

The following list is an overview of process control safeties and interlocks. Refer to the P&ID's and Sequence of Operations documentation for specific listings and explanations of individual interlocks and safeties to be configured.

i. Tanks, reactors, columns and mixers that have in-vessel agitators shall have a LOW level setpoint alarm generated by the vessel level transmitter, a LOW-LOW level shutdown alarm generated by an independent level switch and a HIGH-vibration shutdown alarm generated by a sensor mounted to the agitator.

  - A LOW-level alarm will generate alarms in the SCADA HMI. To clear a LOW-level alarm, alarm acknowledgement in the HMI is required.

  - A LOW-LOW level shutdown shall cause the vessel agitator associated with the shutdown alarm to shutdown to prevent agitator / vessel damage. To clear a LOW-LOW alarm, an adequate level in the vessel to completely immerse the agitator shall be required, combined with alarm acknowledgement in the HMI.

  - A HIGH vibration shutdown shall cause the vessel agitator associated with the shutdown alarm to shutdown to prevent agitator / vessel damage. To clear a HIGH shutdown alarm, a diagnosis into the cause of the agitator vibration shall be required and rectified, combined with alarm acknowledgement in the HMI.

ii. Tanks, reactors, columns and mixers that have in-vessel heating elements shall have LOW level setpoint alarm generated by the vessel level transmitter and a LOW-LOW level shutdown alarm generated by an independent level switch.

- A LOW-level alarm will generate alarms in the SCADA HMI. To clear a LOW-level alarm, alarm acknowledgement in the HMI is required.
- A LOW-LOW level shutdown shall cause the vessel heating element associated with the shutdown alarm to shutdown to prevent vessel / heating element damage. To clear a LOW-LOW alarm, an adequate level in the vessel to immerse the heating element completely shall be required, combined with alarm acknowledgement in the HMI.

iii. Tanks, reactors, columns and mixers with source fill valves, feed and/or discharge pump(s) will have HIGH- and LOW-level setpoints alarms and HIGH-HIGH-level shutdown alarms generated by the vessel level transmitter and LOW-LOW level shutdown alarms generated by an independent level switch.

- A HIGH- or LOW-level alarm will generate alarms in the SCADA HMI. To clear a HIGH- or LOW-level alarm, alarm acknowledgement in the HMI is required.
- A LOW-LOW level shutdown will cause the vessel discharge pump to shutdown to prevent pump damage due to running dry. To clear a LOW-LOW alarm, an adequate level in the vessel shall be required to ensure full flow to the pump suction to allow proper pump operation, combined with alarm acknowledgement in the HMI.
- A HIGH-HIGH level shutdown will cause the feed pump to the vessel to shutdown or the vessel fill valve to close to prevent vessel overfill. To clear a HIGH-HIGH alarm, an adequate lower level in the vessel shall be required to allow process flow to resume without the risk of vessel overfill, combined with alarm acknowledgement in the HMI.

iv. The LOW-LOW level shutdown switch may be utilized for the vessel agitator, heating element and discharge pump(s) shutdowns in each vessel.

v. Feed hopper conveyor discharge valves shall have OPEN- and/or CLOSED-position switches that will indicate the Open or Closed status of the valve.

- A feed hopper conveyor shall not be permitted to start or continue to run if the conveyor discharge valve is indicated closed in the SCADA HMI.

vi. Manual or automatic starting of any pump, vessel agitator, vessel heating element or feed hopper conveyor shall not be permitted if any of the above shutdown interlock alarms are active.

c. **Management of Information**

Logging of setpoint changes, control of process variable changes, control system access, alarms and shutdowns shall be automatically logged in the Plant Historian system.

END OF DOCUMENT