DISA

June 16, 2025

Mr. Duane E. White
Chief
Low-Level Waste and Projects Branch
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Re: Response to Requests for Additional Information, Disa Technologies, Inc., License Application for a Performance-Based, Multi-Site Radioactive Materials License to Operate a High-Pressure Slurry Ablation Remediation System, Revision 3, Docket 40-38417

Dear Mr. White:

Disa Technologies, Inc. (Disa) is pleased to submit its responses to the U.S. Nuclear Regulatory Commission (NRC) staff's Requests for Additional Information (RAIs) regarding the subject application that were transmitted by letter dated, June 2, 2025 (ADAMS Accession No. ML25141A029). The subject RAIs refer to Disa's application identified by ADAMS Accession Nos. ML25087A097 and ML25087A095. Disa would like to thank the NRC staff for providing its RAIs in a timely manner and consistent with its review schedule as stated in its acceptance letter of April 11, 2025 (ADAMS Accession No. ML25099A303). We know the staff has worked diligently in reviewing this first-of-a-kind license and these efforts are applauded. Disa's responses presented below are organized by reiterating the original RAI, then adding Disa's response. Please note that once the NRC staff approves of Disa's responses, it will submit a revised application and environmental report that incorporates the information presented herein.

RAI 1. Licensing Information (L). L-1 Sources

Additional information is needed for the Thorium-230 sources described in Section 3.1 of the application.

- Manufacturer name
- Model Number
- Leak Test Frequency recommended by manufacturer

Response:

Disa does not currently possess any sources. However, after we receive our license, we will obtain Th-230 sources from Eckert and Ziegler, Product Code - TZR01011. Eckert and Ziegler uses ISO 9978 to perform leak tests prior shipment to a customer. ISO 9978 does not specify a frequency for leak tests for customers; however, NUREG-1556, Volume 18, Page 8-33, specifies a 6-month frequency for leak testing. Therefore, Disa will perform leak tests on its sealed sources every 6 months.

RAI 2. L-2 Sampling Plan

Additional information is needed about the sampling and analysis that is planned for the fines, the coarse fraction, and the process water resulting from the use of high-pressure slurry ablation (HPSA) at the temporary job sites. Staff recommends Disa develop a sampling plan that outlines the number and locations of samples, sample collection methodology (e.g., composite samples), analytical methods, analytical parameters, and quality assurance/quality control measures that sampling staff use to ensure confidence in assessments of the radioactive material concentrations remaining at the temporary jobsites. This sampling plan should address all three streams of the HPSA process.

Response to RAI 2.

General Sampling Strategy

Disa will be collecting grab samples of materials as they are being generated using HPSA. Many samples will be analyzed by portable X-ray fluorescence (XRF) equipment; however, only samples analyzed by a commercial, accredited laboratory will be used for final decision making. Collection frequencies for laboratory samples are discussed below.

Justification for Clean Coarse Sampling Frequency

Disa's choices when sampling the clean coarse material are collecting samples while the clean coarse material is being generated or sampling this material after treatment is completed and prior to site reclamation. Sampling the clean coarse material while the process is ongoing is preferable since we can get early indications of any treatment issues and make subsequent corrections. The assumption for the stated rate is that the clean coarse material will be relatively homogenous because of the mixing, crushing, grinding, slurrying, and ablating that occurs during treatment.

To address the NRC staff's RAI, Disa attempted to utilize ProUCL to calculate a sample size that could be used per 40,000 tons and would satisfy the staff's purpose of statistical validity. However, Disa does not have the data to estimate the standard deviation of the clean coarse material. Therefore, Disa proposes the following:

1. Laboratory testing, prior to mobilization, will include analysis of 5 samples of clean coarse material to estimate the standard deviation of a site.
2. This standard deviation will be used to calculate the sample size, in ProUCL, using the Estimating Mean function. This function is size/area independent, but Disa will assume it's for 40,000 tons.
3. As an example, assuming a 95% confidence interval, an allowable error margin of 10, and a standard deviation of 20 units, the sample size is 18 samples per 40,000 tons. This equals approximately 1 sample every 4 days of treatment with a 50 ton per hour unit.
4. The no. of samples/40,000 tons will be presented in the pre-mobilization notification along with the ProUCL output.

Justification for Fines Concentrates Sampling Frequency

The sampling frequency for the fines concentrates is 1 sample per 10 to 20 tons, which is approximately 1 to 2 samples for roll-off container. Similar to the clean coarse material, the fines concentrates will be relatively homogenous. Therefore, the proposed sampling frequency will be sufficient to prepare shipping papers, prepare the post-remediation notifications, quantify source material for the Additional Protocol requirements, and provide information regarding the HPSA effectiveness.

Analytes and Analytical Methods

Disa is proposing the following analytes and analytical methods for its Clean Coarse Material and Water matrices, which will be performed by Pace Analytical in Sheridan, Wyoming.

1. Clean Coarse Material and Fines Concentrates
    a. Uranium – EPA Method 200.8, Reporting Limit – 1 mg/kg

- b. Vanadium - EPA Method 200.8, Reporting Limit – 5 mg/kg
- c. Radium-226 – EPA Method 901.1 (Gamma Spectroscopy), Reporting Limit 0.2 pCi/g
- d. Thorium-230 – Method ACW01 (Alpha Spectroscopy), Reporting Limit 0.2 pCi/g
- e. TCLP RCRA Metals (Clean Coarse Material only) – EPA Method 6010 C
  - i. Arsenic – Reporting Limit - 0.2 mg/L
  - ii. Barium - Reporting Limit - 0.5 mg/L
  - iii. Cadmium - Reporting Limit - 0.05 mg/L
  - iv. Chromium - Reporting Limit - 0.01 mg/L
  - v. Lead - Reporting Limit - 0.2 mg/L
  - vi. Selenium - Reporting Limit - 0.05 mg/L
  - vii. Silver - Reporting Limit - 0.2 mg/L
- f. TCLP Mercury (Clean Coarse Material Only) – EPA Method 7470A, Reporting Limit – 0.005 mg/L

2. Treated Process Water Samples
   - a. Total RCRA Metals – All EPA 200.8
     - i. Arsenic, Reporting Limit - 0.005 mg/L
     - ii. Barium, , Reporting Limit - 0.005 mg/L
     - iii. Cadmium, Reporting Limit - 0.002 mg/L
     - iv. Chromium, Reporting Limit - 0.01 mg/L
     - v. Lead, Reporting Limit - 0.001 mg/L
     - vi. Selenium, Reporting Limit - 0.005 mg/L
     - vii. Silver, Reporting Limit - 0.003 mg/L
   - b. Uranium, EPA Method 200.8, Reporting Limit - 0.0003 mg/L
   - c. Vanadium, EPA Method 200.8, Reporting Limit - 0.02 mg/L
   - d. Mercury, EPA Method 245.1, Reporting Limit - 0.001 mg/L
   - e. Radium-226, Method SM 7500 Ra-B, Reporting Limit - 0.2 pCi/L
   - f. Thorium-230, Method ACW10, Reporting Limit - 0.2 pCi/L

Sampling Plan and Quality Assurance Plan

Disa is currently preparing a sampling and quality assurance plan and will submit it with our revised application.

RAI 3. L-3 Process Water Treatment

Additional information is needed about the liquid treatment that is planned for the process water resulting from the use of HPSA at the temporary job sites.

Basis

Section 5.14 of the application states:

> The plan also includes treating and discharging water or transporting liquids and solids to licensed disposal facilities. Liquids treatment will be designed to meet 10 CFR Part 20, Appendix B effluent standards, and Disa will not discharge treated water directly to surface water.

Please explain the applicability of the 10 CFR Part 20, Appendix B effluent standards to mine waste remediation at AUM sites. Please describe the water treatment process so that NRC staff can confirm any discharge of the treated water will meet the unrestricted release criteria in 10 CFR 20.1402.

Response to RA 3:

10 CFR 20, Appendix B effluent standards address discharges from a licensed process. Water is used to slurry the mine waste upstream of the collision cell, and is, therefore, part of a licensed process. As stated in 10 CFR 20.1302, Compliance with Dose Limits for Individual Members of the Public, licensees must demonstrate that the annual average concentration of radioactive material released in liquid effluents at the boundary of the unrestricted area do not exceed the values in Table 2 of Appendix B. Therefore, the Appendix B effluent standards apply to the slurry water used during the HPSA process.

Regarding the water treatment process, Disa will be utilizing a proprietary absorbent alumina complex with other proprietary reagents to treat the slurry water onsite. Headwater Technologies will be providing the treatment train design and the treatment media. Disa is attaching to this letter information regarding the proposed treatment system and the treatment media. The entire treatment system will consist of bag filter housings followed by a TurnAbout^{TM} upflow filter system that will contain the aforementioned media.

RAI 4. H-1 Radiation Protection Staff Qualifications and Responsibilities

Additional documentation is needed to support the qualifications and training of the proposed Radiation Safety Officer (RSO) and Alternate Radiation Safety Officer (ARSO) specific to health physics and radiation protection associated with uranium operations. Additional justification is needed to support the proposed reduction in the education and training requirements for the RSO and ARSO who are responsible for the radiation protection program.

Please describe the responsibilities that Disa intends to delegate from the RSO to the Field Service Manager (FSM) and Radiation Safety Technician (RST) related to health and safety at the temporary jobsites. Please provide details on the degree of oversight the RSO will have for day-to-day operations at each temporary jobsite, including the frequency of presence onsite, auditing frequency for each temporary jobsite, observation of monitoring and surveys, incident investigation and emergency response, identification of the need for personnel monitoring, bioassay, and air sampling as work activities change.

Response to RA 4:

1. General information – Regulatory Guide 8.31 is entitled, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable. Disa's proposed activities do NOT involve uranium recovery. For example, the first paragraph in Regulatory Guide 8.31 states the following:

   > This revision of Regulatory Guide 8.31 has been developed to provide guidance on design criteria and administrative practices acceptable to the NRC staff for maintaining occupational exposures as low as is reasonably achievable (ALARA) in ***uranium recovery***

> ***(UR) facilities (for example, uranium milling, in situ leach facilities, ion exchange facilities, heap leach facilities).*** This guidance can also be applied, in part, to other types of UR facilities and portions of conversion facilities since some of the processes used in these facilities are similar to those in UR facilities. (emphasis added)

This paragraph clearly demonstrates that Regulatory Guide 8.31 is not applicable for Disa's license application. Disa's waste treatment activities and uranium recovery (as described above) are completely dissimilar because Disa will not be liberating uranium by any chemical means. Hazards, both radiologically and chemically, are significant to a much higher degree at uranium recovery facilities than at any Disa mine waste treatment site. Considering these differences and the stated inapplicability of Regulatory 8.31 to Disa's mine waste treatment activities, Disa is not required by law and regulation to follow Regulatory Guide 8.31.

However, Disa is paying deference to Regulatory Guide 8.31 by requiring education and specified training, which we conclude is necessary to maintain a safe radiological operation.

2. Additional Documentation.

Regarding additional documentation, Disa's RSO candidate has completed a 1-week RSO training class given by the Oak Ridge Associated Universities (ORAU), which is attached to this letter (Attachment 1). Furthermore, Disa's RSO candidate has regulated uranium mills, served as the mill manager of a decommissioning uranium mill, and has managed and participated in many uranium mine waste characterization projects, and other radiological remediation projects. Below is a table consisting of the RSO responsibilities, as stated in NUREG-1556, Vol. 18, Appendix C, and whether or not Disa's RSO candidate has performed those functions.

Table 1: RSO Functions and Experience

Function	Experience (Y/N)	If yes, Where
Activities involving licensed material that the radiation safety officer (RSO) considers unsafe are stopped.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Ensero Solutions, ERG, Disa
Radiation exposures are kept as low as is reasonably achievable (ALARA).	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Disa
Up-to-date operating, emergency, and security procedures are developed, implemented, maintained, and distributed.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Ensero, ERG, Disa
All activities involving radioactive material, including monitoring and surveys of all areas in which radioactive material is used are overseen	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Ensero, ERG, Disa
Safety consequences of nonroutine operations are analyzed before conducting any such activities that have not been previously analyzed	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Disa
Nonroutine operations are performed by the manufacturer, distributor, or person specifically	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa

Function	Experience (Y/N)	If yes, Where
authorized by the U.S. Nuclear Regulatory Commission (NRC) or an Agreement State		
Any incidents are investigated, and any emergencies are responded to.	Y	Cotter Cańon City, Disa
Availability to serve as a point of contact for the NRC's, Agreement State's, and licensee's management during routine operations, emergencies, or incidents.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Disa
Proper authorities of incidents, such as damage to sealed sources/devices, loss of licensed material, fire, theft, etc. are notified	Y	Cotter Cańon City
Investigation of unusual occurrences, identify cause(s) and appropriate corrective action(s), and take timely corrective action(s) to prevent recurrence.	Y	Cotter Cańon City, ERG
Properly secure licensed radioactive materials.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Disa
Possession, installation, relocation, use, storage, repair and maintenance of sealed sources, devices and radioactive wastes are consistent with the limitations in the license, individual Sealed Source and Device Registration Certificate(s), and the manufacturer's specific recommendations and instructions	N	
Prospective evaluations are performed to demonstrate that unmonitored individuals are not likely to receive a radiation dose in excess of the limits in 10 CFR 20.1502(a) or that personnel monitoring devices are provided.	Y	Cotter Cańon City, Disa
Identification of the need for personnel monitoring, distribute and collect personnel radiation monitoring devices, evaluate bioassays, monitor personnel radiation exposure and bioassay records for trends and high exposures, notify individuals and their supervisors of radiation exposures approaching the limits, and recommend appropriate remedial action. Record and maintain the results of such monitoring.	Y, except bioassays since none were necessary in my circumstances	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa
Documentation is maintained to demonstrate, by measurement or calculation, that the total effective dose equivalent to the individual member of the public likely to receive the highest dose from the licensed operation does not exceed the annual limit in Title 10 of the Code of Federal Regulations (10 CFR) Part 20.1301, "Dose limits for individual members of the public."	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa

Function	Experience (Y/N)	If yes, Where
Licensed material is transported in accordance with all applicable NRC and DOT requirements	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa
Understanding of and maintenance of up-to-date copies of NRC regulations, the license, 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 the NRC during the licensing process.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Ensero, Disa
Amendment and renewal requests are submitted in a timely manner.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine
All areas in which radioactive material is used are monitored and surveyed.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Ensero, Disa
The inventory and leak testing of sealed sources is performed/overseen.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine
The inventory and calibration of radiation survey instruments is performed/overseen.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine
Necessary information on all aspects of radiation protection to personnel at all levels of responsibility, pursuant to 10 CFR Part 19 and Part 20 and any other applicable regulations	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa
Proper delivery, receipt, and conduct of radiation surveys for all shipments of radioactive material arriving at or leaving from the facility, as well as packaging and labeling all radioactive material leaving the facility are overseen	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa
Individuals involved with using radioactive materials are properly trained and evaluated.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa
The radioactive waste disposal program, including effluent monitoring and recordkeeping on waste storage and disposal records is supervised and coordinated.	N	
Licensed material is disposed of properly.	Y	Cotter Cańon City
The storage of radioactive material not in current use, including waste, is overseen.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa
An inventory of all radioisotopes possessed under the license and limit the quantity to the amounts authorized by the license is maintained.	N	
Decontamination and recovery activities are overseen	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa

Function	Experience (Y/N)	If yes, Where
Periodic audits are performed, at least annually, of the radiation safety program to ensure that the licensee is complying with all applicable NRC regulations and the terms and conditions of the license	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Disa
The results of audits, identification of deficiencies, and recommendations for change are documented (and maintained for 3 years after the record is made) and provided to management for review; ensure that prompt action is taken to correct deficiencies.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Ensero, Disa
The audit results and corrective actions are communicated to all personnel who use licensed material.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Ensero, Disa
When the licensee identifies violation(s) of regulations or license conditions or program weaknesses, corrective action(s) are developed, implemented, and documented.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine
All incidents, accidents, and personnel exposure to radiation in excess of ALARA or 10 CFR Part 20 limits are investigated and reported to NRC and other appropriate authorities, if required, within the required time limits.	N. Have not experienced exceedances of ALARA or 10 CFR 20 limits	
Required records that are necessary to support the license and satisfy NRC or Agreement States regulations are maintained.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, ERG, Disa
Documents are posted as required by 10 CFR 19.11, "Posting of notices to workers," (10 CFR Part 19, license documents, operating procedures, NRC Form 3, "Notice to Employees,"), and 10 CFR 21.6, "Posting Requirements," (10 CFR Part 21 Section 206 of the Energy Reorganization Act of 1974, procedures adopted under Part 21), or a notice is posted indicating where these documents can be examined.	Y	Cotter Cańon City, Cotter Schwartzwalder Mine, Disa

The NRC staff states that the RSO candidate does not have 1 year of actual experience relevant to uranium mill operations. Considering the additional information presented above, Disa concludes that the RSO candidate does indeed meet the 1 year of work experience relevant to uranium mill operations, even though Disa's operations are not uranium milling and the RG 8.31 criterion does not actually apply in this case.

Regarding Disa's ARSO, although one is not required, Disa is nominating an ARSO, for those times that the RSO is not available. Instead of the current candidate, Disa is nominating Mr. Bryan Erdmann, CHP, as the ARSO for this project. Mr. Erdmann's resume and training certificates are attached to this letter

(Attachment 2). Mr. Erdmann, is a Certified Health Physicist (see https://www.aahp-abhp.org/membership/membership-list/?first=E) and has executed the RSO functions for multiple licenses. He will be available to perform all the RSO functions and will be available in an advisory role for this license.

3. RSO/RST Interactions

The RSO will not be onsite full time for any uranium mine waste treatment project. Instead, a radiation safety technician, meeting Disa's qualification and training requirements, will be onsite full-time, performing the monitoring and documentation functions necessary to maintain occupational and public health. This RST will be in communication with the RSO daily or weekly depending upon the length of the project. Communications will occur through a portable Starlink internet connection; therefore, the RSO can be easily involved in managing or addressing urgent or emergency situations. The RSO or ARSO will make regular visits to a remediation site. Site visits/audits could occur weekly, biweekly, or monthly depending on the duration of the project. The RSO/ARSO will conduct an audit of the site radiation protection program including reviewing records and observing radiation protection activities (i.e., surveys, sampling, monitoring). All radiation protection documentation will be maintained at the Mills, Wyoming, headquarters.

RAI 5. HP-2 Dose Assessment for Multiple HPSA Units

Additional information is needed regarding dose assessment for sites with more than one HPSA unit operating concurrently. Alternatively, please provide justification for why the occupational and public doses would not be expected to change with additional HPSA systems operating concurrently at a temporary jobsite.

Response to RAI 5.

Additional modeling has been performed to investigate how dose rates to the public vary when multiple HPSA units and additional fines storage trailers are present during operations. Section 7.0 has been updated to discuss the modeling results (Attachment 3). Conservative and simplifying assumptions (i.e., protective) were made using the Tier 5 parameters (i.e., based on parameters in Table 4-1 of the Application). Associated with this (and related to RAI 6. HP-3 below), the public dose occupancy time assumptions have been revised to be consistent with guidance found in NUREG-1556 Volume 12 Appendix J (Table J-1). This guidance suggests an occupancy factor of 1/40 (0.025) for situations which meet the following description "Outdoor areas with only transient pedestrian or vehicular traffic, unattended parking lots, vehicular drop off areas (unattended), stairways, and unattended elevators". Calculated public annual dose rates have been adjusted (for previous modeling and the recent modeling) to account for this occupancy.

The results are summarized here. The previous modeling efforts (for one HPSA unit and associated fines concentrate storage) shows an average expected exposure rate at a restricted area boundary 50-ft from operations as 0.02 mrem/hr. The maximum observed in this model was 0.05 mrem/hr (see Table 7-4 of Application). Using the occupancy described above, this results in expected annual doses of 4.4 mrem (average) up to 11 mrem (maximum).

The additional modeling for using much larger source terms to account for up to 4 HPSA units and up to 64 fines concentrate storage trailers (consistent with "Tier 5" operations) show comparable results at a boundary 50-ft from operations (see Table 7-5 of Application). The expected dose rate from the model is 0.02 mrem/hr at the boundary of the storage trailers or HPSA units. This suggests that the potential dose rates are primarily driven by the storage trailers/HPSA units nearest the boundary, and trailers/units deeper within the restricted area are less influential.

Note – 50-ft boundary is a reasonable assumption or approximation of the necessary minimum area required for operations; however, it should be noted that this is somewhat arbitrary. If field measurements indicate dose rates are more elevated than expected, boundaries can be extended to reduce exposure rates the public may potentially have access to.

RAI 6. HP-3 Dose Assessment for Long-Term Operations

Additional information is needed on Disa's dose assessment exposure assumptions. Please provide justification for the 6-month exposure assumptions for the public dose assessments for long-term sites where Disa expects to operate for longer than 2 years (i.e., Tiers 2 through 5 on Table 4-1). Alternatively, revise the dose assessment assumptions for these sites to account for longer occupancy times.

Response to RAI 6.

The initial model assumed a 6-month exposure assumption for the public. This was chosen somewhat arbitrarily to be extremely conservative for operations considering where temporary job sites will generally be located. In response to the RAIs, we have revised our public occupancy assumptions to be in line with NRC guidance. In particular, NUREG-1556 Volume 12 Appendix J provides guidance on public dose estimates including assumed occupancy times (See Table J-1). A factor of 1/40 (0.025) is recommended for the following description, "Outdoor areas with only transient pedestrian or vehicular traffic, unattended parking lots, vehicular drop off areas (unattended), stairways, and unattended elevators". Disa feels this is an appropriate, conservative description of the likely scenarios to be present at temporary job sites. Therefore, Disa has adjusted and updated the models to reduce the occupancy time originally stated.

Because doses limits are on an annual basis, 1 year is the longest amount of time necessary for modeling. Annual dose rates are modeled and reported (See Tables 7-4 and 7-5 of the Application). Results indicate expected doses will be well below the public dose limit. Whether operations run for 1 year or 12+ years does not affect this annual dose rate.

RAI 7. HP-4 Public Dose Modeling and Calculations

Additional information is needed to support the calculated public dose during operations, to release a site for unrestricted use, and post-demobilization, under the recreational use scenario. In order for NRC staff to be able to validate Disa's calculated public dose for these scenarios, please provide information regarding the assumptions and description of the recreational use scenario, justification of calculating the external public dose at 1 foot from the pile of coarse material rather than at the edge of the pile or the middle of the pile post-demobilization, and justification for calculating the internal public dose at 254 feet from the edge of the pile rather than next to the pile. For the modelled doses, the input and output sheets should be provided, and the formulas (if calculated) or input values (if modelled) should be provided to allow the NRC staff to verify the dose. If default values are used in the modelling, please indicate which defaults and if site information is used, please provide the origin of that information.

Response to RAI 7.

The updated dose modeling presented in Section 7.0 is focused on potential doses to the public during site operations. Section 7.4 presents some modeling to support the use of HPSA as a dose reduction technique. It is meant to be illustrative of the benefits of the technology, not as an assessment of potential doses to a site for unrestricted release or doses post demobilization. Therefore, the models of an abandoned waste pile and a related clean coarse fraction are somewhat arbitrary and only for comparison. It should be noted that for internal dose calculations, MILDOS cannot model meaningful concentrations and dose rates on top of or immediately adjacent to source terms which is why some of the parameters in this comparison were chosen (e.g., 100-m or 254-feet from the source rather than on top of or next to the source).

Some additional tables with source and receptor information for the internal dose models (during operations) have been added. All doses (internal or external) are modeled, and calculations are limited to simple sums (e.g., TEDE = DDE + CDE). Microshield and MILDOS input/output files can be provided if necessary. Source and receptor locations and source information (such as source concentrations) are now provided in tables. Any other parameter, including wind rose data, was assumed to be the modeling program default (see MILDOS Technical Manual Ver. 4.1). Wind rose data will vary highly from site to site, so it is assumed the default wind rose is as applicable as any other wind rose for this modeling effort.

With the updates described in HP-2 and HP-3 RAIs, the previous maximum external dose rate (e.g., 74 mrem/yr) is now reported as 11 mrem/yr. The internal dose rate has remained the same at 6.1 mrem/yr. This results in a maximum TEDE during operations of < 20 mrem/yr. The conservativism in these results is explained in previous RAIs and in the application document. Because of the monitoring to be performed during operations (exposure rate, air monitoring, etc.) and the ability to adjust boundaries accordingly, Disa feels strongly that public doses to the public will remain well below public dose limits.

RAI 8. HP-5 Airborne Environmental Monitoring

Justification is needed for the radon monitoring approach Disa proposes in Table 5-6. For Tier 1 sites (100,000 tons of abandoned uranium mine [AUM] waste), the table does not indicate a radon detector to be at each station, as is shown in the table for Tiers 2 through 5. It is not clear why Disa does not plan for radon monitoring at the Tier 1 sites. In addition, provide justification for the elimination of monitoring described in Table 5-6.

Response to RAI 8.

Experience has shown that radon concentrations from uranium mine waste or abandoned uranium mine workings do not produce noteworthy doses to members of the public. However, Disa will commit to radon monitoring for all projects, and will be using track-etch detectors or continuous radon monitoring detectors.

RAI 9. HP-6 Baseline Surveys

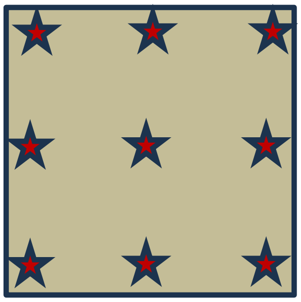
Please describe the objectives of the baseline survey and the parameters to be measured and how they relate to the unrestricted release criteria.

Response to RAI 9.

Baseline surveys will be performed by locating 5m x 5m sample plots outside the area of the waste pile. Disa has observed, at almost all waste piles it has surveyed, that baseline gamma concentrations occur between 10,000 and 15,000 counts per minute and these baseline counts occur close the outside edge of waste pile areas. Therefore, Disa will seek background sample plot locations within 0.25-mile upgradient and upwind of a uranium mine waste pile/area.

Baseline surveys will be conducted by performing walkover GPS-gamma scans then collecting nine shallow surface samples in the orientation presented below.

Figure 1: Typical Background Soil Sampling Patter



Soil samples will be collected from the top 6 inches. All nine individual soil samples will be blended into one composite sample for analysis of natural uranium, thorium-230, and radium-226. Gamma measurements will be averaged to calculate one overall baseline gamma count rate. Gamma and the other parameters previously mentioned will be used to estimate the baseline Total Effective Dose Equivalent (TEDE) and the post-remediation TEDE for each site to determine if the unrestricted release criterion in 10 CFR 20.1402 and the exemption limit in 10 CFR 40.13(a) are met.

Disa disagrees that FC 83-23 forms the basis of 10 CFR 20.1402. FC 83-23 is guidance that is dated May 1987. This guidance contains concentration based standards for radionuclides and external radiation. However, 10 CFR 20.1402 is a dose based standard that was promulgated in 62 FR 39088, July 21, 1997. Therefore, the acceptable soil contamination levels in FC 83-23 are completely inapplicable to Disa's license application. Furthermore, Disa's remediation projects will not include buildings; therefore, the surface contamination limits of Table 1 in FC 83-23 will also not apply to the unrestricted release of Disa's remediated sites.

Disa's compliance with 10 CFR 20.1402 will be based on the GPS-gamma scans and analytical data described above that will be incorporated in dose modeling using MILDOS. The use of MILDOS to calculate doses complies with the definition of surveys found in 10 CFR 20.1003, which states the following:

> Survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and ***measurements or calculations*** of levels of radiation, or concentrations or quantities of radioactive material present. (emphasis added)

These measurements or calculations are required by 10 CFR Subpart F.

RAI 10. E-1 Air Emissions

Additional information is needed for estimates of generator and non-generator air emissions during construction, operation, and demobilization for the five HPSA operating tiers:

- Criteria pollutants under the National Ambient Air Quality Standards: sulfur dioxide, lead, ozone, PM10 for generator emissions, and PM2.5 for generator and non-generator (construction and operation) emissions.
- Greenhouse gases that would be emitted, such as carbon dioxide, methane, nitrous oxide, and any fluorinated gases. Alternatively, provide estimates of aggregated greenhouses gases in the form of CO_2e (CO_2 equivalents) and an explanation of the CO_2e estimates.

In addition, indicate whether the estimates already included in Table 1-2 of the Environmental Report (ER) (for nitrogen oxides, hydrocarbons, carbon monoxide and particulates) account for construction and demobilization activities. If they do not, provide estimates for construction and demobilization activities.

Response to RAI 10.

Disa provided all the information that was published for generators, trucks, and heavy equipment. We cannot provide information regarding parameters for which we cannot obtain. Generator emissions were obtained from Caterpillar products (one of which is attached to this letter) (Attachment 4). The data from Caterpillar does not specify the particulate size fraction. Emissions for diesel trucks were obtained from the document, entitled, “Average In-Use Emissions from Heavy-Duty Trucks”(EPA, 2008). Particulate emissions for heavy equipment were obtained from Muleski, et.al., 2005, as stated in the current application.

Disa supplemented its emissions estimates to account for trucks, which was not included in the original application. Table 2 contains the emissions rates for pollutants, and Table 3 contains the total pollutant mass for trucks based on phase of operations.

Table 2: Heavy-Duty Truck Emissions (in grams per mile)

Pollutant	Heavy-Duty Diesel Vehicle
VOC	0.447
THC including methane	0.4583
CO	2.311
NOx	8.613
$PM_{2.5}$	0.202
PM_{10}	0.219

Source: EPA, 2008

To address the issue of emissions from project phases, Table 3 presents the emissions estimates for mobilization, demobilization, and operations. Assumptions for mobilization/demobilization emissions are as follows (per 50 tph unit):

1. Nine semi-tractor/trailers
2. Two personnel trucks
3. One water truck
4. One fuel truck
5. Trips are 275 miles per truck during mobilization and demobilization. Trips are 50 miles on average during operations because fuel and water will be sourced closer to project sites.

Table 3: Total Emissions Estimate by Phase

Tiers	No. of 50 TPH HPSA Units	Mobe/Demobe Trucks	No. of Vehicle Miles[1]	Mobilization Truck Emissions (kg)						Demobilization Truck Emission (kg)						Truck Emissions During Operations (kg)								
				VOC	THC incl. Methane	CO	NOx	$PM_{2.5}$	PM_{10}	VOC	THC incl. Methane	CO	NOx	$PM_{2.5}$	PM_{10}	No. of Weeks	Total No. of Trucks	Total No. of Miles	VOC	THC incl. Methane	CO	NOx	$PM_{2.5}$	PM_{10}
Tier 1	1.00	12.00	3,300.00	1.48	1.51	7.63	28.42	0.67	0.72	1.48	1.51	7.63	28.42	0.67	0.72	37.00	999.00	178,071.75	79.60	81.61	411.52	1,533.73	35.97	39.00
Tier 2	1.00	12.00	3,300.00	1.48	1.51	7.63	28.42	0.67	0.72	1.48	1.51	7.63	28.42	0.67	0.72	185.19	5,000.00	891,250.00	398.39	408.46	2,059.68	7,676.34	180.03	195.18
Tier 3	2.00	24.00	6,600.00	2.95	3.02	15.25	56.85	1.33	1.45	2.95	3.02	15.25	56.85	1.33	1.45	185.00	9,805.00	1,747,741.25	781.24	800.99	4,039.03	15,053.30	353.04	382.76
Tier 4	3.00	36.00	9,900.00	4.43	4.54	22.88	85.27	2.00	2.17	4.43	4.54	22.88	85.27	2.00	2.17	617.00	49,360.00	8,798,420.00	3,932.89	4,032.32	20,333.15	75,780.79	1,777.28	1,926.85
Tier 5	4.00	48.00	13,200.00	5.90	6.05	30.51	113.69	2.67	2.89	5.90	6.05	30.51	113.69	2.67	2.89	926.00	98,156.00	17,496,307.00	7,820.85	8,018.56	40,433.97	150,695.69	3,534.25	3,831.69

Notes: 1. Assumes 275 (57% of Trucks) miles for mobilization/demobilization and fines concentrates recycling. Assumes 50 miles for fuel and water trucks, each (43% of Trucks).

The total emissions for the various phases of projects and addressing trucks, equipment, and generators is summarized in Table 4, which is the sum of emissions from Table 3 above and information from 1-2:

Table 4: Total Emissions

Tiers	Total Emissions (kg)					
	VOC	THC incl. Methane	CO	NOx	$PM_{2.5}$	PM_{10}
Tier 1	82.55	86.66	463.26	2,824.82	37.30	6,649.41
Tier 2	401.34	423.40	2,432.26	14,284.29	181.37	31,748.77
Tier 3	787.14	837.04	4,609.54	33,436.99	355.71	62,763.74
Tier 4	3,941.74	5,226.58	42,156.68	216,099.48	1,781.28	311,122.86
Tier 5	7,832.65	17,363.99	72,461.64	361,389.74	3,539.59	618,253.24

Notes: Particulates from heavy equipment and generators are added to PM_{10}.

The staff states that it needs information regarding greenhouse gas emissions. However, neither 10 CFR Part 51 nor NUREG-1748 require applicants or licensees to address greenhouse gas emissions in environmental reports; therefore, Disa is not required to provide that information.

RAI 11. E-2 Socioeconomics

Provide estimates or estimated ranges of the number of full- and part-time employees for each HPSA operating tier for the construction, operation, and demobilization phases. The NRC staff assumes that each tax estimate in Table 4-7 of the ER applies to a single employee. Please confirm this or explain the assumptions underlying the estimates in Table 4-7. To provide a description on tax revenues in areas of abandoned mine clusters, provide tax information for each of the communities listed in Table 3-10.

Section 4.10.4 of the ER states “communities located near clusters of abandoned uranium mines may experience longer commercial activity and the need for temporary housing.” Please explain the meaning of this statement. Is Disa indicating that portions of communities or entire communities may require alternative housing arrangements to mitigate the potential impacts of HPSA operations? Describe the situations in which alternative housing would be pursued and the types of environmental impacts from HPSA operations that could result in the need for alternative housing.

Response to RAI 11.

An estimate of the full-time employees needed for HPSA operations, based on the project tiers, is presented in Table 5.

Table 5: Number of Full-Time Personnel and Tax Calculations

Tier	HPSA Operators	Radiation Safety	Supervisor	Heavy Equipment Operator	Total Persons	Person Days	Person Weeks	Person Months	Lodging ($1600/mo.)	Meals ($74/day)	Supplies	Income Tax (4.4%)	Sales Tax Meals (8.53%)	Sales Tax Supplies (8.53%)	Fuel Taxes ($0.205/gal)	Total Taxes
Tier 1	2	1	1	1	5	925	185	46.25	$74,000.00	$ 68,450.00	$46,250.00	$3,256.00	$5,838.79	$3,945.13	$1,537.50	$14,577.41
Tier 2	2	1	1	1	5	4630	926	231.5	$370,400.00	$342,620.00	$231,500.00	$16,297.60	$29,225.49	$19,746.95	$1,537.50	$66,807.54
Tier 3	4	1	1	2	8	7408	1481.6	370.4	$592,640.00	$548,192.00	$370,400.00	$26,076.16	$46,760.78	$31,595.12	$1,537.50	$105,969.56
Tier 4	6	2	2	3	13	40118	8023.6	2005.9	$3,209,440.00	$2,968,732.00	$2,005,900.00	$141,215.36	$253,232.84	$171,103.27	$3,075.00	$568,626.47
Tier 5	8	3	2	4	17	78710	15742	3935.5	$6,296,800.00	$5,824,540.00	$3,935,500.00	$277,059.20	$496,833.26	$335,698.15	$3,075.00	$1,112,665.61

Disa's statement regarding temporary housing was a general statement regarding Disa's employees not local residents. Based on our assessment presented above, we expect the maximum number of employees working on HPSA sites is 17. These employees will be full-time not part-time. Whereas some small towns nearest to our HPSA sites may not have the capacity to house 17 employees, we conclude, based on our recent experience, that larger towns within 1.5 hours of our HPSA sites will be large enough to absorb 17 employees. Disa concludes that all Disa employees will be housed within 1.5 hours of a HPSA treatment site, and no local residents will be displaced.

RAI 12. E-3 Coarse Material Handling

Additional information is needed about the actions Disa will take to disposition the coarse material onsite after treatment, including plans for monitoring, regrading, seeding, and any other measures to prevent erosion, biointrusion, animal intrusion, and windblown dust. In addition, in what ways would the handling of coarse material be different from site to site?

Response to RAI 12.

Once Disa analyzes the analytical data for the clean coarse material and calculates residual doses to confirm that we will meet the cleanup criteria (unrestricted release and source material limit), Disa will grade the material into the existing topography and seed. Seed mixes will be provided by Disa's ecological resources consultant. Because our HPSA sites will be released for unrestricted use, biointrusion and animal intrusions do not need to be addressed because these sites will become part of the natural environment. Also, HPSA separates out the fines, which will be transported offsite. Consequently, the degree to which windblown dust occurs will be substantially less from HSPA-treated areas than in the natural environment because the fines have been removed.

RAI 13. E-4 Materials and Wastes

Describe chemicals and materials (e.g., generator fuel, explosives, gravel for roads and the site) that may be used and stored at the HPSA sites, describe storage plans, and provide estimates of quantities for each HPSA operating tier. Please explain the conditions under which explosives would be used. Describe the expected quantity and frequency of explosives use.

List the expected radioactive and nonradioactive waste types that would be generated during HPSA and support operations (other low-level radioactive wastes, mixed wastes, hazardous wastes, nonhazardous solid waste, any construction/demolition wastes) in addition to those listed in Table 5-1 of the application. Provide estimated quantities for each waste type for each HPSA operating tier. Describe planned onsite storage (including timeframes) and management of wastes before transporting offsite for disposition.

Response to RAI 13.

Table 1-1 in the Environmental Report presents the amount of fuel that will be consumed daily and the amount of fuel that will be delivered to the site. Table 1-1 also provides an estimate of the mass of road base that we assumed would be required to stabilize roads. Fuel would be stored in the fuel trucks that are delivered to any site, as we expect fueling to occur at the time of delivery and then the trucks would leave the site. Disa is not anticipating storing road base at any site.

No explosives will be used at any HPSA treatment site. The word "explosive" was used as part of a general guideline for radioactive waste management safety. Disa will revise this text. Disa's projects will not involve any construction or demolition, so no wastes will be involved. Disa uses the term "construction" in Table 1-2 to describe remediation activities that are ancillary to HPSA treatment, such as moving waste to the HPSA units. Disa will replace the term "construction" with "remediation."

Table 5-1 in the Application presents the wastes that Disa expects to generate at any given site. Table 6 below presents this information, and additional waste management information requested by the NRC staff.

Table 6: Waste Generation

Material	Radioactive Waste (Y/N)	Rationale	Quantity	Storage
Fines Concentrates	Both	Yes, if the material is disposed of a low-level radioactive waste. No, if the material is recycled as equivalent feed.	See Table 1-1	Storage will occur in roll-off containers or dump trailers. All fines concentrates storage will occur in one area that will be designated as a restricted area unless exposure rates warrant designation as a radiation area.
Clean Coarse Material	No	Material is inert and can be used onsite for reclamation.	See Table 1-1	No storage required
Water	Both	Yes, if the water cannot be treated to meet 10 CFR 20, Appendix B, effluent standards and discharged. No, if water is treated to 10 CFR 20, Appendix B, effluent standards and discharged.	See Table 1-1	Storage will occur in polyethylene water tanks until discharge. If water does not meet standards, it will be transported to next site and reused until disposed at an authorized water treatment plant
Water Treatment Solids	Both	Yes, if the material is disposed of as a low-level radioactive waste. No, if the material is recycled as equivalent feed.	30 cubic feet per HPSA unit (HWT, undated)	Material will be placed in fines concentrates containers or trailers for processing.
Spilled Fuel oil	No		Unknown	Spilled fuel oil will contaminate soil. Contaminated soil will be land-farmed in a designated area if project duration is sufficiently long. If necessary, contaminated soil will be placed in a roll-off container and transported to an authorized disposal facility by a permitted hauler.
General Debris (i.e., rags, towels, etc.	No	This material will be scanned for release, but experience from batch studies tells us that these materials will pass release surveys	Unknown	Placed in plastic drums and disposed at a solid waste disposal facility.

RAI 14. E-5 Transportation

Estimate the quantity of gravel and resulting number of truck shipments that would be needed per 10 miles of road as indicated in Table 1-1. Clarify how the information on quantities of trucks provided in the first paragraph of ER Section 4.2.4 relates to the tiers and estimates of trucks in Table 1-1.

Response to RAI 14.

The NRC staff is correct in its assertion that the quantity of gravel and resulting number of truck shipments are not related to the tiers presented in the Environmental Report. Disa identified almost 300 sites to date, and has surveyed approximately 30. The assumption that 10 miles of road will need to be improved is a conservative placeholder. In reality, most of the sites we have observed are near roads that will be suitable for HPSA operations. Furthermore, the larger sites appear to be closer to the more suitable roads, whereas the smaller sites are more isolated. The staff's request for "accurate" information is not a fulfillable request considering that each site is different and may require a different quantity of road improvements. This information can be provided in the pre-mobilization notification.

RAI 15. CI-1 Equivalent Feed

Based on its review of the application, the NRC staff understands that the HPSA technology does not utilize ion exchange resins or any accompanying infrastructure (tanks, piping, vents) as part of Disa's HPSA system. It is unclear to the staff how material from Disa's process would be processed as equivalent feed (as described in guidance in Regulatory Issue Summary (RIS) 2012-06) (NRC, 2012) when it does not appear to be utilizing equipment or techniques that implicate that RIS. If ion exchange resins are used within the HPSA process, that may alter monitoring locations for worker doses and effluents. Please confirm that Disa is not planning to use ion exchange resins and any accompanying infrastructure (tanks, piping, vents) as part of Disa's HPSA system.

Response to RAI 15.

In this RAI, the NRC staff, is narrowly interpreting the intent of the RIS, to the exclusion of other obvious situations. To directly address the staff's request, Disa is not using any ion exchange resin or any accompanying infrastructure in its HPSA process or for process water treatment. However, a more global issue exists regarding equivalent vs. alternate fee. Regulatory Information Summary (RIS) 2012-06 states the following (page 2 of 7):

> As stated above, the NRC is issuing this RIS to clarify the NRC's policy regarding alternate feed. In SECY-99-012, "Use of Uranium Mill Tailings Impoundments for the Disposal of Other Than 11e.(2)2 Byproduct Materials, and Reviews of Applications to Process Material Other Than Natural Uranium Ores," (available at http://www.nrc.gov/reading-rm/doccollections/ commission/secys/1999/) ***the staff defined alternate feed as material other than natural uranium ores***. Alternate feed can, therefore, be certain wastes, including sludges or soils, from other sites that contains recoverable amounts of uranium. The RIS 00-23 provided guidance on evaluating requests for a license amendment for a uranium recovery facility (i.e., conventional mill) to accept this material, recover the uranium, and dispose of the tailings. (emphasis added).

The emphasized phrase above is clear; if a material is not natural but contains recoverable uranium, then it's alternate feed. Disa's fines concentrates is equivalent to uranium ore. Uranium minerals in the fines concentrates have been physically altered, but the chemical structure of the ore is the same as run-of-mine ore that has been crushed. Disa concludes that the fines concentrates are equivalent feed, and this conclusion is supported by RIS 2012-06 by the following statement on page 4 of 7:

> Consequently, in this guidance, the staff is defining the term "equivalent feed" to apply to those circumstances where the feed material is essentially the same chemically and physically as the source material that is normally processed at a uranium recovery facility. Such material should not be considered as alternative feed requiring license amendments as described in RIS 00-23 if it meets the equivalent feed criteria articulated in this RIS.

Again, although RIS 2012-06 was produced to solve a specific problem regarding ion exchange resin, the sentence above dictates that a more global meaning of equivalent feed exists.

RAI 16. CI-2 Cap Installation

Please confirm that Disa does not expect to cap coarse material in place at the temporary jobsites if that material does not meet unrestricted release criteria. Apparently contradictory statements appear in Disa's application package.

Response to RAI 16.

Disa will not cap the clean coarse material. Disa will undertake batch testing prior to mobilizing to a site. Batch testing results will determine whether or not HPSA will successfully treat the uranium mine waste and if the clean coarse material will meet the unrestricted release/source material concentration criteria. If testing indicates that HPSA will not successfully remediate a site, then Disa will not proceed with site remediation. Therefore, the clean coarse material resulting from a site remediation will very likely meet the aforementioned criteria. After confirming a successful remediation, Disa will grade the clean coarse material into the existing topography and add seed.

RAI 17. CI-2 Waste Classification and Shipment

Please confirm that waste to be shipped to a low-level waste disposal facility or a uranium processing facility will be classified and shipped in accordance with 10 CFR Part 61 and 10 CFR Part 20, Appendix G.

Response to RAI 17.

Disa's license is applying for a source materials license, and the cleanup criterion under 10 CFR 40.13(a), which is the 0.05% by weight exemption limit. Disa and its consultant, Environmental Restoration Group, Inc., are experienced with shipping source material, especially natural uranium, which is the primary driver for packaging and labeling requirements. Therefore, waste classification must be based on 10 CFR 40, and transportation must occur in compliance with 10 CFR 71 and 49 CFR 171 – 173. Disa currently has procedures for transporting materials as either LSA I or UN2910, which are the expected classifications.

In addition, 10 CFR Part 61 does not appear to apply to Disa's license application. Section 61.1(b)(3) states that disposal of licensed materials as provided for in Part 20 of this chapter is not applicable to Part 61. Section 20.1002 states, in part, that Part 20 applies to receive, possess, use, transfer, or dispose of byproduct, source, or special nuclear material or to operate a production or utilization facility under parts 30 through 36, 39, 40, 50, 52, 60, 61, 63, 70, or 72 of this chapter. Because the HPSA fines concentrates will be licensed to be disposed under Part 40, Part 61 does not appear applicable.

Again, Disa offers its appreciation to the NRC staff for its prompt review of our application for a multi-site radioactive materials license to operate a HPSA remediation system. The information presented herein was designed to address the specific information requests issued by the NRC staff. As stated above, Disa will submit a revised application and environmental report that incorporates the information presented in this response, once the NRC staff approves our responses. As always, if you have any questions, regarding our responses, please contact me or Mr. Stephen J. Cohen, at 720-237-2358 or s.cohen@disausa.com.

Sincerely,

Greyson Buckingham, CEO
1010 Falcon Avenue
Mills, WY 82644
Phone: (307) 690-2508
Email: greyson@disausa.com

cc: P. Yadav
B. Von Till
D. Mandeville
S. Cohen

Attachments:
1. RSO Training Certificate
2. ARSO Qualifications
3. Revised Draft Section 7.0 Dose Modeling Results
4. Sample Emissions Data Sheet from Caterpillar

ATTACHMENT 1

This is to certify that

Stephen J. Cohen

has completed the

40-Hour Radiation Safety Officer Online Training Course

conducted by

the Professional Training Programs of ORAU

This *9th* **day of** *June, 2025*

Justin Spence

Justin Spence, B.S., CHP, Health Physicist

ORAU

AAHP Course ID Number: 2022-02-08-151 (40 credits)

RADIOLOGICAL SCIENCES TRAINING
PTP
Since 1948

RADIATION SAFETY ENGINEERING

This is to certify that
Bryan Erdmann

has successfully completed
Radiation Safety Officer Course

Given on September 12, 2024

Course Director

ATTACHMENT 2

Bryan J. Erdmann

Health Physicist

Professional Summary

Mr. Erdmann is a Certified Health Physicist and has experience in environmental and occupational health physics including the use of GPS-based gamma detection systems for performing surveys, implementing radiation protection and personnel monitoring programs, radiological characterization of materials, equipment and structures, surface/subsurface soil sampling, and gamma spectroscopy. Mr. Erdmann has experience with developing radioactive materials license applications and radiation safety training programs and has a solid understanding of radioactive materials licensing requirements and regulations. This includes development and implementation of radiation protection plans. Mr. Erdmann has data analysis and coding experience in languages including Python, MatLab, ArcMap, and LabView. Mr. Erdmann also has experience in nuclear transport analysis using MCNP6 with emphasis in gamma detector simulations and dose assessments using MILDOS, RESRAD-ONSITE, RESRAD-BUILD, and MicroShield.

Years of Experience

- 7+ with ERG

Education

- MS, 2017, Environmental Health Physics, Clemson University
- BS, 2015, Nuclear Engineering, University of New Mexico

Professional Registrations/Affiliations

- Member, Health Physics Society

Certifications and Licenses

- Certified Health Physicist (ABHP)
- 40-Hour RSO Training Course (NV5, Thomas Edison State University)
- OSHA 40-Hour HAZWOPER Training
- OSHA 8-hour HAZWOPER Supervisor

Relevant Experience

ERG – Designated Radiation Safety Officer on service provider license application. Involved development of service provider license application for NM Radiation Control Bureau and development and implementation of the associated Radiation Protection Plan, Standard Operating Procedures, and Training program.

Abandoned Uranium Mines, Northern Agency Tronox Mines – U.S. EPA, Navajo Nation, AZ – Performed GPS gamma radiation surveys at > 30 abandoned uranium mines on the Navajo Nation. Performed x-ray fluorescence measurements on surface soils to determine metals concentrations across a number of sites. Developed gamma-Ra-226 and gamma-exposure rate correlations. This involved collecting soil samples and using a high-pressure ionization chamber along with multilinear regression modeling of the data. Additionally, radiation protection controls were employed including personnel breathing zone monitoring and personnel contamination surveys. UN2910 surveys for shipping were completed. A drilling program was also supported at the mines. This included access control via exclusion zones, downhole gamma radiation logging, air monitoring, and equipment release surveys. Radon monitoring was performed via deployment of track-etch detectors.

Navajo Abandoned Uranium Mines – U.S. EPA, Tetra Tech – Assisted in the development and review of a guidance documents for the U.S. EPA to provide information regarding air sampling for radionuclides and particulates during removal actions at abandoned uranium mines. It provides guidelines for developing air sampling and monitoring programs at NAUM sites. Development of standard operating procedures and support for demonstrating cleanup to background levels during remediation.

Contaminated Structure Program – U.S. EPA, Tetra Tech – Implement work plans to assess potential contamination of structures (including homesites) from historical uranium mining activities on the Navajo Nation. Assist with homesite characterization and radiological controls during structure demolitions. This includes air sampling (radon and particulates), gamma surveys, exposure rate correlations, and personnel exposure monitoring including breathing zone. Provided health physics support for structure demolition including occupational and public exposure monitoring and assessment (via air sampling).

Uranium Mill Site Remediation, Ford, WA – Performed a radiological survey of a power substation at a uranium mill site. This included total and removeable contamination surveys to characterize contamination levels of materials and equipment to show compliance with release criteria to move materials and equipment offsite.

Mount Taylor Mine, San Mateo, NM – Developed a work plan for the radiological characterization of materials and equipment at the Mount Taylor uranium mine for onsite disposal or radiological control clearance using ANSI/HPS N13.12-2013 surface contamination criteria. Develop MARSSIM based characterization survey plan to support decommissioning plan development.

Pitch Mine, Sargents, CO – Developed radiation work permits for work involving licensed materials for pilot water treatment operations. This included training site employees on area contamination, exposure rate, personnel contamination surveys and equipment quality control. Also developed and implemented a work plan for the radiological characterization survey of an onsite sand filter facility. Perform RST training annually for onsite RST support.

Ross ISR Project, Crook County, WY – Performed radium benchmark dose modeling for an in-situ recovery facility using RESRAD-ONSITE. Developed soil cleanup criteria based on the modeled radium benchmark dose. Performed MILDOS modeling to estimate public doses from site releases for various site changes and operational configurations.

Lisbon Valley Mill site, La Sal, UT – Supported operations at the Lisbon Valley mill site. This included GPS gamma surveys and radiological support of drilling campaigns on mill tailings piles. Responsibilities included implementation of radiation work permits and radiological controls such as radiation worker training, personnel contamination monitoring, access control and logging of exclusion zones around operations, supervising and direction equipment decontamination efforts, and performing equipment release surveys at the conclusion of the project. Additionally, assisted in waste characterization of liquid and solid wastes for RCRA waste classifications. Performed an audit of the radioactive materials license to ensure compliance with license conditions and commitments.

Quantification of the Spatial Distribution of Radionuclides in Field Lysimeters with a Collimated High-Resolution Gamma-Ray Spectrometer, Master's Thesis, Clemson - An analytical method was developed to perform non-destructive measurements to quantify the spatial distributions measured in field lysimeters. This method provides an alternative to traditional destructive techniques to determine the spatial distribution of activity. A user control interface was developed with LabView that synchronizes the data acquisition from the radiation detector with the lysimeter movement and positioning thus allowing the lysimeter scans to be automated. Numerical simulations were run to investigate the hypothesis that ions released from the wasteforms compete for sorption sites in soil, enhancing the mobility of ^{137}Cs. Retardation factors for ^{137}Cs in soil were also determined.

Publications

Erdmann, Bryan J., "Quantification of the Spatial Distribution of Radionuclides in Field Lysimeters with a Collimated High-Resolution Gamma-Ray Spectrometer" (2017). Clemson University. All Theses. 2799.

Erdmann, Bryan J., et al. "One-Dimensional Spatial Distributions of Gamma-Ray Emitting Contaminants in Field Lysimeters Using a Collimated Gamma-Ray Spectroscopy System." Health Physics, 2018, p. 1., doi:10.1097/hp.0000000000000799.

ATTACHMENT 3

DOSE ASSESSMENT

Introduction

Disa performed a dose assessment to estimate potential occupational and public doses from licensed operations. External and internal dose contributions were modeled using conservative estimates of parameters (e.g., occupancy, equilibrium, etc.) and expected maximum concentrations of source terms. Conservatism was incorporated into the models due to the uncertainty in many factors including the exact layout of process equipment, variable concentrations, and material densities (e.g., abandoned mine waste, slurry, clean coarse material, and fines concentrates mixtures), and source volumes.

A comparison between expected external and internal doses from an existing abandoned mine waste pile to the expected doses of the clean coarse material pile was performed to show the estimated dose reduction benefit from this technology. Total doses consider both external (gamma) and internal (inhalation) contributions. External dose contributions were modeled using MicroShield (Grove Software, 2022) while the internal dose contribution was modeled using MILDOS (Argonne National Laboratory, 2020).

It is important to note that Disa presents maximum, mean, and median doses in this application. However, maximum doses are based on unreasonable scenarios, which require employees to be standing immediately adjacent to the source terms for extraordinarily long periods of time; this scenario is actually impossible. Mean and median doses are more reasonable but are still highly conservative.

Dose Assessment Modeling

External Dose

External doses were modeled using MicroShield (Grove Software, 2022). This software is able to model simple shapes and volumes of materials (both shielding and source materials) and provides external exposure rate and absorbed dose rate results. Modeled absorbed doses are related to the reported effective doses via factor 0.7. The nature of Disa's technology involves numerous pieces of complex machinery including a rock crusher, high-pressure slurry ablation unit, and centrifuges. Disa will also maintain a trailer onsite for storage of fines concentrates source material prior to offsite transportation.

The dose assessment was performed by modeling each component individually, as simple cuboids (rectangular prisms), and then piecing the individual components together to create a spatial map of calculated effective dose rates. A 5 ft by 5 ft grid system (see Figure 7-1) was used to approximate the equipment dimensions and layout. External dose rates were calculated for a given grid by summing dose contributions from nearby components (see Figure 7-2). Modeled components are shown in Table 7-1. Table 7-2 provides details on the various source material types.

Table 7-1: Components Included in External Dose Model as Source Terms

Equipment	Approximate Size (L x W x H), ft[a]	Source Material Type
Crusher and 0.25" Screen	56.5 x 19 x 15.5	Feed stock (abandoned mine waste)
HPSA Unit	30 x 9 x 11	Slurry
Fines Concentrates Centrifuge	16 x 9 x 10	Fines Concentrates
Clean Coarse Material Centrifuge	16 x 9 x 10	Clean Coarse Material
Transportation Truck Trailer	(24 x 8 x 5.6) x 2	Fines Concentrates
Process Water Tank	24 x 12 x 13	Process water
Process Water Treatment Unit	11 x 8 x 8	Process water
Fines Concentrates Centrifuge Hopper	8 x 5 x 4	Fines Concentrates
Fines Concentrates Centrifuge Auger Conveyor	20 x 6 x 1	Fines Concentrates
Clean Coarse Material Centrifuge Stacker	35 x 2 x 2	Clean Coarse Material

[a] Components were considered rectangular parallelepipeds with the given dimensions.

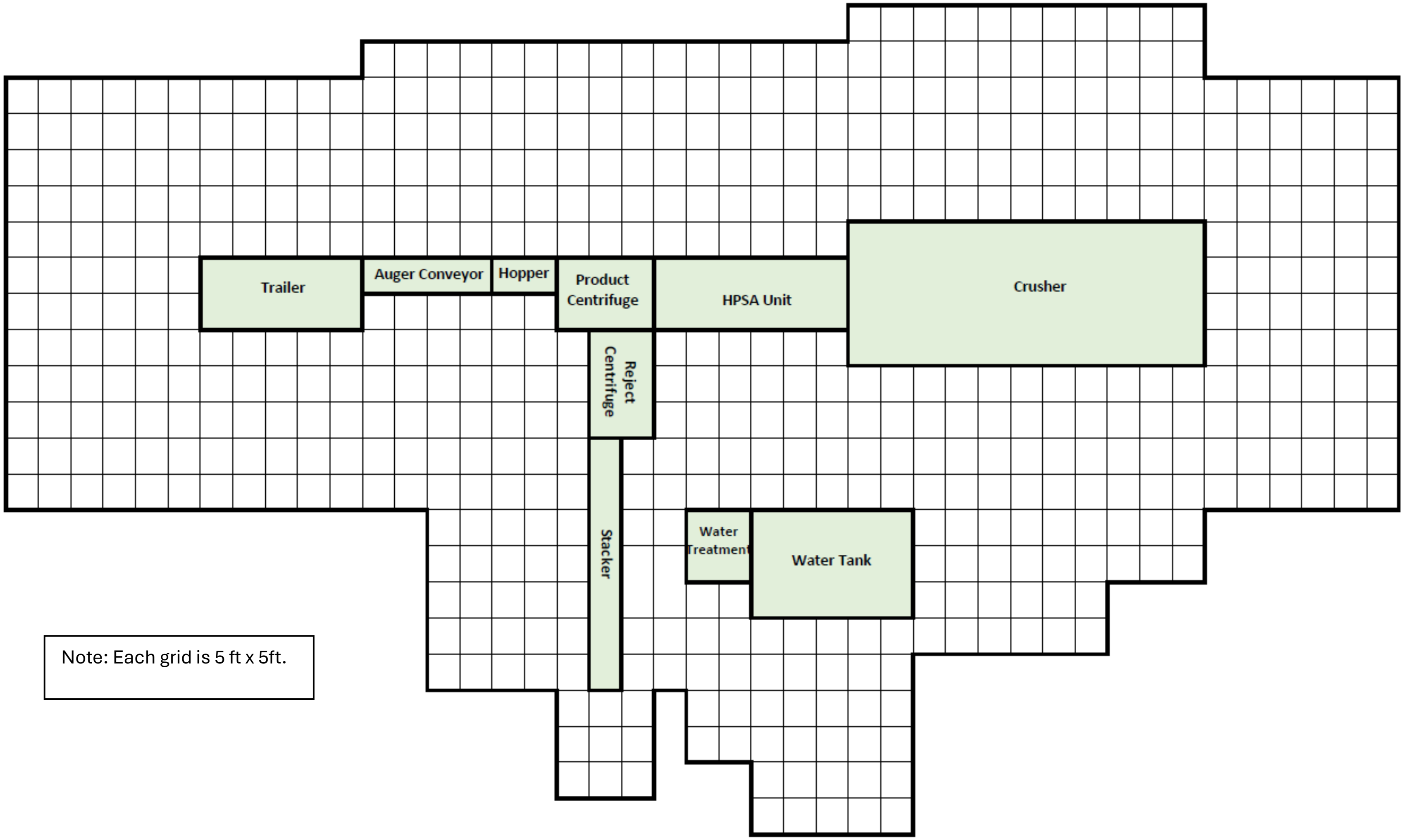
Table 7-2: Materials Used in the Models

Materials[b]			Activity		
Type	**Properties**	**Density**	**mg U/kg**	**µCi U/cm^3**	**pCi/g[a]**
Equipment	*Steel*	8	-	-	-
Feed Stock (Abandoned mine waste)	*Iron*	2.3	1500	2.34E-03	1.02E+03
Slurry	*Water*	1.3	1500	1.31E-03	1.02E+03
Fines Concentrates	*Iron*	2.3	7000	1.09E-02	4.74E+03
Clean Coarse Material	*Iron*	2.3	500	7.79E-04	3.39E+02
Process Water	*Water*	1	35	2.37E-05	2.37E+01

[a] Assumes specific activity of 0.677 µCi/g.

[b] Densities and activities are given or calculated.

Figure 7-1: Model Components and Grid System Dose Model



Note: Each grid is 5 ft x 5ft.

Figure 7-2: Modeled Dose Rates (mrem/hr)

0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.03	0.02	0.05	0.04	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.00																																																			0.00
0.00																																																			0.00
0.00																																																			0.00
0.00																														0.06	0.07	0.08	0.09	0.09	0.09	0.09	0.09	0.08	0.07	0.06											0.00
0.01										0.08	0.09	0.09	0.09	0.08	0.02	0.02	0.02	0.02	0.02	0.02	0.12	0.12	0.12	0.04	0.05	0.05	0.05	0.05	0.04	0.08	0.10	0.11	0.12	0.12	0.12	0.12	0.12	0.11	0.10	0.08											0.00
0.01										0.11	0.13	0.13	0.13	0.11	0.03	0.03	0.03	0.03	0.04	0.04	0.18	0.18	0.17	0.06	0.07	0.07	0.09	0.06	0.05	0.11	0.13	0.15	0.16	0.17	0.17	0.17	0.16	0.15	0.13	0.11	0.00	0.00	0.02	0.00	0.01	0.01					0.01
0.01										0.17	0.20	0.21	0.20	0.17	0.05	0.05	0.05	0.05	0.06	0.06	0.28	0.30	0.27	0.09	0.11	0.11	0.11	0.10	0.08	0.15	0.20	0.22	0.24	0.24	0.24	0.24	0.24	0.22	0.20	0.15	0.00	0.00	0.01	0.01	0.01	0.01					0.01
0.01										0.28	0.35	0.37	0.35	0.28	0.09	0.11	0.11	0.09	0.12	0.12	0.50	0.56	0.47	0.14	0.19	0.19	0.17	0.16	0.12	0.26	0.34	0.36	0.37	0.37	0.37	0.37	0.37	0.36	0.34	0.26	0.00	0.01	0.00	0.02	0.02	0.02					0.01
0.01				0.03	0.04	0.06	0.09	0.12	0.01	0.58	0.74	0.78	0.74	0.58	0.21	0.27	0.27	0.21	0.31	0.31	1.09	1.25	1.01	0.25	0.30	0.36	0.36	0.30	0.23	0.58	0.60	0.60	0.60	0.61	0.60	0.61	0.60	0.60	0.60	0.58	0.00	0.00	0.04	0.03	0.03	0.02					0.01
0.01				0.03	0.05	0.08	0.16	0.37	1.49	2.40	2.52	2.54	2.60	2.68	0.96	1.12	1.23	1.15	2.10	1.54	3.45	3.57	3.27	0.78	1.11	0.99	0.93	0.96	0.98	Crusher											0.24	0.12	0.08	0.05	0.04	0.03					0.01
0.01				0.03	0.05	0.09	0.17	0.46	2.11	Trailer					Auger Conveyor				Hopper		Product Centrifuge			HPSA Unit																	0.25	0.17	0.10	0.06	0.04	0.03					0.01
0.01				0.03	0.05	0.09	0.17	0.46	2.11						0.94	1.14	1.33	1.24	2.52	4.54																					0.25	0.17	0.10	0.06	0.04	0.03					0.01
0.01				0.03	0.05	0.08	0.16	0.37	1.48	2.39	2.50	2.50	2.50	2.39	0.30	0.37	0.42	0.45	0.70	0.49	3.56	Reject Centrifuge		0.92	0.82	0.80	0.81	0.85	0.91												0.24	0.12	0.08	0.05	0.04	0.03					0.01
0.01				0.03	0.04	0.06	0.09	0.12	0.01	0.58	0.74	0.78	0.74	0.58	0.09	0.11	0.12	0.11	0.16	0.26	1.34			0.49	0.42	0.40	0.39	0.32	0.25	0.58	0.61	0.60	0.60	0.61	0.60	0.61	0.60	0.60	0.60	0.58	0.00	0.00	0.04	0.03	0.03	0.02					0.01
0.01										0.28	0.35	0.37	0.35	0.28	0.05	0.06	0.07	0.07	0.10	0.14	0.74			0.37	0.25	0.23	0.20	0.18	0.14	0.26	0.34	0.36	0.37	0.37	0.37	0.37	0.37	0.36	0.34	0.26	0.00	0.01	0.00	0.02	0.02	0.02					0.01
0.01										0.17	0.20	0.21	0.20	0.17	0.03	0.03	0.04	0.03	0.04	0.04	0.33	Stacker	0.25	0.11	0.12	0.12	0.12	0.10	0.09	0.15	0.21	0.22	0.24	0.24	0.24	0.24	0.24	0.22	0.20	0.15	0.00	0.00	0.01	0.01	0.01	0.01					0.01
0.01										0.11	0.13	0.13	0.13	0.11	0.02	0.02	0.03	0.03	0.01	0.02	0.26		0.30	0.15	0.15	0.14	0.15	0.13	0.11	0.12	0.15	0.15	0.16	0.17	0.17	0.17	0.16	0.15	0.13	0.11	0.00	0.00	0.02	0.00	0.01	0.01					0.01
0.01										0.08	0.09	0.09	0.09	0.08			0.00	0.01	0.01	0.02	0.19		0.09	0.05	Water Treatment		Water Tank					0.11	0.12	0.12	0.13	0.12	0.12	0.11	0.10	0.08											0.00
0.00																	0.00	0.01	0.01	0.03	0.07		0.08	0.05								0.10	0.09	0.10	0.10	0.09	0.09	0.08	0.07	0.06											0.00
0.00																	0.00	0.01	0.01	0.02	0.06		0.07	0.03	0.03	0.03						0.01	0.00	0.00	0.00	0.00	0.00														0.00
0.00																	0.01	0.01	0.01	0.02	0.06		0.07	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00														0.00
0.00															0.00	0.00	0.01	0.01	0.02	0.03	0.05		0.05	0.02	0.01	0.01	0.01	0.00	0.01	0.00	0.01																				0.00
0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04							0.00	0.03	0.00		0.00	0.00	0.00	0.00	0.01	0.00	0.00		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
																					0.00	0.01	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.03																		
																					0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00		0.02																		
																					0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00		0.02																		
																					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02																		

Does are calculated by summing the nearby individual component contributions for each grid. This figure includes the dose model boundary.

Each component (source term) was modeled individually as a solid shape of source material at a particular concentration. Concentrations are dependent on where the source term is in the process. All equipment was assumed to be surrounded by 0.25 inches of stainless-steel shielding. Material properties are used by the software to approximate build-up factors and attenuation characteristics. Iron is a default material in MicroShield and was used as an analog for the abandoned mine waste and process streams. The 40% density by mass solids slurry material was assumed to be similar to water.

Assumptions and Approximations

The following conservative assumptions and approximations were made. These assumptions ensure a large margin of safety in modeled results. Because of this, modeled results represent conditions that are maximum potential values. During normal operation, actual dose rates are expected to be much lower.

- Equipment and Process Layout - Due to the limitations of the modeling software and the grid system used to combine the results from multiple modeled components, a very rigid layout of components was used. In general, the layout modeled is comparable to expected field conditions; the main process equipment will occur in a linear process train while the clean coarse material will be directed away from the fines concentrates. However, actual equipment positions will affect potential occupational and public doses.
- Source Terms - In all cases (internal and external models), it is assumed that uranium is in secular equilibrium with all decay progeny. Each source term is modeled as a solid block of source material at a specific concentration. While these dimensions are accurate for considering the footprint and overall volume of space occupied by each component, it is highly unlikely that the volume of source material within each component is accurately represented by the equipment dimensions.
- The actual volume of source material will be some fraction of this total volume. For this model, the source volume was assumed to be 75% of the total volume. Equipment often has internal components that occupy space and provide additional shielding. Furthermore, smooth operations of this nature do not allow for components to be completely full; otherwise, overtopping, or high back pressures could occur. Also, it is likely that the source material will be shielded by more than a single layer of 0.25 steel. However, for the sake of simplicity and conservatism, this factor is ignored.
- Concentrations and Densities - Concentrations of materials are the maximum values expected. These values were determined from field observation and lab-scale testing. Concentrations will vary, but the concentrations used provide a reasonable estimation of actual field conditions.
- Modeling Extents - As seen in Figure 7-2, occupational dose rates were modeled up to 20-30 feet from the surfaces of equipment. This is a limiting factor in the model results and is related to the software modeling capabilities. To model the potential public doses, an average distance of 50 feet from equipment was modeled. This distance varies slightly depending on the layout and size of the equipment. This distance represents a potential restricted area, beyond which no members of the public would be allowed access.
- Occupancy - Occupancy times for occupational and public exposures will be highly variable. For occupational doses, it is assumed that a worker will be exposed 8 hours a day, 7 days a week, for 9 months out of the year. Nine months was selected because mobilization, demobilization, time between projects, travel to project sites, weekends, and holidays, will reduce employees time being exposed to radioactive materials. Consequently, assuming a full year of employee exposure, which is typically assumed, is physically impossible.
- The occupancy factor for a member of the public is assumed to be 1/40 or 0.025 (i.e., 2.5% of the year). This is based on guidance provide in NUREG-1556 Volume 12 Appendix J (Table J-1). This is equivalent to 219 hours per year. In reality, public occupancy times in unrestricted areas are likely to

be much less because sites are expected to be remote and controlled beyond the restricted area around active operations. Therefore, this occupancy assumption is highly conservative.

External Dose Results

Occupancy values used in calculations are provided in Table 7-3. Using these occupancy times, 3 different dose rates were used to calculate potential doses. These dose rates are the maximum dose rate, the average dose rate, and the median dose rate. The maximum dose rates were identified for both occupational dose and public dose. For the occupational worker, all modeled grids were included. For a member of the public, only the boundary grids were included, as members of the public will be restricted from entering the work zone. The maximum dose rate was then multiplied by the number of occupancy hours in Table 7-3 to give the annual external dose. Dose rates and annual external dose results are given in Table 7-4.

To ensure the public dose remains below 100 mrem/yr for the assumed occupancy scenario, the effective dose rate at the boundary needs to be less than 0.46 mrem/hr. The public dose model has a maximum effective dose rate of 0.05 mrem/hr at 50 feet from the transportation truck (when full). This meets the requirements for compliance with the public dose limits. Routine exposure rate surveys (using a Ludlum Model 19, or similar) will be performed along the restricted area boundary to document and verify radiation levels.

Table 7-3: Assumed Occupancy Time

Individual Type	Hours/ Day	Months	Days	Hours	Occupancy Fraction
Occupational	8	9	270	2160	0.25
Public [a]	-	-	-	-	0.025

[a] Based on guidance in NUREG-1556 Volume 12 Appendix J Table J-1 occupancy factor of 1/40.

Table 7-4: Modeled External Dose Rates and Annual Doses - Workers and Members of the Public

Case	Type	Dose Rate (mrem/hr)	Annual Dose (mrem)	Dose Limit (mrem)	% of limit
Maximum	*Occupational*	4.54	9808	5,000	196%
	Public	0.05	11	100	11%
Average	*Occupational*	0.40	870	5,000	17%
	Public	0.02	4.4	100	4.4%
Median	*Occupational*	0.11	246	5,000	5%
	Public	0.01	2.2	100	2.2%

As stated in Section 6.1, the calculated maximum doses reported in Table 7-4 to employees and the public are unreasonable estimates because this would require constant exposure at the absolute maximum dose rate observed in the models. Administrative controls (i.e., communication of maximum dose rate locations to workers) will ensure this exposure scenario is impossible. Average or median dose rates are significantly more likely scenarios. To ensure that public doses remain below the 100-mrem limit, Disa will utilize monitoring, access, and sampling procedures found in Appendix C and will adjust restricted area boundaries accordingly to ensure the public is not exposed to dose rates that would result in doses greater than 100 mrem.

Multiple HPSA Units and Extended Fines Concentrate Storage

The external modeling above is based on the production of one HPSA unit. There may be situations where multiple HPSA units are being used to process material simultaneously. Additionally, this may result in larger amounts of processed fines concentrate material being stored onsite. Therefore, another scenario is modeled and described here for comparison with the case presented above. Conservative and simplifying assumptions are used to ensure modeled estimates are sufficiently protective for the public.

Estimates of total area for the HPSA units and the fines storage area for Tier 5 (Table 4-1 of Application) operations were used to develop source terms for the dose model. The same material concentrations and densities described in Sections above are used for these cases. This will allow for some comparisons for numbers however the specific geometry used above is different from the simplified geometries used for the case with multiple HPSA units and extended fines storage areas. Each component (4 HPSA units or storage area with 64 concentrate trailers) was modeled as a rectangular volume with an area equivalent to the estimated areas given in Table 4-1. The source terms properties are given in Table 7-2 for the HPSA units and fines storage trailers. The materials assumed from Table 7-2 are Slurry and Fines Concentrate for the HPSA units and fines storage trailers, respectively.

To enable comparison with the results above, public dose rates from each source term are calculated at 50 ft from the source. Again, this distance is arbitrary but reasonably representative of where a restricted area boundary might be. It is reiterated that field measurements will be completed at temporary job sites at the restricted area boundaries to ensure dose rates to the public will not result in exposures greater than 100 mrem/yr. The restricted area boundary can be adjusted (e.g., distance increased) as necessary.

Table 7-5: Estimated Dose Rates and Total Annual Dose for the Public from Multiple HPSA Units and Extended Fines Storage Area

Source Term	Dose Rate at Boundary [a] (mrem/hr)	Total Dose [b] (mrem)
HPSA Units (Tier 5, four units)	0.02	5.2
Extended Fines Storage Area (Tier 5, 64 storage trailers/bins)	0.02	3.2

[a] 50 foot boundary distance assumed

[b] Total external dose rate a product of calculated dose rate and occupancy scenario described in Table 7-3

Dose rates at the boundary of either the HPSA units or fines storage area are similar at 0.2 mrem/hr. The total dose rates are calculated using the occupancy scenarios presented in Table 7-3. The difference in total dose rates is due to using more significant figures in calculations than the reported values. The calculated external doses are well below the public dose limit of 100 mrem/yr. Additionally, when compared with the more complicated dose model for one HPSA unit and the associated fines concentrate storage, they are similar. This indicates that the influence from extended operations (e.g., Tier 5 vs Tier 1) to the dose rates at an arbitrary boundary will be similar. This is likely due to the geometry and arrangement of the source term. The dose contributions from a HPSA unit or storage trailer at the center of a restricted area is less influential to the public dose than the contributions from units or trailers nearest the boundaries.

Internal Dose

Modeling Approach

Internal doses during operation were modeled using MILDOS. Four source terms were considered in the model. These four source terms and concentrations are given in Table 7-6. Other sources of particulate emission are considered negligible because processes downstream of the HPSA unit are contained wet processes. Dust control measures will be used on the abandoned mine waste and during crushing, but for modeling purposes these materials are considered dry. It is assumed that the uranium is in secular equilibrium with its decay progeny. In most cases, MILDOS default values for parameters are used (see MILDOS Technical Manual and User's Guide Version 4.1 for default parameters values). For example, particle size distributions, deposition velocities, wind rose patterns, and surface roughness default values were used. Radon release rates and outdoor equilibrium factors were calculated by MILDOS using the built-in Erosion Model for particulates. The model assumed no ingestion rate from vegetables, meat, or milk. Eight receptors were modeled at various locations around the sources. The occupancy factor was assumed to be 1 for outdoor occupancy for each receptor, i.e., the receptor is present at that location for 100% of the year during operations. This is highly conservative when compared with the occupancy scenario assumed for the external dose models (i.e., a factor of 1/40). The maximum distance from the source that a receptor was modeled is approximately 300 meters. The source and receptor arrangement are shown in Figure 7-3.

Table 7-6: Internal Dose Model Source Terms, Uranium Concentrations, and Material Densities

Source Term	Concentration, mg U/kg	Material Densities
Abandoned Mine Waste Pile	1500	2.3 g / cm^3
Clean Coarse Material	500	2.3 g / cm^3
Crusher	1500	2.3 g / cm^3
HPSA Unit	7000	2.3 g / cm^3

Table 7-7: Internal Dose Model Source Types and Location

Source Term	Type	x (m)	y (m)	z (m)
Abandoned Mine Waste Pile	Area	0	0	0
Clean Coarse Material	Area	0	20	0
Crusher	Area	0	-70	0
HPSA Unit	Area	90	20	0

Note: Locations are relative positions (in meters) from an arbitrary model origin (i.e., abandoned mine waste pile)

Table 7-8: Internal Dose Model Receptor Types and Location

Receptor	Type	x (m)	y (m)	z (m)
1	Public	90	-40	1
2	Public	0	90	1
3	Public	-90	-70	1
4	Public	0	-175	1

5	Public	-250	-15	1
6	Public	300	-15	1
7	Occupational	0	-25	1
8	Public	175	25	1
Note: Locations are relative positions (in meters) from an arbitrary model origin (i.e., abandoned mine waste pile)				

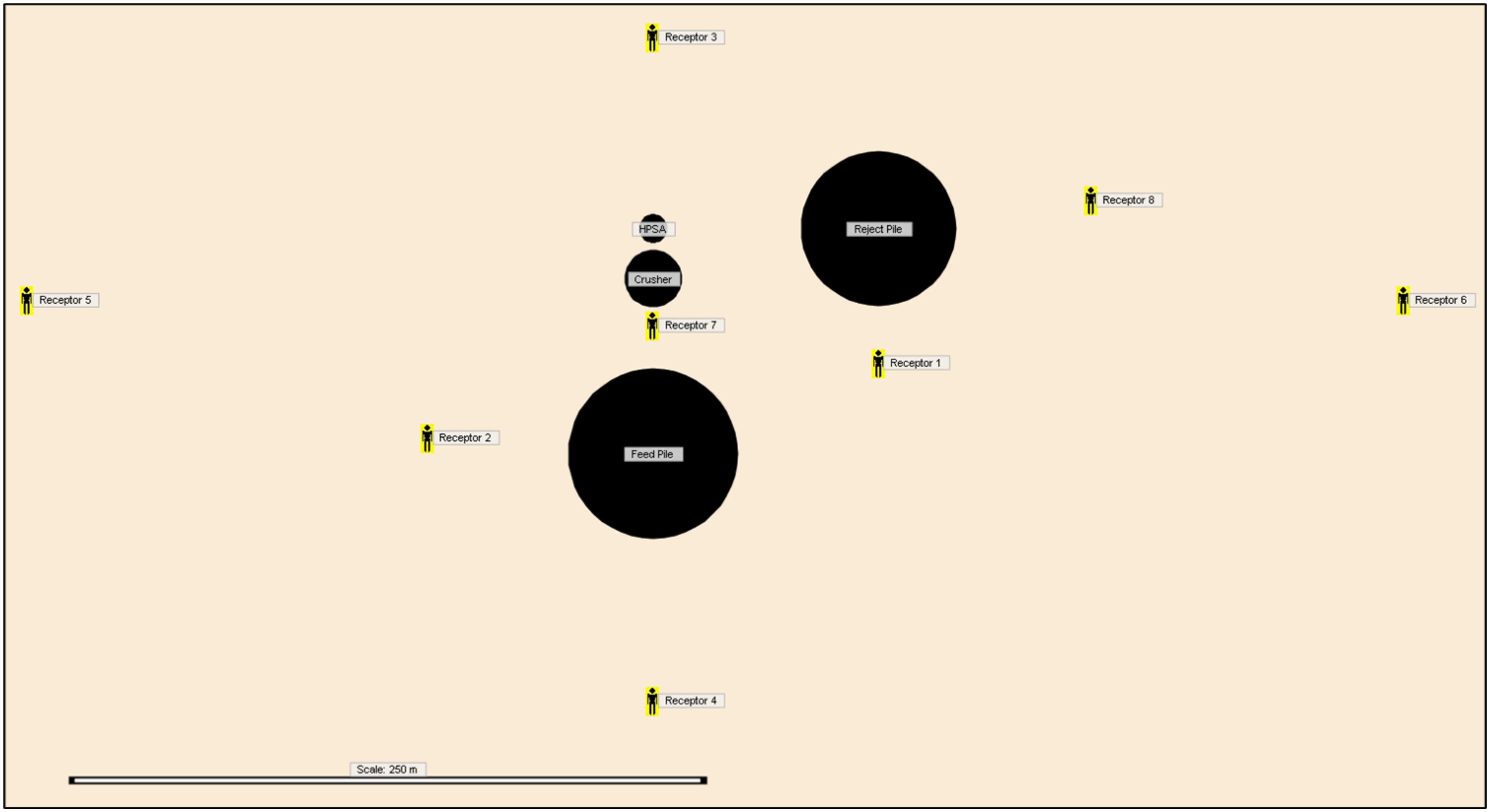
Internal Dose Results

Results for internal doses did not consider occupational or public doses explicitly. Receptors who would be located within a restricted area are representative of occupational doses, while the receptors outside of a potential restricted area (e.g., > 50 feet distance) would be representative of public doses. Results for each receptor are provided in Table 7-9. The maximum value of 22.3 mrem is attributed to Receptor 7, which is located in between the abandoned mine waste pile and the Crusher equipment (i.e., potential occupational exposure). Receptor 1, located between the abandoned mine waste pile and clean coarse material pile, would receive a dose of 6.1 mrem. Results representative of potential public doses range from 0.4 to 2.4 mrem. These values suggest that internal doses will be negligible. Actual doses are likely to be less than those modeled due to the conservative occupancy factor (1) used in the MILDOS model versus the factor assumed for external dose modeling (1/40).

Table 7-9: Annual Internal Dose Results for each Modeled Receptor

Receptor	Receptor Type	Total Annual Dose (mrem)
1	Public	6.1
2	Public	1.7
3	Public	2.1
4	Public	1.8
5	Public	0.4
6	Public	0.6
7	Occupational	22.3
8	Public	2.4

Figure 7-3: Source Term and Receptor Locations for MILDOS Internal Exposure During Operations Model



Comparison of Dose from Abandoned Mine Waste Material to Processed Coarse Fraction

Simple external and internal dose modeling of the abandoned mine waste and clean coarse material were performed individually to investigate the potential benefit from dose reduction for materials that are present on these sites. The models are consistent with those included in the models above (e.g., source concentrations). For the external dose, 6 receptors were modeled at 5 ft increments, starting at 1 ft from the edge of the pile. For the internal doses, 4 receptors were modeled at distance of 254 feet (100 m) in the primary cardinal directions around each pile. The results of these models are provided in Table 7-10. From these results, it is clear there is a reduction in doses from onsite materials. The reduction in dose ranges from 59 to 72% with an average reduction in external dose of 67% and internal dose of 73%. This analysis was performed to show the benefit of the technology in reducing risks as sites. It is not meant to support unrestricted release conditions. These will be assessed on a site-by-site basis using analytical and field measurements to show that applicable release criteria are met. Some modeling using site-specific data may be performed at that time to investigate doses to the public after release and demobilization.

Table 7-10. Dose Reduction Comparison Between Abandoned mine waste and Clean coarse material

	Receptor	Distance from Source (ft)	Abandoned Mine Waste Dose, (mrem)	Clean Coarse Material Dose (mrem)	Reduction (%)
External	1	1	0.99	0.40	59
	2	5	0.46	0.15	68
	3	15	0.15	0.05	69
	4	25	0.07	0.02	70
	5	35	0.04	0.01	70
	6	45	0.02	0.01	66
Internal	1	254	3.08	0.83	73
	2	254	1.44	0.40	72
	3	254	1.94	0.52	73
	4	254	1.77	0.49	72

Summary

The external and internal doses were modeled using conservative assumptions and parameters. In general, these results represent conservative upper boundaries to potential doses. The external results indicate that expected occupational dose will remain below occupational dose limits, on average. However, the results also indicate there is a potential for workers to exceed their annual dose limit.

Based on the current external dose model and occupancy scenario, a member of the public may receive an external dose of 11 mrem/yr if exposed to the maximum modeled dose rate during operations. Doses on the order of 4-5 mrem/yr are calculated if the average modeled dose rate is assumed. Additionally, a member of the public may receive an internal dose on the order of 6 mrem/yr during operations. At no point does any dose rate along the model boundary approach 2 mrem/hour. During operations with multiple HPSA units and extended fines storage areas, expected dose rates at the area boundaries are expected to be similar, with a slight increase on the order of 1-2 mrem/yr.

Routine exposure rate measurements, air monitoring, and site access control will be used to ensure public doses remain ALARA and boundaries will be adjusted as needed to ensure occupancy of accessible areas by the public will not result in public dose limits being exceeded.

Finally, it is clear from the dose reduction comparison that there is a great benefit, both to the environment and to humans, from this process. While there is a short-term risk incurred during the operations, there is a permanent reduction of approximately 70% in potential dose to the public from exposure to abandoned mine waste versus processed clean coarse material. Applicable release criteria will be met following operations during site decommissioning and demobilization.

Cat® 3606

Diesel Generator Sets

ATTACHMENT 4

Image shown may not reflect actual configuration.

Bore – mm (in)	280 (11.0)
Stroke – mm (in)	300 (11.8)
Displacement per cylinder – L (in^3)	18.5 (1127)
Total Displacement – L (in^3)	111 (6,762)
Compression Ratio	13:1
Aspiration	TA
Fuel System	Direct Unit Injection

Features

Cat® Diesel Engine

- Designed and optimized for low fuel consumption
- Reliable, rugged, durable design

Alternators

- Superior motor starting capability minimizes need for oversizing generator
- Designed to match performance and output characteristics of Cat diesel engines

Generator Set Package

- Fully prototype tested with certified torsional vibration analysis available

Worldwide Product Support

- Cat dealers have over 1,800 dealer branch stores operating in 200 countries
- Your local Cat dealer provides extensive post-sale support, including maintenance and repair agreements

Cat Generator Set Monitoring System (GSM)

- Simple user friendly interface and navigation
- Provides protection, monitoring, and control of the diesel generator set
- Redundant shutdown protection
- 10 inch (254 mm) color monitor to display all engine parameters and alarm annunciation
- Annunciation of all engine shutdowns, alarms, and status points
- Start/prelube control switch, fuel control switch and emergency stop buttons
- Speed control switch with automatic changing to ball head control when a governor failure occurs, if ball head control is available
- Contacts are available for customer use
- Selection of local/remote control of engine
- Selection of idle/rated control of engine
- Equipped for remote communication
- Four 4-20mA outputs (programmable)
- Relay contact signals to the remote monitoring system (summary shutdown, summary alarm, local operation/remote, engine running, PLC failure, fuel control and idle/rated)

Standard and Optional Equipment

Air Inlet

☐ Aftercooler, fresh water, corrosion resistant coated (air side)
☐ Air inlet shutoff
☐ Air cleaner
☐ Breather, crankcase, top-mounted
☐ Turbocharger, engine oil lubricated
☐ Soot filter
☐ Air cleaner louver assembly
☐ Vertical support bracket
☐ Heavy duty air cleaner
☐ Air inlet adapter
☐ Boost control valve

Cooling

☐ Engine coolant water drains
☐ Front mounted turbos
☐ Three-bundle oil cooler
☐ Water temperature regulator
☐ Jacket water thermostats
☐ Heat exchanger for single circuit
☐ Heating aids
☐ Cooling system aids
☐ Auxiliary water pump
☐ Expansion tank

Exhaust

☐ 457 mm (18 in) Cat bolt pattern
☐ Dry, gas tight, exhaust manifold
☐ Includes adapter, flexible exhaust fitting
☐ Flexible exhaust fittings
☐ Weld flange and related hardware

Fuel

☐ Simplex or Duplex
☐ Fuel Priming Pump
☐ Duplex Primary Fuel Strainer
☐ Fuel System Connections

Generator

☐ Custom generator
☐ 3 Phase, six leads, WYE
☐ Class F insulation
☐ Busbar connections
☐ Winding temperature detectors
☐ Anti-condensation space heaters

Governor

☐ UG Actuator
☐ Electronic / actuators
☐ Digital programmers
☐ Battery backup / power supply
☐ 230 UA
☐ 723 Plus
☐ EGB Actuator

Lube

☐ Centrifugal oil filters with single shutoff
☐ Service side engine mounted on cylinder block inspection covers
☐ Wet oil sump. Includes engine-driven main lubrication pump, installed oil lines, engine-driven oil pump and oil pan
☐ Oil filler and dipstick
☐ Valve, oil pressure regulating
☐ Valves, crankcase explosion relief
☐ Oil pan drain valve
☐ Lube ANSI adapter (emergency connection)

Mounting

☐ Damper, torsional vibration
☐ Engine and generator mounting
☐ Isolator
☐ Spring type vibration isolator
☐ Vertically restrained
☐ Non-vertically restrained

Starting / Charging

☐ Vane type air starter
☐ Two motors, engine mounted at rear, on left side
☐ Includes air silencer
☐ Line group for single point custom connection
☐ Pressure reducing valve
☐ Compressed air flex hose
☐ Turbine type air starters
☐ Redundant air starters

General

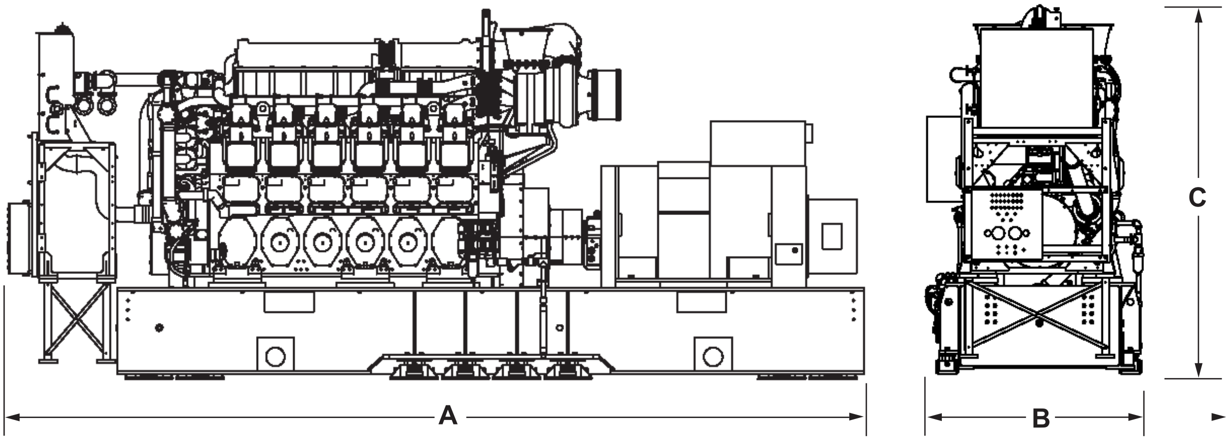
☐ Paint, Caterpillar yellow
☐ Pumps, gear driven: fuel, oil, jacket water, aftercooler / oil cooler water
☐ Custom paint colors

Package Performance

Performance – 900 rpm	Notes	Standby	Prime	Continuous
Frequency		60 Hz	60 Hz	60 Hz
Engine power – bkW	(2)	2090	1900	1730
Generator power – ekW	(2)	2000	1820	1650
Performance number		DM5404-06	DM5402-06	DM5400-06
Engine Data				
Fuel consumption (ISO 3046/1) – g/bkW-hr	(1)	198.9	197.6	197.4
Fuel consumption (nominal) – g/bkW-hr	(1)	202.8	201.5	201.2
Fuel Consumption (90% confidence) – g/bkW-hr	(1)	207.3	207.3	207.3
Air flow (@ 25°C, 101.3 kPa) – m^3/min		194.0	194.0	178.3
Air mass flow – kg/hr		12985	12985	11936
Compressor outlet pressure – kPa (abs)		286.3	248.3	215.2
Compressor outlet temperature – °C		286.3	186.5	171.7
Inlet manifold pressure – kPa (abs)		282.7	244.9	212.1
Inlet Manifold temperature – °C		60.2	57.4	55.5
Timing – °BTDC	(10)	15.5	15.5	15.5
Exhaust stack temperature – °C		432.8	426.5	428.3
Exhaust gas flow (@ stack temperature, 101.3 kPa) m^3/min		427.9	12230	—
Exhaust gas mass flow – kg/hr		13473	—	11128
Energy Balance Data (nominal)				
Fuel input energy (LHV) – kW	(1)	5062	4572	4157
Heat rejection to jacket water – kW	(4)	413	384	360
Heat rejection to atmosphere – kW	(5)	101	91	83
Heat rejection to oil cooler – kW	(6)	217	207	199
Heat rejection to exhaust (LHV to 25°C) – kW	(4)	1692	1520	1383
Heat rejection to exhaust (LHV to 177°C) – kW	(4)	1025	926	837
Heat rejection to aftercooler – kW	(7), (8)	454	361	283
Emissions				
NOx – g/bkW-hr	(9)	11.88	12.58	13.41
CO – g/bkW-hr	(3)	0.98	0.92	0.91
HC – g/bkW-hr	(3)	0.76	0.78	0.83
PM – g/bkW-hr	(9)	0.88	0.71	0.80

Notes
1) Fuel consumption tolerance. ISO 3046/1 is 0, + 5% of full load data. Nominal is ± 3% of full load data.
2) Engine power tolerance is ± 3% of full load data.
3) Emission data shown are not to exceed values.
4) Heat rejection to jacket water and exhaust tolerance is ± 10% of full load data. (Heat rate based on treated water.)
5) Heat rejection to atmosphere tolerance is ± 50% of full load data. (Heat rate based on treated water.)
6) Heat rejection to lube oil tolerance is ± 20% of full load data. (Heat rate based on treated water.)
7) Heat rejection to aftercooler tolerance is ± 5% of full load data. (Heat rate based on treated water.)
8) Total aftercooler heat = aftercooler heat x ACHRF. (Heat rate based on treated water.)
9) Emission data shown are dry and nominal values.
10) Timing based on AFM Injectors.

Weights and Dimensions



Dim "A" mm (in)	Dim "B" mm (in)	Dim "C" mm (in)	Weight kg (lb)
10261.7 (404.0)	2530.3 (99.62)	3977.7 (156.6)	34 070 (74,970)

Note: *For reference only. Do not use for installation design. Contact your local Cat dealer for precise weights and dimensions.*

Ratings and Definitions

Standby
Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby rated ekW. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Prime
Output available with varying load for an unlimited time. Average power output is 70% of the prime rated ekW. Typical peak demand is 100% of prime rated ekW with 10% overload capability for emergency use for a maximum of 1 hour in 12. Overload operation cannot exceed 25 hours per year.

Continuous
Output available with non-varying load for an unlimited time. Average power output is 70-100% of the continuous rated ekW. Typical peak demand is 100% of continuous rated ekW for 100% of the operating hours.

Applicable Codes and Standards
AS 1359, CSA, IEC 60034-1, ISO 3046, ISO 8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 2014/35/EU, 2006/42/EC, 2014/30/EU.

Note: Codes may not be available in all model configurations. Please consult your local Cat dealer for availability.

Engine Rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JAN90 standard reference conditions of 25°C, 100 kPa, 30% relative humidity and 150m altitude at the stated aftercooler water temperature. Consult altitude curves for applications above maximum rated altitude and/or temperatures.

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO 3046 standard conditions.

Fuel Rates are based on fuel oil of 35º API [16ºC (60ºF)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 15ºC (59ºF) and weighing 850 g/liter (7.0936 lbs/U.S. gal). Additional ratings may be available for specific customer requirements, also, for information regarding low sulfur fuel and biodiesel capability, please consult your Cat dealer.

www.cat.com/electricpower

The International System of Units (SI) is used in this publication.