TECHNICAL EVALUATION REPORT OF US ECOLOGY IDAHO'S PROPOSED METHODOLOGY SUPPORTING ALTERNATE WASTE DISPOSAL PROCEDURES IN ACCORDANCE WITH 10 CFR 20.2002

INTRODUCTION

US Ecology Idaho, Inc. (USEI) operates a Resource Conservation and Recovery Act (RCRA) Subtitle C disposal facility located in Grand View, Idaho. USEI is permitted by Idaho's Department of Environmental Quality (IDEQ) and is not a U.S. Nuclear Regulatory Commission (NRC) licensee. However, alternate disposal actions require an NRC review. This review of the safety implications of these alternate disposal options could ultimately allow for the disposal of licensed material in non-NRC licensed facilities.

In a letter dated June 14, 2013, USEI requested that the NRC staff review and accept USEI's proposed site-specific dose assessment (SSDA) methodology for calculating doses and the corresponding Technical Basis Document (TBD). According to USEI this process would provide a streamlined methodology for preparing and reviewing future 10 CFR 20.2002 alternate disposal requests (ADR) (i.e., exemption requests) from USEI.

This technical evaluation report (TER) is intended to serve as the NRC staff's technical review of the proposed methodology. Similar to a review of a 10 CFR 20.2002 exemption request, the NRC staff performed a technical review of the SSDA methodology and associated TBD and evaluated the technical basis and assumptions incorporated into the calculations used by USEI. In addition to the example problems provided in the TBD the NRC staff also used the SSDA methodology to evaluate previously evaluated exemption requests and compared the conclusions. The combination of these tasks is what led to the NRC staff's findings and conclusions as to whether this is an acceptable method for submitting ADRs.

It should be noted that this document is the publicly-available version of the TER that NRC staff developed to document the SSDA methodology and accompanying TBD determined to contain proprietary information. This version of the NRC staff's review describes, on a more general level, the basis on which USEI's proposed SSDA methodology and supporting TBD were reviewed and summarizes the NRC staff's findings. Specific details related to the calculations used in the SSDA are not explained in this document. Instead, references to publicly-available documents and relevant computer codes will provide the basis for the findings made in this review.

PURPOSE

Section 20.2002 is a general provision that allows for alternate disposal methods, different from those already defined in the regulations, provided that doses are maintained as low as reasonably achievable (ALARA) and within the dose limits defined in 10 CFR Part 20. This provision is generally used to allow the disposal of low-level waste in hazardous or solid waste landfills that are permitted under Resource Conservation and Recovery Act (RCRA), or municipal landfills. Although a licensee could dispose of these materials in a low-level waste facility licensed under 10 CFR Part 61, this provision allows for the consideration of additional disposal options that may reduce costs while still providing for protection of public health and

safety and the environment. Specific considerations included in the review are outlined in subparts (a) through (d) of 20.2002 and include:

(a) A description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal; and
(b) An analysis and evaluation of pertinent information on the nature of the environment; and
(c) The nature and location of other potentially affected licensed and unlicensed facilities; and
(d) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in this part.

The exemption request review process done in conjunction with an ADR involves evaluating the parameters and models used by a submitter and, if necessary, performing additional analyses to confirm that the proposed ADR meets the regulatory requirements established in 10 CFR Part 20. NUREG-1757, Volume 2, "Consolidated Decommissioning Guidance – Decommissioning Process for Materials Licensees – Final Report," is generally used as a guide for these reviews. The review is intended to ensure that the description of the source term, the scenarios evaluated, the parameters used, and the conceptual and mathematical models utilized in USEI's dose assessment are appropriate for the alternate method of disposal requested and that the doses associated with the ADR are maintained ALARA and within the dose limits as directed by 20.2002(d).

Under the current review process, individual 10 CFR 20.2002 ADR's are evaluated for each requested disposal action at USEI. The NRC staff reviews the exposure scenarios and corresponding exposure pathways associated with the individuals expected to be involved in the disposal activities as well as post-closure exposure scenarios that may occur in the future, once operations have ceased. NRC staff also reviews dose models, such as MicroShield® and RESRAD (onsite), and the corresponding site-specific parameter values. In addition to alternate exposure scenarios, staff may also perform sensitivity analyses when considering the appropriateness of a specific parameter value. This risk-informed process enables the review to focus on those aspects that are expected to have the greatest effect on the doses and overall review findings.

The SSDA methodology proposed by USEI is intended to streamline the exemption request process by establishing a bounding, risk-based performance criteria that can be used to obtain an exemption for purpose of alternate disposal at USEI per 10 CFR 20.2002. This is done by combining the information provided in subparts (a) through (d) of 20.2002, including project-specific information (e.g., radionuclides of concern, number of trucks transporting waste, etc.) with site-specific parameter values associated with the USEI site, and the dose assessment models commonly used when considering these types of exemptions. This methodology is intended to improve both the preparation of ADRs prepared under 20.2002 as well as provide the necessary details needed for the NRC staff to process exemption requests more efficiently. USEI proposes to use this SSDA methodology when submitting future exemption requests to the NRC. Using this process, USEI would submit an ADR with the relevant information, as required by 10 CFR 20.2002 (a) through (d), to the NRC for review. The NRC staff would

review the parameter values and exposure scenarios to determine whether sufficient information has been provided. If the NRC staff determines that there are issues with information provided they would submit comments, questions, or formal Requests for Additional Information to USEI. Once accepted, the NRC staff would document their review. This review, along with a summary of any additional analyses that may have been performed, would be used by the NRC staff to evaluate the proposed exemption request and develop a Technical Evaluation Report (TER). The TER would be used in the final decision-making process for granting the alternate disposal option. Should the NRC staff grant the exemption, USEI would then forward the NRC-approved review to the IDEQ for concurrence.

EVALUATION

APPROACH FOR CONDUCTING A REVIEW OF THE SITE-SPECIFIC DOSE ASSESSMENT METHODOLOGY (SSDA METHODOLOGY)

Although this analysis was not conducted in furtherance of a specific request for an exemption for the disposal of a specific volume of radioactive material, the NRC staff reviewed the SSDA methodology and supporting TBD based on the guidance provided in NUREG-1757, Volume 2, and other relevant documents used to evaluate 20.2002 exemption requests. The review included ensuring adequate descriptions of the source term, the scenarios evaluated, and the parameters used as defined in 20.2002 (a) through (c) and that the conceptual and mathematical models utilized are appropriate to meet the dose requirements outlined in 20.2002(d). This evaluation also considered methods used for performing sensitivity analyses as well as calculating potential doses to long-term offsite and intruder scenarios.

The NRC staff also evaluated the SSDA methodology using specific analyses. In addition to evaluating the three example problems included in the TBD, the NRC staff also used the SSDA methodology to compare doses from a previous 20.2002 exemption request submittal that was approved by the NRC. A comparison of the resulting doses using the different approaches helped in evaluating the performance of the SSDA methodology.

SUMMARY OF THE SSDA METHODOLOGY

The SSDA was created by USEI to ensure that the cumulative post closure dose of a few millirem associated with a licensee's waste stream is compatible with the dose requirements established in 10 CFR 20.2002(d) and USEI's Waste Acceptance Criteria (WAC). From the NRC's perspective, since USEI is permitted by Idaho and is not licensed by the NRC or an Agreement State, Part 72 transportation dose limits would apply to shipments being received by USEI. Because USEI does not possess a Part 61 license the NRC would view USEI employees as members of the public, and not workers covered under occupational doses found in 10 CFR 20.1201.

Doses to workers are calculated by modeling various activities to estimate internal and external exposure dose rates. Dose conversion factors (DCF) from Federal Guidance Report 11 (FGR 11), "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion

Factors for Inhalation, Submersion, and Ingestion (EPA, 1988)," are used to calculate internal doses from various handling and disposal activities. MicroShield® (Version 7.02) with standard geometries is used to perform external dose estimates for these activities. Post-closure exposure to a potential future resident and an inadvertent intruder are also evaluated. This was done using RESRAD (onsite), Version 6.5, with site-specific input parameters that reflect the characteristics of the site. These analyses were performed using NRC guidance, including NUREG-0782 (NRC, 1981) and NUREG/CR-4370 (NRC, 1986).

REVIEW OF THE SSDA METHODOLOGY PROCESS

The SSDA methodology utilizes site-specific parameters, shipment-specific model input values, and other information needed to perform a conservative dose assessment for an ADR at USEI. The SSDA methodology allows the site-specific data to be considered and applied, where appropriate, to the scenarios being considered and the calculations being performed. Ultimately the SSDA methodology calculates doses for the various exposures scenarios associated with the disposal of material at USEI. The SSDA methodology is set up to compare the dose from each ADR to a maximum annual dose of a few millirem. This per ADR dose was established by USEI as the maximum annual dose for each shipment to help regulate their total annual doses for the site. Each ADR will be submitted and evaluated independently since the details, including radionuclides, radionuclide concentrations, waste volumes, shipment types, and packaging, may vary between ADRs.

The SSDA methodology was developed to provide a bounding, risk-based evaluation of a specific waste shipment that can be used for obtaining licensing exemptions per 10 CFR 20.2002(d) for the USEI site. This section of the report provides a summary of the NRC staff's review, including potential issues discovered during the NRC staff's review. In addition, insights gleaned from both this section and the following, which compares results from the SSDA methodology with results derived using the typical exemption request process, will not only provide additional information that can be used in the NRC staff's evaluation of the SSDA methodology but also provide the user with guidance when applying the SSDA methodology to future ADRs.

The SSDA methodology requires specific information related to both the waste being disposed of as well as the disposal process being considered. This includes the type of material being considered for disposal, the volume of material, the radiological content, and the modes of transportation used to get the waste to USEI. The SSDA methodology also maintains a series of checks that will provide the user with instant feedback with regards to whether the proposed ADR will meet USEI's WAC requirements or if changes are required. These checks compare the data provided from the specific ADR with the appropriate WAC requirements. Exceeding any of these WAC requirements would require USEI and the licensee to consider other options regarding the disposal of the material being considered.

Once entered, the input data, in combination with the information already incorporated into the SSDA methodology, is used to calculate the dose to the maximally exposed individual (MEI), a screening post-closure dose, and doses to potential inadvertent intruders. A general discussion of these processes and the associated calculations are provided below.

Data Input

The SSDA methodology uses a description of the waste stream and additional details to help guide the dose assessment calculations. This includes a description of the types of material that will be shipped to USEI, the radionuclide contents of the material, and the mode(s) of transportation used to get the material to USEI. This information is used to not only determine which calculations should be performed but provides the input values for the calculations associated with the specific shipment being evaluated.

The SSDA methodology also includes WAC limit crosschecks to provide instant feedback to identify whether an ADR will meet USEI's WAC as-is or if changes to the shipment will be required. If the proposed shipment of waste satisfies all of these requirements then it is presumed to be acceptable for disposal at USEI. Additional dose calculations performed using the other aspects of the SSDA methodology are then reviewed to further evaluate the acceptability of the waste for disposal.

Summary of Doses

The SSDA methodology summarizes the total effective dose equivalent (TEDE) results for the USEI workers that could be the MEI for the project as well as the post-closure screening dose and three different inadvertent intruder scenarios. The different USEI workers considered by the SSDA methodology include:

- Front-End Dray Truck Drivers
- Long-Haul Direct Truck Drivers
- Gondola Railcar Surveyors
- Truck Surveyors
- Intermodal Container Surveyors
- RTF Excavator Operator
- Gondola Railcar Cleanout
- Rail Transfer Equipment Operator
- Back-End Dray Truck Drivers
- Treatment Workers
- Landfill Cell Operators

Discussion of the different roles and responsibilities as well as the relevant exposure pathways for each worker is included in the TBD.

The SSDA methodology utilizes RESRAD, Version 6.5, to calculate the post-closure dose and the dose to an inadvertent intruder. These calculations are performed using a site-specific RESRAD model that reflects the characteristics of the USEI site. These site-specific parameters have been accepted by IDEQ as part of USEI's Site B RCRA permit. The methods used to calculate the individual doses to the inadvertent intruders are also summarized below.

Calculating External Doses

The SSDA methodology calculates the external dose for the specific job functions associated with the transport and disposal of material at USEI. MicroShield®, Version 7.02, is used to calculate the dose rates to the individual workers using the standard geometries for the specific worker scenarios. Modifications to the MicroShield input parameters are made to consider the various differences in the worker scenarios, including the type and thickness of shielding material, the distance the worker is from the contaminated material, and the time spent in the vicinity of the contaminated material. The external doses are calculated by estimating the amount of time each of the workers is exposed to the contaminated material and multiplying it by the calculated dose rates.

The NRC staff reviewed the MicroShield® external dose calculations provided by USEI using MicroShield®, Version 9.06, and the parameter values provided in the TBD. Analyses were performed for Cs-137 to compare the exposure rate values (mR/hr with Buildup) provided on the MicroShield® summary reports included in the TBD with the MicroShield®, Version 9.06, results calculated by the NRC staff. The NRC staff used the calculated density value of 1.2×10^{-6} $\mu Ci/cm^3$, allowing MicroShield® to update the rest of the related parameters. A density of 1.5×10^{-6} $\mu Ci/cm^3$ was used for the Landfill Cell Operator scenario. Table 1 provides a summary of the results. The first column of exposure rates are the exposure rates provided in the MicroShield® printouts included with the TBD. The second column contains the exposure rates calculated by the NRC staff using MicroShield®, Version 9.06, and the parameters mentioned in the TBD.

Calculating Internal Doses

The SSDA methodology calculates the total internal dose rates for the different USEI job functions where uptake of airborne contaminants resulting from waste handling and disposal activities is likely to occur. Radionuclide-specific hourly dose rates are calculated using radionuclide-specific DCFs, a breathing rate, and a dust loading fraction. The total hourly internal dose rate is calculated by summing the contributions from the individual radionuclides associated with the specific ADR. The internal doses are then calculated by estimating the amount of time each of the workers is exposed to the contaminated material and multiplying it by the calculated dose rates.

Calculating a Post-Closure Screening Dose

USEI's RCRA permit requires that they demonstrate that the dose will not exceed 0.15 mSv/year (15 mrem/year) for 1000 years after the facility closes. The SSDA methodology uses the USEI site-specific RESRAD model to perform an initial screening calculation for the post-closure dose to residents in the future using DSRs derived from the RESRAD model included in USEI's RCRA permit. The concentrations of the individual radionuclides included in ADR are adjusted to account for USEI's annual disposal volume and multiplied by the radionuclide-specific DSR. This process allows USEI to calculate separate doses for each individual ADR. This process also allows adjustments to the radionuclide concentrations and

Table 1. Comparison of External Exposure Rates (mR/hr)

Scenario	Radionuclide	External Exposure Rate (mR/hr) Attachment B, Exhibit 2	NRC Value[4]
Bulk Truck Driver	Cs-137	2.12E-04	2.14E-04
IMC Truck Driver	Cs-137	1.76E-05	1.92E-05
IMC Truck Surveyor[1]	Cs-137	1.64E-04	1.65E-04
Gondola Surveyor	Cs-137	1.90E-04	1.60E-04
Excavator Operator	Cs-137	2.37E-04	2.38E-04
Gondola Cleanout	Cs-137	6.30E-05	6.30E-05
Rail Transfer Equipment Operator[2]	Cs-137	1.86E-05	1.87E-05
Stability Worker[3]	Cs-137	6.59E-05	6.59E-05
Cell Operator	Cs-137	6.63E-05	5.39E-05

[1] Listed value from Attachment B, Exhibit 2 of the TBD is the middle value of the three values considered
[2] Analysis of the Rail Transfer Equipment Operator scenario was not provided by USEI. As indicated in the Attachment B Exhibit 2 table, the Rail Transfer Equipment Operator uses the same model as the IMC Truck Surveyor with a dose point at 2 m from the source.
[3] The scenario description in the Attachment B Exhibit 2 table indicates that dimensions of the stabilization pit are 12' 6" X 12' 6" X 12' 6". USEI MicroShield® analyses used stabilization pit dimensions of 12' 7.8" X 12' 7.8" X 12' 7.8". Values for these dimensions are included in the table above. Separate analyses using the dimensions listed in the table yielded minimal differences.
[4] Calculated using MicroShield®, Version 9.06

volumes being considered when calculating doses from multiple disposals that may occur at the same time.

Calculating Inadvertent Intruder Doses

The SSDA methodology also calculates doses for three possible future inadvertent intruder scenarios assuming all institutional controls are removed. These include the Intruder-Construction, Intruder-Well Driller, and Intruder-Driller Occupancy scenarios. The Intruder-Construction scenario assumes that an inadvertent intruder excavates and constructs a building on the site. The Intruder-Well Driller scenario considers a worker that accesses and develops a drinking water well on the site. This scenario assumes the driller spends a total of 40 hours on

the site and that drilling is accomplished in 8 hours, meaning the driller is assumed to be exposed to the undiluted cuttings for 8 hours and to diluted material for the balance of the exposure time. The Intruder-Driller Occupancy scenario assumes the individual occupies the site after the drinking water well has been drilled. Although not involved in the well construction, this individual will continue to be exposed to the remaining well drillings. All three scenarios consider both internal and external exposure pathways. Details for calculating doses for these scenarios are included in Appendix G of NUREG-0782 and NUREG/CR-4370, Volume 1.

INDEPENDENT ANALYSIS

This section of the report provides an independent analysis of the individual dose calculations performed using the SSDA methodology for a previously accepted USEI 20.2002 exemption request. This includes a comparison of the external doses calculated for the truck driver, the internal doses calculated for the excavator operator, and the inadvertent and post closure doses. Comparing the results from the SSDA methodology with the results from the original analyses provides a way of evaluating the effectiveness of the SSDA methodology compared to the process currently used by the NRC staff. For this independent analysis the NRC staff used a 2009 exemption request that USEI submitted to the NRC for the shipment and disposal of low-activity radioactive material from Toronto, Ontario, Canada to USEI. Both the submittal (ADAMS ML#090860763) and the final SER (ADAMS ML#110110283) were used in this analysis. Relevant information was evaluated and the corresponding doses were calculated using the SSDA methodology.

External Dose – Truck Driver

The analyses assume that the material is transported 400 miles from the Ontario Realty Corporation (ORC) site to a railhead where it is trans-loaded onto rail cars and shipped to the USEI Simco Road rail transfer facility located near Grand View, ID. The time estimated for the 400 mile trip is eight hours with a minimum of 10 trucks per day transporting contaminated material. The same driver is assumed to operate a truck each day for the 13 work days required to remove the estimated volume of contaminated material. The original submittal and the NRC staff's independent analysis used MicroShield®, Version 7.02, to calculate an external dose rate of 0.0256 mrem/hr for the driver who transported the waste from ORC to the railhead. The shielding and distance between the driver and the waste makes the internal ingestion and inhalation pathways unlikely routes of exposure. Using the additional information provided in the submittal the overall dose to the truck driver was calculated to be 2.7E-02 mSv/yr (2.7 mrem/yr) assuming the use of the minimum 10 trucks per day for this project. The SSDA methodology calculated a similar external dose rate of 0.023 mrem/hr which resulted in a similar external dose to the driver of 2.96E-2 mSv/yr (2.96 mrem/yr) for the project.

Internal Dose – Excavator Operator

In the submittal and corresponding SER the excavator operator responsible for unloading the radioactive material from the railcars was identified as the MEI for inhalation of radioactive material. The dose was calculated by multiplying the radionuclide concentration by an inhalation factor of 3.99E-04 g/railcar and an overall dose associated with the inhalation

pathway was 5.89E-04 mSv/yr (5.89E-02 mrem/yr). The SSDA methodology resulted in an internal dose rate for the excavator operator of 3.08E-03 mrem/hr and a total internal dose of 2.08E-4 mSv/yr (2.08E-2 mrem/yr).

Differences in the internal dose can be attributed to the method used to calculate the internal dose. The method used to calculate the internal dose in the original submittal focused on calculating the dose per rail car while the SSDA methodology calculates the dose based on the breathing rate and exposure time of the excavator operator to the entire shipment of material. Discrepancies in the DCF values used in the SSDA methodology versus those used in the initial submittal and evaluation also impacted the internal dose results. The DCFs used in the initial submittal and SER are from ICRP-60. The SSDA methodology uses the radionuclide-specific dose conversion factors listed in FGR 11.

Post-Closure and Inadvertent Intruder Dose

The current USEI permit from the Idaho Department of Environmental Quality (IDEQ) requires USEI to demonstrate that no individual would receive a dose in excess of 0.15 mSv/yr (15 mrem/yr) for a period of 1000 years after closure of the facility. This permit requirement is more restrictive than the NRC's 0.25 mSv/yr (25 mrem/yr) TEDE regulatory requirement for the release of a site for unrestricted use. For the purpose of the SSDA methodology, USEI considers a more restrictive annual dose of a few millirem for each ADR.

The original submittal and corresponding SER developed by NRC staff used RESRAD, Version 6.4, and site-specific parameter values to calculate a post-closure dose of 7.71E-6 mSv/yr (7.71E-4 mrem/yr) after 1000 years. As part of this review the NRC staff duplicated the results of this analysis using RESRAD, Version 6.5.

The SSDA methodology uses site-specific DSRs developed using RESRAD, Version 6.5, and the site-specific parameter values from the approved RESRAD model included in USEI's RCRA permit (IDEQ, 2012) to calculate a post-closure screening dose. This method calculated a more conservative post-closure dose of 6.24E-5 mSv/yr (6.24E-3 mrem/yr). The SSDA methodology also considers individual doses for inadvertent intruder scenarios, calculating individual doses for the construction worker, well driller, and driller occupancy scenarios. These scenarios were evaluated using the dose models discussed in NUREG-0782 (for the construction worker) and NUREG/CR-4370 (for the well driller and driller occupancy scenarios). The original submittal and the NRC's SER did not consider these specific scenarios and instead focused on the resident farmer scenario. For this review the NRC staff performed a conservative RESRAD analysis by modifying the post-closure dose to evaluate the dose to the resident farmer without consideration of a protective cover. This modification removes any shielding contributions from the protective cover and assumes exposures for much longer periods of time and through additional pathways not considered in the construction worker, well driller, and driller occupancy scenarios. This analysis resulted in a dose of 1.60E-02 mSv/yr (1.60 mrem/yr).

CONCLUSIONS

The NRC staff performed an extensive review of the SSDA methodology and the TBD with regards to its acceptability as a means for obtaining approval from the NRC for the disposal of licensed material at USEI. The review included an evaluation of the methods used and the formulas incorporated into the process. Based on a review of recently completed exemption requests from USEI, the NRC staff did note that specific parameter values, in the necessary form, are not always included with current submittals and would need to be added in order for the SSDA methodology to be used. Independent analyses were also performed using a previously approved ADR and the results were comparable. Based on this review, the NRC staff considers the use of USEI's SSDA methodology to be an appropriate method for evaluating future proposed disposals.

In addition, the NRC staff concluded that some portions of the SSDA methodology are proprietary and thus the SSDA methodology for supporting USEI's ADRs can be maintained as proprietary. That being said, future submittals must include a publicly available document (i.e., table or similar) containing the specific information, as defined in subparts (a) through (d) of 10 CFR 20.2002, needed to perform an independent review and, if necessary, additional analyses. This would ensure that the NRC staff and members of the public have a clear understanding of the waste being evaluated and the possible risks associated with its disposal.

REFERENCES

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