

Appendix H

Procedures for the Transportation of Radioactive Materials

H1.0 Purpose

The purpose of this procedure is to ensure that radioactive material is transported (1) using best management practices, (2) in compliance with U.S. Department of Transportation (DOT) requirements, and (3) with minimal risk to human health and the environment. For the purposes of this procedure, radioactive material refers to uranium mill tailings (UMT)-related material, unless stated otherwise.

H1.1 Scope

- Establishes the requirements for transporting radioactive material on public highways safely and in compliance with DOT requirements.
- Establishes the DOT requirements for transporting radioactive material from locations within Monticello to the U.S. Department of Energy (DOE) Temporary Storage Facility (TSF) located at the DOE repository site in Monticello and from the repository site to an off-site disposal facility such as the Grand Junction Disposal Site (GJDS).
- Addresses the requirements for transporting bulk (i.e., truckload) quantities and samples of radioactive material; including documentation, packaging, marking and labeling, vehicle inspections, training, records, and spill response.
- Provide guidance in calculating the total radioactivity of a shipment to determine DOT compliance requirements.

This procedure specifically excludes transportation of radioactive material that is not UMT-related such as radiometric calibration sources, nonradioactive hazardous materials or wastes, and UMT-related radioactive material that is mixed with other hazardous material (mixed waste), hazardous substances (e.g., asbestos or polychlorinated biphenyls [PCBs], or hazardous wastes). Shipment of non UMT-related material or nonradioactive hazardous waste under the current long-term surveillance and maintenance (LTS&M) scope is not likely; however, mixed waste may be encountered. Procedures for the identification and management of mixed waste are provided in Section 4.3.3 of this plan. The Monticello LM Representative shall contact the Site Manager in the event that shipment of any of the above-listed materials becomes necessary.

The primary waste-type addressed by this procedure is radiologically contaminated soil and debris excavated from supplemental standards areas of the Monticello National Priorities List sites. Radioactive material that is UMT-related is regulated by DOT (i.e., it is DOT-RAM) if the specific activity for Ra-226 exceeds 27 picocuries per gram (pCi/g) and the total activity for Ra-226 in the consignment exceeds 27,000 pCi. In accordance with standard operating procedures at supplemental standards properties, the Monticello Legacy Management (LM) Representative will use the radiological scanning procedures provided in Appendix F of this plan to determine if the materials encountered are radiologically contaminated (> 5 pCi/g Ra-226) and whether the materials exceed the DOT-RAM threshold of 27 pCi/g Ra-226. These procedures require a delta scintillometer scan of materials exceeding 1.3 times background in total gamma activity. The method for converting the delta measurement to pCi/g Ra-226 is a component of the radiological survey procedures in Appendix F.

The Monticello LM Representative will notify the Site Manager prior to having any material shipped to the TSF that exceeds this threshold. The Site Manager will enlist the support of an

Environmental Specialist to ensure that, in coordination with the Monticello LM Representative and all involved parties, the wastes are transported to the TSF in compliance with applicable DOT regulations. For transfers of DOT-RAM to the TSF, the Monticello LM Representative will provide radioactivity measurements and associated waste volumes to the certified shipper. This information is initially recorded by the Monticello LM Representative in the appropriate supplemental standards property record book while or soon after the excavation is in progress. The certified shipper will use the specific activity data, in pCi/g Ra-226, and volumes to calculate the average and bulk activities of the shipment(s) for determining the specific DOT compliance requirements.

The Monticello LM Representative will also notify the Site Manager when the quantity of material in the TSF approaches 75 cubic yards in volume. At that time, the Site Manager will schedule a shipment of the TSF materials to a permanent disposal facility. The Site Manager will enlist the support of an Environmental Specialist to ensure that, in coordination with the Monticello LM Representative and all involved parties, the wastes are transported from the TSF to the permanent disposal facility in compliance with applicable DOT regulations. The Monticello LM Representative will provide radioactivity measurements, in pCi/g Ra-226, and associated waste volumes in the TSF to the Environmental Specialist. The Monticello LM Representative records this information with each transfer to the TSF on the TSF Materials Transfer Log (Figure 3-10, Section 3.4 of this plan). The certified shipper will use the specific activity data, in pCi/g Ra-226, and volumes to calculate the average and bulk activities of the shipment(s) for determining the specific DOT compliance requirements.

H1.2 Responsibilities

DOE-LM Monticello Project Manager—Will be responsible for:

- Informing U.S. Environmental Protection Agency and Utah Department of Environmental Quality (UDEQ) of any emergency or noncompliant situation
- Completing required regulatory reports resulting from transportation incidents or relevant to the storage of hazardous materials.

Site Manager—Will be responsible for:

- Ensuring that the Monticello LM Representative receives required training.
- Providing assistance to the Monticello LM Representative in emergency situations.
- Coordinating with the Monticello LM Representative and an Environmental Specialist in the proper transport of all radiologically contaminated material.
- Reporting emergency situations to DOE.

Environmental Specialist—Will serve as the DOE-DOT certified shipper and will be responsible for:

- Providing support as requested by the Site Manager for determining transport and disposal requirements for waste shipments to and from the TSF.
- Calculating bulk and specific activity to determine if wastes are DOT-RAM.

- Preparing shipping documentation, packaging, marking, and labeling for radioactive materials mixed with other hazardous substances.
- Preparing shipping documentation, packaging, marking, and labeling for radioactive materials.
- Arranging with qualified carriers for transporting radioactive material to the TSF or to the GJDS.
- Maintaining copies of shipping related documents in the record files.
- Ensuring that the receiving facility has received the shipment by calling the receiving facility and requesting a copy of the signed shipping document.
- Providing guidance for regulatory reporting and notifications.

Monticello LM Representative—Will serve as the Radiological Control Technician (RCT). These responsibilities include:

- Measuring and recording the radioactivity of any material excavated in accordance with routine radiological control procedures described in this plan and in accordance with radiological survey procedures described in Appendix F of this plan.
- Notifying the Site Manager of materials exceeding 27 pCi/g Ra-226 prior to transport to the TSF.
- Coordinating with the Environmental Specialist for transportation of DOT-RAM.
- Performing transportation surveys in compliance with DOT requirements.
- Following the procedures for transferring radioactive material to and from the TSF in Section 3.4 “Management of the Temporary Storage Facility,” of this manual.
- Ensuring that carrier operators comply with these procedures.
- Conducting documented inspections of vehicles, tarpaulins, packages, and containers to ensure that there are no leaks, spills, or damaged containers for shipments of radioactive material prior to transport.
- Responding to incidents that may occur during transport of materials.
- Contacting the Site Manager and Security Personnel at the DOE–LM office in Grand Junction, and emergency services in the event of an emergency. Emergency numbers are listed in Section H.1.3.4, “Spills”.
- Providing immediate notification and follow-up documentation to the Site Manager of incidents or potential incidents occurring during transport.

Carrier Operators—Will be responsible for transporting and handling radiologically contaminated materials in accordance with these procedures and under supervision of the Monticello LM Representative.

Health and Safety Specialist—Will be responsible for:

- Assisting the Site Manager and Monticello LM Representative with worker safety issues for transportation incidents or emergencies.

H1.3 Procedures for Transporting Radioactive Materials

The following procedure is used to ensure compliance with DOT requirements for shipping bulk quantities or samples of radioactive material.

The specific activity (radioactivity per unit mass) and total activity per consignment¹ must be determined for the radionuclides of interest in radioactive material in order to establish applicable DOT requirements. The starting radionuclide used to establish DOT requirements for UMT radioactive material is U (nat) (see the table at 49 CFR 173.436).

H1.3.1 Determination of Activity

Radioactive material that is UMT-related is regulated by DOT (i.e., it is DOT-RAM) if the specific activity for Ra-226 exceeds 27 pCi/g and the total activity for Ra-226 in the consignment exceeds 27,000 pCi. If either of these values is not exceeded, the radioactive material is not DOT-RAM. The procedure used to measure Ra-226 specific activity is found in Appendix F, "Radiological Survey Procedures." The calculation for determining total activity Ra-226 in a consignment is provided in Figures H-1 and H-2. The calculation to determine if the consignment is DOT-RAM will be made by the DOT-certified Environmental Specialist.

H1.3.1.1 Bulk Shipment

Only the average specific activity for Ra-226 in a bulk shipment of radioactive material needs to be compared to the limit of 27 pCi/g Ra-226 for determining whether the shipment is DOT-RAM. It is assumed that a bulk shipment of radioactive material will exceed the total activity limit of 27,000 pCi Ra-226 in a consignment because of the relatively large quantity of material being transported.

If the data indicate that any of the material identified for transport is greater than 27 pCi/g Ra-226, then the average Ra-226 activity for the material must be determined. This will be determined by the Environmental Specialist using the activity and volume data recorded by the Monticello LM Representative in the applicable supplemental standards record books or in the TSF inventory log. The Environmental Specialist may also direct the Monticello LM Representative to measure and record the activity of the stockpiled materials at the TSF for confirmation. If the averages determined by the Environmental Specialist does not exceed 27 pCi/g Ra-226, then the material is not regulated by DOT. If the average exceeds 27 pCi/g Ra-226, then the material will be shipped as DOT-RAM under the direction of the Site Manager and Environmental Specialist, in coordination with the Monticello LM Representative.

H1.3.1.2 Sample Shipment

Both the specific activity and total activity for Ra-226 should be considered for determining whether a shipment of a sample of radioactive material is DOT-RAM. A sample is typically a small quantity of radioactive material and may not be DOT-RAM even if it exceeds the specific activity limit of 27 pCi/g Ra-226. To determine whether a shipment containing more than one

¹A consignment is a package or group of packages containing radioactive material offered for transport in the same shipment. For example, a truckload of radioactive material is considered a consignment. If a vehicle is transporting a cooler containing several samples of radioactive material, all the samples together are considered one consignment.

radioactive material sample is DOT-RAM, the specific activity for Ra-226 in all the samples is averaged and compared to the limit of 27 pCi/g Ra-226, and the total activity for Ra-226 in all the samples is combined and compared to the limit of 27,000 pCi Ra-226. The calculation for determining total activity Ra-226 in a sample is provided in Figure H-1.

H1.3.2 Radioactive Material Not Regulated by DOT

A shipment of radioactive material with an average Ra-226 concentration less than or equal to 27 pCi/g is not regulated by DOT. The following “best management practice” will be considered in transporting bulk shipments of radiologically contaminated material that is not DOT-RAM. Specific requirements of these shipments will be provided in the Statements of Work prepared by LM construction management personnel in procuring subcontractor transportation services.

H1.3.2.1 Bulk Shipment

The Monticello LM Representative will review of the Statement of Work for the shipment of radiologically contaminated material that is not DOT-RAM for “best management practice” requirements of transport. The Monticello LM Representative will coordinate with the carrier operator to ensure that requirements are implemented. Typical “best management practice” requirements include:

- Dump trucks are equipped with end-dump tailgate “diapers,” which will be constructed of at least a 6-mil plastic (or equivalent) and will not allow soil or liquid leakage. The tailgate diaper will extend horizontally a minimum of 4 feet (ft) into the dump bed, up the inside of the tailgate, and hang vertically a minimum of 12 inches over the outside of the tailgate. It also will cover the vertical edges of the tailgate by a minimum of 4 ft. The diaper will not interfere with the visibility of the taillights, turn signals, or license plate.
- Covering the load of radioactive material during transport with a tight sealing bed cover (canvas or equal) over the loaded truck bed that will overlap the truck-bed sides, front, and back by a minimum of 6 inches. Mechanical tarping devices may be specified to enable remote tarping to avoid the need of the carrier/operator to climb onto or into the truck bed to cover the load.
- Inspecting the transport vehicle to ensure that tailgates, latching mechanisms, tarping device, and hoisting/dumping devices operate properly prior to loading and transport.
- After loading, inspecting the transport vehicle to ensure that there is no loose contaminated material on the exterior surfaces of the vehicle.
- Transporting the material directly to either the TSF or to the designated location at City property MS-01006-VL.
- Placing the material in the TSF in accordance with the procedures in Section 3.4 of this plan “Management of the Temporary Storage Facility.”

H1.3.2.2 Sample Shipment

A shipment of radioactive material samples with an average concentration of less than or equal to 27 pCi/g Ra-226 or a total activity of less than or equal to 27,000 pCi Ra-226 (sum of Ra-226 activity in all samples) is not regulated by DOT. There are no special requirements for shipping radioactive material samples that are not DOT-RAM other than those normally used to ensure

that samples comply with any pertinent health and safety requirements and are properly identified and secured.

H1.3.3 Radioactive Material Regulated by DOT

H1.3.3.1 Bulk Shipment

A bulk shipment of radioactive material with an average Ra-226 concentration that exceeds 27 pCi/g is regulated by DOT. A bulk shipment of radioactive material will usually be classified as Low Specific Activity-I (LSA-I), as defined in 49 CFR 173.403. The upper limit for classifying radioactive material as LSA-I is 207 pCi/g Ra-226 (see Figure H-1). A bulk shipment of radioactive material that exceeds an average concentration of 207 pCi/g Ra-226 cannot be classified as LSA-I and is outside the scope of this procedure. An Environmental Specialist must be consulted to develop a special procedure for meeting the shipping requirements for radioactive material with an average concentration that exceeds 207 pCi/g Ra-226.

Bulk shipments of radioactive material regulated by DOT must comply with the requirements and with the best management practices specified in Section H1.3.2.1. DOT requirements for a bulk shipment of LSA-I radioactive material, which may be shipped non-exclusive use or exclusive use, are summarized in Table H-1.

H1.3.3.2 Additional Requirements for Bulk Shipments

A bulk shipment of LSA-I radioactive material that is transported to the TSF will be placed there in accordance with the procedures in Section 3.4, “Management of the Temporary Storage Facility.” As requested by UDEQ, a courtesy notification shall be made to the Utah Division of Radiation Control prior to shipping any radioactive material from the TSF to any disposal facility. The Monticello LM Representative shall call the Division of Radiation Control at (801) 536-4250.

Shipping Paper—The shipping papers may be generated at the DOE-LM office in Grand Junction, Colorado, and a signed copy faxed to Monticello for use in the shipment; shipping papers must be kept within arms reach of the driver during transport; the Monticello LM Representative must retain a copy of any signed shipping document.

Radiological Surveys—Pertinent radiological surveys of the radioactive material and the transport vehicle shall be performed by an RCT (normally the Monticello LM Representative) with a gamma dose rate instrument and a contamination survey meter in accordance with radiological survey procedures Appendix F. The results shall be documented on the appropriate survey form, a copy of which must be attached to the shipping papers.

Vehicle Inspections—Before the loaded transport vehicle departs for its destination, the Monticello LM Representative must inspect the vehicle to ensure that the requirements listed in Section H.1.3.2.1 “Bulk Shipments” are met.

Carrier Operator—Transport vehicle operators must have the training referenced in Table H-1 and in Section 2.0, Table 2.8 of this plan, and have a valid commercial drivers license.

Emergency Notification—Before radioactive material is transported, the responsible certified shipper shall contact security personnel at the DOE-LM Grand Junction Site (970-248-6070) and provide information about the shipment (DOT regulations require a 24-hour emergency contact to be available during transportation of radioactive material). The responsible certified shipper (e.g., Environmental Specialist) shall insure that a copy of the shipping papers is provided to the security personnel at the DOE-LM office in Grand Junction, Colorado, prior to the start of transportation.

H1.3.3.3 Sample Shipment

A shipment of radioactive material samples with an average concentration of greater than 27 pCi/g Ra-226 and a total activity of greater than 27,000 pCi Ra-226 is regulated by DOT. Radioactive material samples may have a low enough concentration or may be a small enough quantity such that the samples can be shipped as a limited quantity of radioactive material.

A limited quantity of radioactive material regulated by DOT is defined as a quantity of radioactive material that does not exceed the material's package limits specified at 49 CFR 173.425 and conforms with the requirements specified at 49 CFR 173.421. The upper limit for classifying a package of radioactive material as a limited quantity is 75,500,000 pCi of total activity (all isotopes, not just Ra-226).¹ The upper limit for Ra-226 in the same package is 19,328,000 pCi (see Table H-1). If the total activity for Ra-226 in a sample package exceeds 19,328,000 pCi, the sample cannot be shipped as limited quantity and must be shipped as LSA-I radioactive material. The calculation for determining total activity Ra-226 in a sample is provided in Table H-1.

In addition to having less than or equal to 19,328,000 pCi total activity Ra-226, a sample package must conform with the following requirements specified in 49 CFR 173.421 in order to be shipped as a limited quantity of radioactive material:

- Package must meet the design requirements of 49 CFR 173.410
- Radiation level on any exterior surface of the package cannot exceed 0.5 millirem per hour (mrem/hr)
- Exterior surface of the package cannot exceed the non-fixed external contamination limits specified at 49 CFR 173.443(a)

The DOT requirements for a sample shipment that qualifies as a limited quantity of radioactive material are summarized in Table H-2.

H1.3.3.4 Additional Requirements for Sample Shipments

Radiological Surveys—Pertinent radiological surveys of the radioactive material samples and associated packaging shall be performed by an RCT (normally the Monticello LM Representative) with a gamma dose rate instrument and a contamination survey meter in accordance with radiological survey procedures in Appendix F. The results shall be documented on the appropriate survey form, a copy of which must be included with the shipment.

¹ For the purposes of shipping, the only radioisotopes of interest contributing to the total activity are Th-234, Th-230, Ra-226, Pb-210, and Po-210.

Carrier Operators—Transport vehicle operators must have hazardous materials driver training as specified in Section 2.0, Table 2.8 of the LTS&M Plan.

H1.3.4 Spills

If a spill of radioactive material should occur during transport, the carrier operator shall:

- Stop the truck, and put on an orange safety vest.
- Place orange emergency triangles in front and behind the truck.
- Secure the spill.
- Notify the operator's immediate supervisor and the Monticello LM Representative (**Note:** the operator's supervisor will also contact the Monticello LM Representative to ensure awareness of the spill).
- Isolate the spill from public access.

The Monticello LM Representative shall:

- Report the spill to the Site Manager who in turn will notify the DOE–LM Monticello Project Manager (the DOE–LM Monticello Project Manager will notify the Utah Division of Radiation Control and UDEQ if in Utah, and the Colorado Department of Public Health and the Environment if in Colorado).
- Determine the extent of contamination from the spill.
- For spills occurring within the city of Monticello, arrange for the City to recover the spilled material under direction of the Monticello LM Representative and transport it to the TSF.
- For spills occurring outside of San Juan County, arrange to recover spilled material by calling the Radiological Emergency number listed below.
- Evaluate the spill and report findings on the DOE Incident Report form (GJO 1743e). A copy of this form is available in the Monticello LM Representative's office.

In case of emergency, contact one or more of the following personnel:

- | | |
|---|-----------------------|
| - Police: Monticello City Police | (435) 587-2615 |
| - Fire: Monticello Fire Department | 911 or (435) 587-2500 |
| - Medical Emergency: San Juan County Emergency Medical Services | 911 or (435) 587-2237 |
| - Radiological Emergency: DOE–LM office in Grand Junction Security Desk (staffed 24 hours/day) | (970) 248-6070 |
| - Site Manager: Timothy Bartlett | (970) 248-7741 |
| - DOE–LM: Jalena Maestas DOE–LM Monticello Project Manager | (970) 248-6023 |
| - Utah Division of Radiation Control | (801) 536-4250 |
| - UDEQ Monticello Project Manager | (801) 536-4219 |
| - Colorado Department of Public Health and Environment | (970) 248-7171 |

Calculations for Shipping Radioactive Material in Compliance with Department of Transportation Requirements

Given values for use in the calculations:

- 1 pound (lb) = 454 grams (g)
- A₂ value for uranium mill tailings (UMT) = 0.0755 Curies (Ci)
- See the conversion table (Figure G-2) for metric conversions and TBq → Ci conversions. A radioactivity conversion calculator can also be found on the Internet at:
<http://www.calculator.org/property.html?name=radioactivity>

1. Calculating total activity Ra-226 in a consignment (truckload):

$$Ra_{226} \frac{pCi}{g} \times \frac{454 g}{lb} \times \frac{lb \text{ of radioactive material}}{\text{consignment}} = \frac{\text{total activity Ra226 pCi}}{\text{consignment}}$$

2. Calculating total activity Ra-226 in a sample:

$$Ra_{226} \frac{pCi}{g} \times \frac{g \text{ of radioactive material}}{\text{sample}} = \frac{\text{total activity Ra226 pCi}}{\text{sample}}$$

3. Calculating total activity (all isotopes^a) from Ra-226 activity

$$Ra_{226} \frac{pCi}{g} \text{ or } pCi \times 3.9 = \text{total activity (all isotopes)} \frac{pCi}{g} \text{ or } pCi$$

4. Calculating Ra-226 activity from total activity (all isotopes^a)

$$\text{Total activity (all isotopes)} \frac{pCi}{g} \text{ or } pCi \times 0.256 = Ra_{226} \frac{pCi}{g} \text{ or } pCi$$

5. Calculating LSA-I Upper Limit for Ra-226 in UMT (207 pCi/g Ra-226)

- LSA-I upper limit = 30 x activity concentration specified in 49 CFR 173.436
- Isotope in 49 CFR 173.436 representing UMT is U(nat); U(nat) has an activity concentration of 27 pCi/g total activity (not just Ra-226)
- 30 x 27 pCi/g total activity = 810 pCi/g total activity
- Using Calculation 4 above:

$$810 \frac{pCi}{g} \text{ total activity} \times 0.256 = 207 \frac{pCi}{g} Ra_{226}$$

6. Calculating Limited Quantity Upper Limit for Ra-226 in UMT (19,328,000 pCi Ra-226)

- Limited quantity upper limit = 10⁻³ x A₂ (49 CFR 173.425, Table 4)
- A₂ for UMT = 0.0755 Ci total activity all isotopes (not just Ra-226)
- 10⁻³ x 0.0755 Ci total activity = 0.0000755 Ci total activity
- Using Calculation 4 above:

$$0.0000755 \text{ Ci total activity} \times 0.256 = 0.000019328 \text{ Ci Ra226}$$

$$0.000019328 \text{ Ci Ra226} = 19,328,000 \text{ pCi Ra226}$$

^aFor the purposes of shipping, the only radioisotopes of interest contributing to the total activity are: Th-234, Th-230, Ra-226, Pb-210, and Po-210.

Figure H-1. Calculation Guidance

Nomenclature and SI Units

Multiplication Factors		Prefix	Symbol
1,000,000,000,000,000,000	=	10^{18}	exa E
1,000,000,000,000,000	=	10^{15}	peta P
1,000,000,000,000	=	10^{12}	tera T
1,000,000,000	=	10^9	giga G
1,000,000	=	10^6	mega M
1,000	=	10^3	kilo k
100	=	10^2	hecto h
10	=	10^1	deka da
0.1	=	10^{-1}	deci d
0.01	=	10^{-2}	centi c
0.001	=	10^{-3}	milli m
0.000,001	=	10^{-6}	micro U or μ
0.000,000,001	=	10^{-9}	nano n
0.000,000,000,001	=	10^{-12}	pico p
0.000,000,000,000,001	=	10^{-15}	femto f
0.000,000,000,000,000,001	=	10^{-18}	atto a

Radiological

The Curie and Becquerel are units of measure of the quantity or activity of radioactive material which indicates the rate that atoms in the material are giving off radiation or disintegrating. The Curie (Ci) is equal to 37 billion disintegrations per second while the Becquerel (Bq) is equal to only one disintegration per second. Thus, for example, one Curie is equal to 37 gigabecquerels or 0.037 terabecquerels; in symbols, 1 Ci = 37 GBq = 0.037 TBq.

The rem and Sievert (Sv) are units of radiation dose (technically, of dose equivalent) absorbed by the body. A Sievert is equal to 100 rem, or 1 Sv = 100 rem. One one-thousandth of this would be one millisievert, or 100 millirem. In symbols, 1 mSv = 100 mrem.

1 TBq	=	27 Ci	=	27,000 mCi	=	
1 GBq	=	0.027 Ci	=	27 mCi	=	27,000 μ Ci
1 MBq	=	0.000027 Ci	=	0.027 mCi	=	27 μ Ci
1 Ci	=	0.037 TBq	=	37 GBq	=	37,000 MBq
1 mCi	=	0.000037 TBq	=	0.037 GBq	=	37 MBq
1 μ Ci	=	0.037 MBq	=	37,000 Bq		
1 nCi	=	0.000037 MBq	=	37 Bq		
1 pCi	=	0.037 Bq	=	37 mBq		

Equivalents for Conversions

Quantity (Activity)
Radiation Level (Dose Equivalent rate)

1 Sv/h	=	100 rem/h	=	100,000 mrem/h	
1 mSv/h	=	0.1 rem/h	=	100 mrem/h	
1 μ Sv/h	=	0.0001 rem/h	=	0.1 mrem/h	
1 rem/h	=	0.01 Sv/h	=	10 mSv/h	= 10,000 μ Sv/h
1 mrem/h	=	0.00001 Sv/h	=	0.01 mSv/h	= 10 μ Sv/h

Use of Conversion Factors

To convert a value from one system of units to another:

- First, in the left column find the unit you wish to convert from.
- Second, find the factor in that line for the unit you wish to convert to.
- Third, multiply your original value by that factor and the result will be the value in the new unit.

Example: To convert 20 mCi to its value in MBq: Go to the line which starts with "1 mCi". The factor in that line for MBq is 37. The value in MBq is 20 x 37 = 740, i.e., 20 mCi = 740 MBq.

Figure H-2. Conversion Table

Table H-1. U.S. DOT Requirements for a Bulk Shipment of Uranium Mill Tailings-Related LSA-I Radioactive Material

Shipping Topic	Requirements ^a	
	Non-Exclusive Use Shipment	Exclusive Use Shipment
Packaging	Truck is considered equivalent to an IP-1 package (49 CFR 173.411(a), 49 CFR 173.427(b)(1))	Contents are considered unpackaged (transported loose within a conveyance) (49 CFR 173.427(c))
Shipping Paper Information An example of shipping papers for LSA-I radioactive material is shown in Figure H-4	<p>Description entry: Radioactive Material, low specific activity (LSA-I), 7, UN2912, Th-230, Ra-226, Pb-210, Po-210, total activity for all isotopes (not just Ra-226) in Bq (followed by average total activity in Ci in parentheses)^b, uranium mill tailings, name of the radioactive label used (e.g., Radioactive White-I)^c, Transport Index^c, net weight of radioactive material (49 CFR 172.101 and .200 - .203, 49 CFR 173.433(g))</p> <p>Certification statement at 49 CFR 172.204(a)(1)</p> <p>Applicable emergency response phone number (49 CFR 172.201(d))</p> <p>Originating address and destination address</p> <p>Date of shipment</p> <p>Signature of the hazardous material certified shipper (usually the Environmental Specialist)</p> <p>Signature of an RCT (usually the Monticello LM Representative)</p> <p>Attach a copy of emergency response guide no. 162 from the North American Emergency Response Guidebook (see Figure H-5) (49 CFR 172.600 - .602)</p>	<p>Description entry: Radioactive Material, low specific activity (LSA-I), 7, UN2912, Th-230, Ra-226, Pb-210, Po-210, total activity for all isotopes (not just Ra-226) in Bq (followed by average total activity in Ci in parentheses)^b, uranium mill tailings, net weight of radioactive material (49 CFR 172.101 and .200 - .203, 49 CFR 173.433(g))</p> <p>Statement of "Exclusive Use Shipment" (49 CFR 172.203(d)(9)(ii)).</p> <p>All remaining shipping paper requirements are the same as a non-exclusive use shipment (certification statement, emergency response phone number, etc.)</p>

Table H-1 (continued). U.S. DOT Requirements for a Bulk Shipment of Uranium Mill Tailings-Related LSA-I Radioactive Material

Shipping Topic	Requirements ^a	
	Non-Exclusive Use Shipment	Exclusive Use Shipment
Marking	<p>UN2912 (one on all sides of truck, four total) (49 CFR 172.302(a))</p> <p>Gross weight of truck + load (one on opposite sides of truck, two total) (49 CFR 172.310(a))</p> <p>TYPE IP-1 (one on opposite sides of truck, two total) (49 CFR 172.310(b))</p> <p>USA (one on opposite sides of truck, two total) (49 CFR 172.310(c))</p> <p>Markings must meet size, color, shape, and placement requirements specified at 49 CFR 172.302 through .310, and .331 thru .338</p>	<p>Not required except outside of truck must be marked "RADIOACTIVE-LSA". (49 CFR 173.427(a)(6)(vi))</p> <p>"RADIOACTIVE-LSA" can be stenciled onto or otherwise applied onto opposite sides of the truck (two total). Appearance of marking should be in accordance with requirements at 49 CFR 172.302(b)(3) and 49 CFR 172.304.</p>
Labeling ^c	<p>Correct radioactive label per radiation levels (type of label determined using instructions in 49 CFR 172.403(a through c))</p> <p>Place one radioactive label on opposite sides of truck, two total (49 CFR 172.403(f))</p> <p>Radioactive label must include information required for that specific type of label (as described at 49 CFR 172.403(g), and as indicated by radioactive label designs illustrated at 49 CFR 172.436 and .438)</p> <p>Labels must meet size, color, shape, and placement requirements specified at 49 CFR 172.400. .406, .407, .436, and .438</p>	<p>Not required (49 CFR 173.427(a)(6)(vi))</p>
Placarding	<p>Not required (assumes a Radioactive Yellow-III is not used) (49 CFR 172.504)</p>	<p>Placard required per 49 CFR 173.427(a)(6)(v). However, in lieu of placards, labels can be used in the same manner as a non-exclusive use shipment. (49 CFR 172.514(c))</p>
Training	<p>Training requirements for a hazmat employee are specified at 49 CFR 172.700 -.704. A hazmat employee is any party that does the following with regard to DOT hazardous material: prepares shipping papers, does packaging, loads/unloads or otherwise handles, drives transport vehicles (including owner-operators), manufactures/tests/repairs packaging, or is responsible for transportation safety. Additional training may be required for transporting radioactive material.</p> <p>The Contractor's Training staff must be consulted to verify all DOT hazardous material training requirements.</p>	<p>Training requirements are the same as those for a non-exclusive use shipment except that additional training for transporting radioactive material may be required beyond that required for a non-exclusive use shipment.</p> <p>The Contractor's Training staff must be consulted to verify all DOT hazardous material training requirements.</p>

Table H-1 (continued). U.S. DOT Requirements for a Bulk Shipment of Uranium Mill Tailings-Related LSA-I Radioactive Material

Shipping Topic	Requirements ^a	
	Non-Exclusive Use Shipment	Exclusive Use Shipment
Security	Security awareness training is required per 49 CFR 172.704(a)(4)	A Security Plan is required per 49 CFR 172.800(b)(7). The components of a Security Plan are specified at 49 CFR 172.802
Additional Exclusive Use Requirements	NA	Instructions for maintaining exclusive use controls must be provided to the transporter with the shipping papers. Exclusive use instructions are provided in Figure H-3. (49 CFR 173.403, 49 CFR 173.427(a)(6)(iv), and 49 CFR 173.441(c))
Miscellaneous	<p>Shipment cannot exceed the external dose rate specified at 49 CFR 173.427(a)(1)</p> <p>Shipment cannot exceed the radiation level specified at 49 CFR 173.441(a)</p> <p>Shipment cannot exceed the non-fixed external contamination limits specified at 49 CFR 173.443</p>	<p>Truck must not leak radioactive material (49 CFR 173.427)(c)(1)). The best management practice for preventing leaks described in Section H1.3.2.1 is adequate.</p> <p>Shipment cannot exceed the external dose rate specified at 49 CFR 173.427(a)(1)</p> <p>Shipment cannot exceed the radiation level specified at 49 CFR 173.441(b)</p> <p>Shipment cannot exceed the non-fixed external contamination limits specified at 49 CFR 173.443</p>

^aPertinent regulatory citations are noted in parentheses.

^bSee Figure H-2 for total activity calculation and conversion of Bq to Ci. For the purposes of shipping, the only radioisotopes of interest contributing to the total activity are Th-234, Th-230, Ra-226, Pb-210, and Po-210.

^cThe radiation levels in each shipment determine the type of radioactive label and the Transport Index (TI) number. Because radiation levels may differ for each shipment, a standard radioactive label and TI cannot be used for all radioactive material shipments. Pertinent radiation levels using exposure rate readings must be determined in the field for each shipment. The exposure rate readings will dictate the correct radioactive label and calculation of the TI. This information is included on the shipping paper with the description entry. Instructions for determining the correct radioactive label and the TI are provided in 49 CFR 172.403 (a through c); Transport Index is defined in 49 CFR 173.403.

INSTRUCTIONS FOR EXCLUSIVE USE SHIPMENT

1. This shipment must be loaded under the direction of the Monticello LM Representative using radiologically trained personnel.
2. This shipment must be unloaded using radiologically trained personnel at the TSF under the direction of the Monticello LM Representative or at the Grand Junction Disposal Site under the direction of an RCT.
3. No additional consignments may be added to the load specified in the shipping papers.
4. The load should not be handled or unloaded during transport.
5. The shipment must be transported to the TSF or to the Grand Junction Disposal Site via the most direct route.
6. If problems occur during transport, the driver should contact the responsible person at the applicable emergency response phone number. This person will then contact the Monticello LM Representative and the Site Manager

Figure H-3. Instructions for Exclusive Use Shipment

For U.S. Department of Energy 2597 B 3/4 Road Grand Junction, Colorado 81503 970/248-6000			Shipping Document			Purchase Order Ref. N/A		Shipper Number 1 of 1	
			Requisition No. N/A		06-11064				
Mo.	Day	Yr.	Date Shipped			Buyer Name		Phone	
4	14	2006	13:46:05			N/A			
<input checked="" type="checkbox"/> Ship to GRAND JUNCTION DISPOSAL SITE 4800 U.S. HIGHWAY 50 WHITEWATER, CO 81527 Attn: MARK REED						<input type="checkbox"/> For Account of Monticello LTSM Representative			
						Shipment Requested by (signature) Request for Shipment Date Monticello LTSM Representative 04/14/2006			
Transportation:			# Pkgs	Frt. Chgs.	Item	Account	Org.	Project	
			1	S.M. Stoller	ALL	21311	150	062051041102	
Way Bill #			31,200 LBS Weight						
Item	Quantity	U/M	HM*	Detailed Description of Articles or Services, Must include DOE Property No., Serial No., and Model No. HMAT: Proper Shipping Name, Hazard Class, ID No.					
1	1	TRUCK	X	Radioactive material, low specific activity (LSA-1), 7, UN2912, Th-230, Ra-226, Pb-210, Po-210, 3.7EB Bq (0.010 Ci), Uranium mill tailings, Radioactive White-1, 31,200 lbs. Emergency response guide #162 Attached					
Emergency Telephone (970) 248-6070									
Survey for Release Monticello LTSM Representative			Authorized Signature			HMAT Certified Shipper Approval Monticello LTSM Representative		Date	
Unconditional Release <input checked="" type="checkbox"/> N/R <input type="checkbox"/>			Date 04/14/2006			Authorized Signature		Date 04/14/2006	
This is to certify that the above-named materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.						Property Management Authorization to Ship		Date	
						N/A			
Equipment furnished to Seller by buyer or specifically paid for by buyer remains the personal property of the Department of Energy. If the Seller believes that furnishing used or reconditioned supplies or components will be in the Government's interest, the Seller is required to notify us in writing. The buyer reserves the right to review and reject the use of used or reconditioned supplies or components.						Warehouse		Date	
						N/A			
Received in Good Condition by Consignee Except as Noted.						Consignee Please Sign and Return White Copy			
Company <u>S.M. Stoller Corp.</u> By <u>Grand Junction Disposal Site Representative</u> Date <u>04/14/2006</u>									

*Mark with "X" to designate Hazardous Material as defined in Title 49 of the Code of Federal Regulations.
 6J 1021 3/2005 White—Consignee Acknowledge Blue—Purchasing/Requester Green—Property Management Numerical File Canary—Consignee Pink—Accounting

Figure H-4. Shipping Document Example

POTENTIAL HAZARDS**HEALTH**

- Radiation presents minimal risk to transport workers, emergency response personnel, and the public during transportation accidents. Packaging durability is related to potential hazards of material.
- Undamaged packages are safe; contents of damaged packages may cause external and/or internal radiation exposure.
- Low radiation hazard when material is inside container. If material is released from package or bulk container, hazard will vary from low to moderate. Level of hazard will depend on the type and amount of radioactivity, the kind of material it is in, and/or the surfaces it is on.
- Some material may be released from packages during accidents of moderate severity. This poses little risk to people.
- Released radioactive materials or contaminated objects usually will be visible if packaging fails.
- Some exclusive use shipments of bulk and packaged materials will not have "RADIOACTIVE" labels. • Placards, markings, and shipping papers provide identification.
- Some packages may have a "RADIOACTIVE" label and a second hazard label. The second hazard is usually greater than the radiation hazard; so follow this Guide as well as the response Guide for the second hazard class label.
- Some radioactive materials cannot be detected by commonly available instruments.
- Runoff from control of cargo fire may cause low-level pollution.

FIRE OR EXPLOSION

- Some of these materials may burn, but most do not ignite readily.
- Uranium and Thorium metal cuttings or granules may ignite spontaneously if exposed to air (see Guide 136).
- Nitrates are oxidizers and may ignite other combustibles (see Guide 141).

PUBLIC SAFETY

- **CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.**
- **Priorities for rescue, life-saving, first aid, and control of fire and other hazards are higher than the priority for measuring radiation levels.**
- Radiation Authority must be notified of accident conditions, and is usually responsible for radiological decisions.
- Isolate spill or leak area immediately for at least 25 to 50 meters (80 to 160 feet) in all directions. • Stay upwind. • Keep unauthorized personnel away.
- Detain or isolate uninjured persons or equipment suspected to be contaminated; delay decontamination and cleanup until instructions are received from Radiation Authority.

PROTECTIVE CLOTHING

- Positive pressure self-contained breathing apparatus (SCBA) and structural firefighters' protective clothing will provide adequate protection.

EVACUATION**Large Spill**

- Consider initial downwind evacuation for at least 100 meters (330 feet).

Fire

- When a large quantity of this material is involved in a major fire, consider an initial evacuation distance of 300 meters (1000 feet) in all directions.

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Figure H-5. Emergency Response Guide 162—Radioactive Materials (Low To Moderate Level Radiation)

EMERGENCY RESPONSE**FIRE**

- Presence of radioactive material will not change effectiveness of fire control techniques.
- Move containers from fire area if you can do it without risk.
- Do not move damaged packages; move undamaged packages out of fire zone.

Small Fires

- Dry chemical, CO₂, water spray or regular foam.

Large Fires

- Water spray, fog (flooding amounts).
- Dike fire-control water for later disposal.

SPILL OR LEAK

- Do not touch damaged packages or spilled material.

Liquid Spills

- Cover with sand, earth or other noncombustible absorbent material.
- Dike to collect large liquid spills.
- Cover powder spill with plastic sheet or tarp to minimize spreading.

FIRST AID

- Medical problems take priority over radiological concerns.
- Use first aid treatment according to the nature of the injury.
- Do not delay care and transport of a seriously injured person.
- Apply artificial respiration if victim is not breathing.
- Administer oxygen if breathing is difficult.
- In case of contact with substance, wipe from skin immediately; flush skin or eyes with running water for at least 20 minutes.
- Injured persons who contacted released material may be a minor contamination problem to contacted persons, equipment and facilities.
- Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

Figure H-5 (continued). Emergency Response Guide 162—Radioactive Materials (Low To Moderate Level Radiation)

Table H-2. U.S. Department of Transportation Requirements for a Shipment of a Uranium Mill Tailings-Related Sample that is a Limited Quantity of Radioactive Material

Shipping Topic	Requirements ^a
Packaging	Must meet the general design requirements of 49 CFR 173.410 (i.e., strong, tight package) (49 CFR 173.421(a)(1))
Shipping Paper Information	Shipping papers not required (49 CFR 173.421(a))
Marking	Sample container must be marked "Radioactive". The outside container that the sample container is transported in, such as a cooler, must be marked "UN2910". Markings must be visible and legible. (49 CFR 173.421(a)(4) and 173.422(a))
Labeling	Not required (49 CFR 173.421(a))
Placarding	Not required (49 CFR 172.504)
Training	<p>Training requirements for a hazmat employee are specified at 49 CFR 172.700 - .704. A hazmat employee is any party that does the following with regard to DOT hazardous material: prepares shipping papers, does packaging, loads/unloads or otherwise handles, drives transport vehicles (including owner-operators), manufactures/tests/repairs packaging, or is responsible for transportation safety. Additional training may be required for transporting radioactive material.</p> <p>The Contractor Training group must be consulted to verify all DOT hazardous material training requirements.</p>
Security	Security awareness training is required per 49 CFR 172.704(a)(4)
Miscellaneous	<p>Radiation level on any exterior surface of the package cannot exceed 0.5 mrem/hr</p> <p>Exterior surface of the package cannot exceed the non-fixed external contamination limits specified at 49 CFR 173.443(a)</p>

^aPertinent regulatory citations are noted in parentheses.