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SILO 3 PROJECT
TRANSPORTATION AND DISPOSAL PLAN

40430-PL-0008, REV. E

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APPROVED BY:

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FERNALD CLOSURE PROJECT
FERNALD, OHIO

U.S. DEPARTMENT OF ENERGY

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ACRONYMS

ACEM	Activity Concentration for Exempt Material
AEA	Atomic Energy Act
AEDO	Assistant Emergency Duty Officer
ALEC	Activity Limit for Exempt Consignment
ASME	American Society of Mechanical Engineers
Bq	Becquerels
Bq/g	Becquerels per gram
CFR	Code of Federal Regulations
DOE	Department of Energy
DOT	Department of Transportation
EDO	Emergency Duty Officer
EMS	Emergency Management System
EOC	Emergency Operations Center
ERP	Emergency Response Plan
FCP	Fernald Closure Project
Fluor Fernald	Fluor Fernald, Inc.
HMR	Hazardous Material Regulations
IAEA	International Atomic Energy Agency
IHASP	Integrated Health and Safety Plan
ILCR	Incremental Lifetime Cancer Risk
IP-2	Industrial Packaging-Type 2
ISMS	Integrated Safety Management System
ISO	International Standards Organization
LCF	Latent Cancer Fatalities
LSA	Low Specific Activity
MCEP	Motor Carrier Evaluation Program
MEF	Material Evaluation Form
NCP	National Contingency Plan
NHASP	Nuclear Health and Safety Plan
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
NTSWAC	Nevada Test Site Waste Acceptance Criteria
OU	Operable Unit
Ra-226	Radium 226
Ra-228	Radium 228
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RD/RA	Remedial Design/Remedial Action
RDP	Remedial Design Package
RI	Remedial Investigation
ROD	Record of Decision
RPP	Radiological Protection Program
RSPA	Research and Special Programs Administration
RWP	Radiological Work Permit

SPR	Safety Performance Requirement
SR	State Route
SRC	Safety Review Committee
TBq	Terabecquerels
TBq/g	Terabecquerels per gram
TEP	Transportation Emergency Plan
Th-230	Thorium 230
TSA	Trailer Staging Area
TSR	Transportation Safety Standards
US	United States
WAC	Waste Acceptance Criteria
WC	Waste Characterization

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This plan describes transportation and disposal operations that will ensure safe and successful staging and transportation of Operable Unit 4 (OU4) Silo 3 material from the Fernald Closure Project (FCP) to the Nevada Test Site (NTS). The mode of transportation for this material will be motor carrier.

This plan serves to: (1) describe the transportation logistics associated with Silo 3 material; and (2) generally describe operational aspects of transportation plans to demonstrate that Silo 3 material can be transported to the designated disposal site safely, and in accordance with applicable regulations.

Submittal of this Transportation and Disposal Plan complies with the requirements put forth in the Silo 3 Project Remedial Design/Remedial Action (RD/RA) Package (40430-RDP-0001, Revision 2, December 2003), which requires an operational description of the transportation and disposal of Silo 3 material, including on-site staging, logistics, packaging configuration, and selected mode of transportation to the selected disposal facility.

The Record of Decision (ROD) Amendment for Operable Unit (OU) 4 Silo 3 Remedial Actions (40430-RP-0026, August 2003), requires treatment to the extent practical, by addition of a chemical stabilization reagent and a reagent to reduce dispersability.

At this time, the NTS is the only viable disposal option for conditioned or unconditioned Silo 3 material, and shipments to the NTS are currently being performed exclusively by truck. The current transportation and disposal approach assumes the Silo 3 material will be conditioned and packaged in 96 ft3, soft-sided containers, loaded into van trailers or International Standards Organization (ISO) containers and transported by truck to the NTS for disposal.

Since this plan is specific to transportation and disposal of Silo 3 material at the NTS , disposal at any other government or commercial site will require a revision of this Transportation and Disposal Plan to reflect the receiving facility's license and permits.

1.2 PROJECT APPROACH

Fluor Fernald is responsible for material retrieval, conditioning, and packaging; selection of the disposal facility and mode of transportation; analysis of the Silo 3 material for compliance with the disposal facility's Waste Acceptance Criteria (WAC); loading Silo 3 material for shipment; and transporting the Silo 3 material to the disposal facility. Plans and requirements for completing this scope are described in the Silo 3 Project Remedial Design/Remedial Action Package (40430-RDP-0001, Rev. 2, December 2003).

2.0 OFF-SITE TRANSPORTATION

2.1 INTRODUCTION

The FCP will conduct its operations in compliance with applicable federal, state, local, and tribal requirements governing materials transportation, unless exemptions or alternatives are approved in accordance with Department of Transportation (DOT) regulations.

2.2 DEPARTMENT OF TRANSPORTATION REQUIREMENTS

DOT regulations, under 49 Code of Federal Regulations (CFR) Part 173.403, categorize low specific activity (LSA) material into three classifications: LSA-I, LSA-II, and LSA-III. To be considered LSA material, the material need only meet criterion under one of the classifications. Evaluation of the radiological content of the Silo 3 material indicates this material meets one criterion for LSA-II material. Specifically, Silo 3 material is considered "other material in which the radioactive material is distributed throughout and the estimated average specific activity does not exceed 10-4 A2/g for solids..."

The results of the LSA-II determination on Silo 3 material are presented in Appendix A-1.

The LSA determination drives the container requirements for packaging the Silo 3 material for off-site shipment. Based on the evaluation performed, the minimum packaging requirement for the Silo 3 material is an Industrial Packaging - Type 2 (IP-2) container. Soft-sided IP-2 containers will be used to containerize the Silo 3 material for staging and subsequent shipment. The soft-sided containers will be placed on pallets to facilitate handling and loading into van trailers or into ISO containers and then loading onto flatbed trailers.

On January 26, 2004, The Nuclear Regulatory Commission (NRC) and the DOT published final rules on compatibility of the United States (US) radioactive material packaging and transportation regulations (10 CFR Part 71 and the Hazardous Materials Regulations, respectively) with the International Atomic Energy Agency (IAEA) Safety Standards Series (TS-R-1). The mandatory compliance date is October 1, 2004, with a voluntary compliance date of February 25, 2004. The low specific activity (LSA) determination for Silo 3 material is based on the regulations prior to the revision, but the impact of the new final rule is included in Appendix A-2.

2.3 MATERIAL TRANSPORT

The carrier will be selected to meet the requirements of each shipment and provide safe, expeditious, and economical delivery to the final destination.

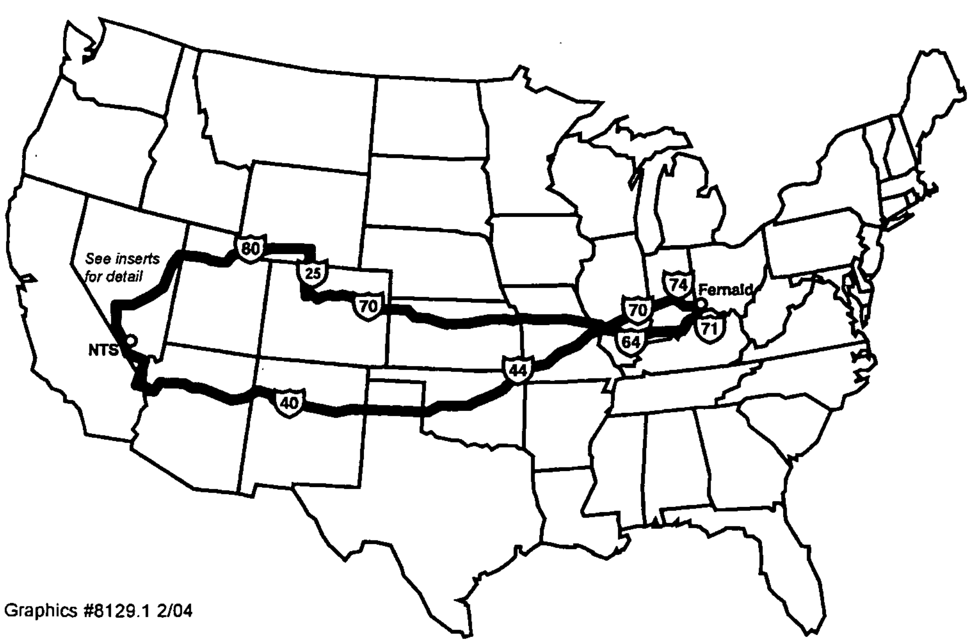
Only motor carriers with satisfactory ratings under the Department of Energy (DOE) Motor Carrier Evaluation Program (MCEP) will be considered.

The FCP provides a detailed briefing to every driver of radioactive material before the shipment departs the FCP. That briefing stresses emergency response actions to take in the unlikely event of an accident, instructions for maintenance of exclusive use shipment controls, and the importance of remaining on the routes assigned by FCP. The FCP also requires motor carriers to utilize a satellite tracking system (e.g., Qualcomm) for each shipment and randomly verifies the motor carrier is adhering to the assigned routes. Motor carrier drivers that fail to adhere to the assigned routes are prohibited from hauling future shipments of material for the FCP.

2.3.1 Routes

There is currently one northern route and two southern routes that could be used for transportation of Silo 3 material to the NTS via truck. Should the routes change, the motor carrier transporting the material will be required to stay on the specified routes. All of these routes utilize beltways around major metropolitan areas when available. The map below gives a simplified view of the main routes. More specific maps follow each detailed route description.

MAP OF ALTERNATIVE ROUTES BETWEEN FERNALD AND NTS

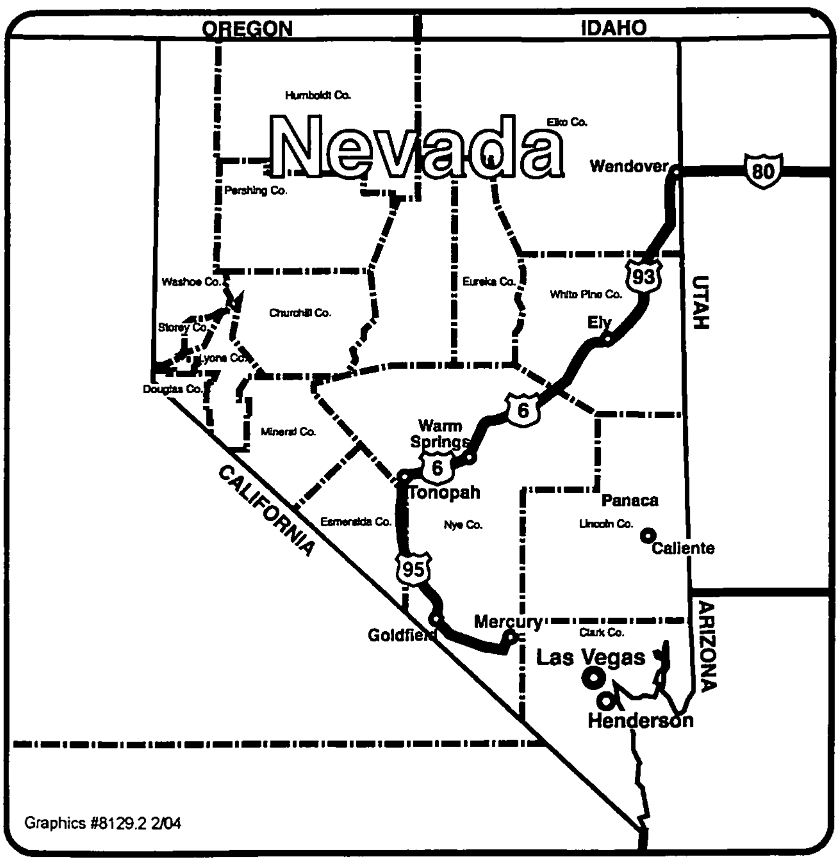


Northern Route

Travel south on Route 128 from the FCP and take I-74 west to I-465 to I-70 West at Indianapolis. Take I-70 west to I-25 north to I-80. Take I-80 west to Alternate US 93, south to US 93. At Ely, NV, take US 6 to Tonopah, NV. At Tonopah, NV, take US 95 to the NTS Mercury Gate.

The Northern Route traverses the following states: Ohio, Indiana, Illinois, Missouri, Kansas, Colorado, Wyoming, Utah, and Nevada.

NORTHERN ROUTE

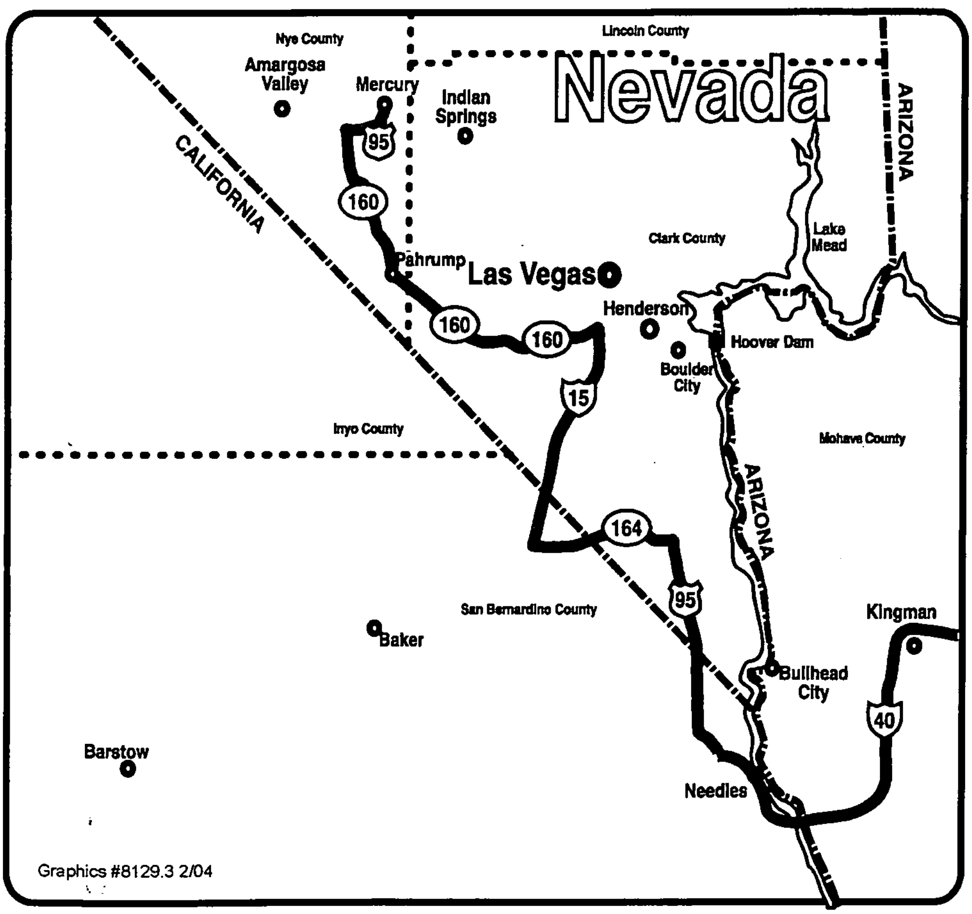


Southern Route - Route No. 1

Travel south on Route 128 from the FCP. Take I-74 west to I-275 west/south. Take I-275 to I-75 south to I-71 west to Louisville, KY. From Louisville, KY take I-64 west to St. Louis, MO. From St. Louis, MO follow I-44 to Oklahoma City, OK. Take I-40 through Kingman, AZ to Needles, CA. Proceed north on US 95 into Nevada. Go west on NV 164/Nipton Road to I-15. Proceed north on I-15 and west on Route 160 to Route 95. Take Route 95 east to Mercury, NV.

The Southern Route No. 1 traverses the following states: Ohio, Kentucky, Indiana, Illinois, Missouri, Oklahoma, Texas, New Mexico, Arizona, California, and Nevada.

SOUTHERN ROUTE #1

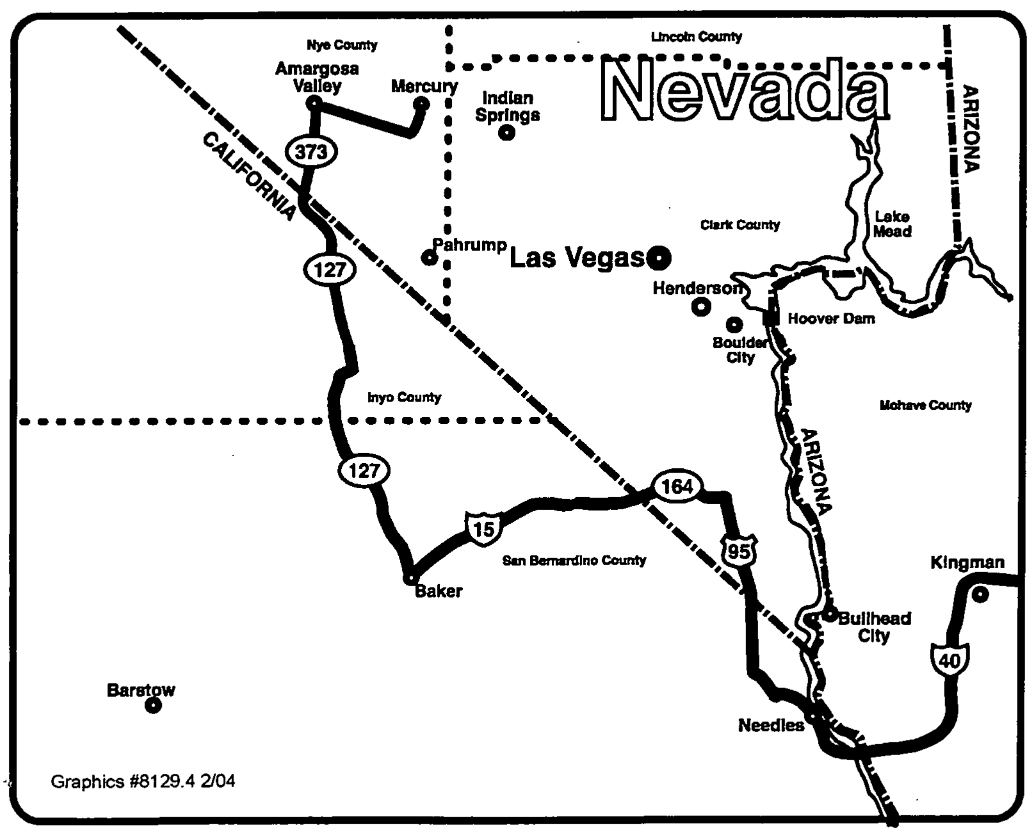


Southern Route - Route No. 2

Travel south on Route 128 from the FCP. Take I-74 west to I-275 west/south. Take I-275 to I-75 south to I-71 west to Louisville, KY. From Louisville, KY take I-64 west to St. Louis, MO. From St. Louis, MO, take I-44 to Oklahoma City, OK. Take I-40 through Kingman, AZ to Needles, CA. Proceed north on US 95 into Nevada. Go west on NV 164/Nipton Road to I-15. Travel southwest on I-15 to Baker, CA. Go north on CA 127 and NV 373 to Amargosa Valley, NV. Take US 95 East from Amargosa Valley to Mercury, NV.

The Southern Route No. 2 traverses the following states: Ohio, Kentucky, Indiana, Illinois, Missouri, Oklahoma, Texas, New Mexico, Arizona, California, and Nevada.

SOUTHERN ROUTE #2



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2.3.2 Risk and Safety Requirements

A transportation risk assessment has been conducted comparing the risks associated with truck transportation of unconditioned Silo 3 material to the NTS, assuming transportation via van trailer or via an ISO on flatbed truck. The assessment was based on unconditioned material as a conservative approach. The assessment evaluated both potential risks associated with accident-free waste transportation (direct radiation) and the risks associated with an accident scenario. As documented in Appendix B, the calculated excess cancer risk to members of the general public for both scenarios meets the criteria specified by the Silo 3 ROD Amendment.

Per 49 CFR 397 Subpart D, Routing of Class 7 (Radioactive) Materials, the truck route selected for shipment of radioactive material to the NTS shall ensure that the radiological risk is minimized. Accident rates, transit time, population density and activities, and the time of day and week in which transportation will occur are included in the radiological risk determination.

2.3.3 Shipping Requirements

2.3.3.1 Department of Transportation Requirements

The FCP shall comply with applicable federal, tribal, state, and local regulations. Each package and shipment of hazardous materials for off-site shipment shall be prepared in compliance with 49 CFR 171-180, Hazardous Materials Regulations and the applicable tribal, state, and local regulations.

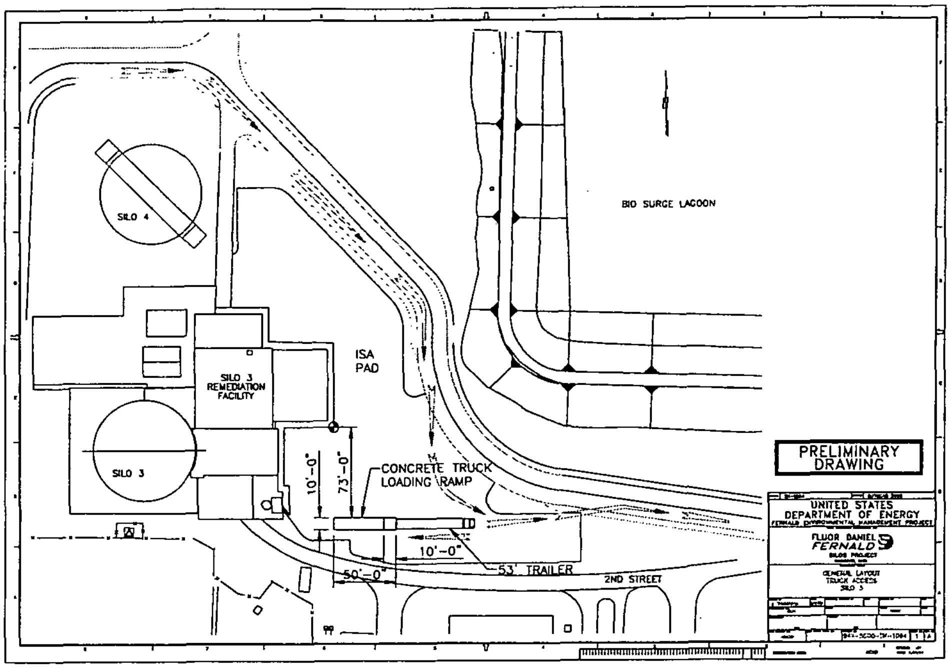
2.3.3.2 Motor Carrier Selection

The FCP will participate in and use the DOE MCEP in the selection of motor carriers as needed, or upon request from the DOE Field Element. Upon request from the DOE Field Element, the FCP shall evaluate carriers, in accordance with the DOE MCEP. Carrier selection will be performed consistent with DOE Orders and 41 CFR 101-40, Transportation and Traffic Management. Shipments will be consolidated to the extent practicable into larger shipping quantities or units whenever such arrangements will result in transportation or administrative economies.

3.0 ON-SITE WASTE MANAGEMENT

3.1 INTRODUCTION

This section addresses the on-site management of the Silo 3 material, including the characterization, packaging, staging, inspections, and Silo 3 material container movements. The following diagram is a representation of the layout of the Silo 3 Area:



3.2 WASTE CHARACTERIZATION

The Silos Project is responsible for characterizing the conditioned Silo 3 material to coordinate the appropriate waste disposal/storage, packaging and transportation options for this waste. To accomplish these tasks, the Waste Characterization (WC) group has reviewed project submittals, the regulatory status, process knowledge, and analytical data from the OU4 Remedial Investigation (RI) for Silo 3 waste. Based upon this review, the conditioned Silo 3 waste has been characterized. This characterization is documented in Material Evaluation File (MEF) 3851.

3.3 PACKAGING

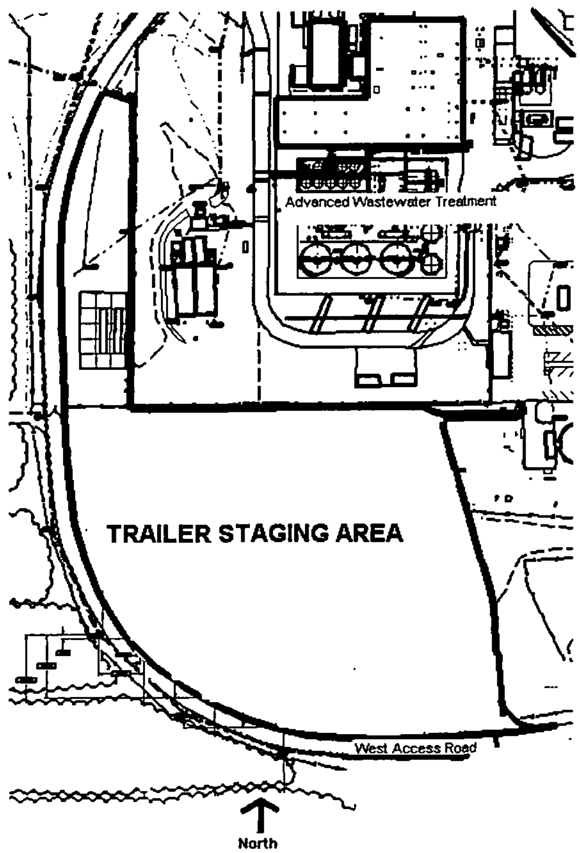
Packaging of waste for shipment will require evaluation by WC, Shipping, the Safety Review Committee (SRC) for container evaluations, and the NTS Quality Control organization. The Silo 3 waste and packaging was evaluated for absorbent requirements and material and container compatibility. The packaging configuration (i.e., blocking and bracing in the conveyance), etc. will be determined.

The current Silo 3 packaging approach assumes conditioned Silo 3 material is packaged in 96 ft3 Industrial Packaging- Type 2 (IP-2) soft-sided containers, placed on pallets, loaded into van trailers or ISOs/flat bed trailers and staged for shipment to the NTS.

The containers will be filled with Silo 3 material, weighed, labeled, and surveyed before being placed in the trailer or ISO for shipping to NTS. The Package Loading Stand is equipped with a scale to allow weighing of the filled soft-sided container prior to being placed on pallets.

3.4 STAGING AND INSPECTIONS

Inbound trailers will be inspected and surveyed before being moved to the Trailer Staging Area (TSA), using a yard tractor. The TSA will serve as a place for staging of empty and loaded trailers (as long as dose is within limits), as well as repair of unfit trailers. Following is a diagram of the TSA:



A trailer loading ramp will be constructed south of the Silo 3 cargo bay. Once the packages are approved for disposal, loading of the trailers will be performed, either by directly loading into a van trailer or into an ISO and then onto a flatbed trailer.

After the trailer is surveyed and released from the Silos area for shipment, the Shipping organization will prepare the remaining paperwork. Individual containers of Silo 3 material will be tracked using the existing on-site waste tracking databases.

3.5 CONTAINER MOVEMENTS

Once an inventory of material is approved for shipment, the final shipping certification will occur prior to loading. Containers will be loaded onto an acceptable transport conveyance, such as, ISOs/flat bed trailers or van trailers using fork trucks or other necessary heavy equipment.

4.0 HEALTH AND SAFETY

4.1 INTRODUCTION

The focus of this section will be the Health and Safety approach for on-site transportation operations-related activities. The overall on-site project Health and Safety responsibility lies directly with the DOE, Fluor Fernald, and its contractors and is implemented according to PL-3081, Safety Management System Description, which incorporates the core functions of the Integrated Safety Management System (ISMS). The specific functional areas of safety addressed in this section are Nuclear and Systems Safety, Occupational Safety and Health, Radiological Protection, and Security.

4.2 NUCLEAR AND SYSTEMS SAFETY

The FCP Nuclear and System Safety Program is identified in RM-2116, System Safety Requirements and is implemented by Fluor Fernald through site procedures. Safety analyses are performed to help ensure the health and safety of the public, the workers, and the environment. A Nuclear Health and Safety Plan (NHASP) has been developed for operation of the Silo 3 Project and has been approved by DOE.

Safety analysis documentation is being developed for staging of material and motor vehicle shipping activities for Silos projects. The format will be an Integrated Health and Safety Plan (IHASP). All shipments and containers (including Silo 3 shipping containers) will comply with DOT regulations, which will help to ensure the health and safety of the public, the workers, and the environment.

4.3 OCCUPATIONAL SAFETY AND HEALTH

The FCP Occupational Safety and Health Program requirements are defined in the RM-0021, Safety Performance Requirements (SPR) Manual. The SPRs apply to activities at the FCP. SPRs identify requirements established by federal, state, and local regulations, in addition to requirements from DOE Orders and Best Management Practices established by Fluor Fernald through experience, lessons learned, and employee input. SPRs identify safety and health standards for assessing and planning work at the FCP. SPRs contain guidelines on what must be done to safely execute work and are not intended to specify how to execute work. The Fluor Fernald Silo 3 Project team will implement the SPRs by incorporating their requirements into any project-specific procedures and contracts that will be developed to guide the performance of transportation activities. Silo 3 material shipments will be performed in accordance with existing shipping procedures, which incorporate the required SPRs.

Project-specific safety and health requirements will be developed as the details of the project unfold. For planning purposes, however, existing SPRs are being used as the basis for health and safety on this project. The SPRs and additional project-specific safety requirements are incorporated into planning documents and implementing procedures.

4.4 SAFETY PRECAUTIONS

Staging of packaged Silo 3 material will be in designated and approved area(s).

4.5 RADIOLOGICAL PROTECTION

Equipment and material, including containers of Silo 3 material, will be released from the Silo 3 facility when the exterior of the item meets DOT surface contamination limits. Therefore, it is planned that shipping activities will take place in a Controlled Area. FCP Radiological Control Technicians (RCTs) will conduct routine radiological surveys to ensure contamination levels are maintained below Contamination Area limits. The exterior of each container (soft-sided containers) will be surveyed by FCP Radiological Control for compliance with DOT regulations and Fluor Fernald Radiological Protection Program (RPP) requirements. Exterior non-fixed contamination levels will be determined per 49 CFR 173.443, Contamination Control for shipments and 10 CFR 835, Occupational Radiation Protection for staging. Once the containers have been surveyed and are ready for release, they will be loaded into van trailers or into ISOs and placed on flatbed trailers. After the trailers have been surveyed and released, they will be transported to the TSA or other on-site staging location.

If the equipment or material in the Controlled Area exceeds Contamination Area levels, a Contamination Area will be established and a new Radiation Work Permit (RWP) will be issued. The RWP will define the level of anti-contamination clothing and RCT coverage required. If decontamination is feasible, decontaminating the work surface to a level below Contamination Area limits will eliminate the need for routine wearing of anti-contaminating clothing and reduce the RCT coverage requirements. If/when Contamination Areas are established, whole body monitoring will be required for exiting the area. Immediately following the completion of work, the area will be decontaminated, as necessary, and surveyed for the purpose of down-posting.

Detailed project-specific radiological control requirements will be developed and incorporated into procedures and work permits.

4.5.1 Access of Personnel

Only necessary personnel with the appropriate training will be given access to the radiologically-controlled areas. The crew will ingress/egress through a radiological control point(s) and will be subject to personal contamination monitoring upon exit. Incidents of personal contamination will be addressed per existing, approved site procedures.

4.6 SECURITY

Areas where Silo 3 material will be loaded and staged pending the completion of shipment will be within the site fence and provided with the appropriate levels of security and lighting. FCP Security monitors site access by using stationary posts, conducting walking, driving, and perimeter patrols on a 24-hour basis.

5.0 EMERGENCY RESPONSE

5.1 INTRODUCTION

This section documents the emergency response procedures that are in place to respond to transportation accidents involving shipments of Silo 3 material. The scope of this discussion focuses on off-site occurrences and references procedures for on-site occurrences.

DOE Order 151.1, Comprehensive Emergency Management, provides for a DOE Emergency Management System (EMS). Pursuant to this order, DOE must maintain a Transportation Emergency Preparedness Program that enhances and integrates transportation emergency preparedness capabilities within the EMS. The Transportation Emergency Preparedness Program has been established at DOE headquarters. The FCP has a similar program. The Transportation Emergency Preparedness Program ensures that an adequate DOE response to transportation incidents involving DOE materials is performed and that DOE's responsibilities under the National Contingency Plan (NCP) and the Federal Radiological Emergency Response Plan are adequate. The Transportation Emergency Preparedness Program also provides technical advice and assistance as required for transportation incidents involving radioactive wastes.

5.1.1 Department of Energy Requirements

DOE Order 435.1, Radioactive Waste Management and associated manual DOE M 435. 1-1, Chapter IV, Section L.2, Transportation, also state that the volume of waste and number of waste shipments shall be minimized to the extent practical. This requirement was considered in development of the Silo 3 waste form and associated transportation planning.

5.2 FCP EMERGENCY RESPONSE PREPAREDNESS PLANS

The FCP Transportation Emergency Plan (TEP), PL-3043, is part of the DOE-FCP Transportation Emergency Preparedness Program. The FCP TEP provides a centralized program approach to off-site transportation emergency response including products, samples, waste, and rail shipments.

The FCP TEP describes the overall DOE/FCP process developed for the coordination of response efforts to off-site transportation incidents. This assistance planning is accomplished by adherence to applicable federal, state, and local transportation-related emergency response requirements, plus utilizing existing DOE programs designed to protect the well-being of citizens and the environment from accidental release of transported materials.

Procedures for on-site emergencies are addressed in PL-3020, FCP Emergency Plan, which details the procedures to be followed at the FCP in the event of an accident or emergency, highlights FCP safety features, and governs the spill response actions. The FCP Emergency Plan is distributed to participating mutual aid organizations, such as local fire departments and hospitals, in the general vicinity of the FCP. Additionally, PL-2194, the FCP Spill Prevention Control and Countermeasure Plan will be implemented accordingly for incidents on, or in close proximity to, the FCP. Silo-specific emergency procedures are addressed in EM-0030, Silos Area Emergency Procedure.

5.3 EMERGENCY RESPONSE FOR THE FCP OFF-SITE SHIPMENTS

A Silo 3 material shipment will become an off-site shipment at the point when the entire shipment crosses the facility boundary. When the shipment is off-site, the motor carrier will be responsible for providing emergency response support to the local authorities in proximity of any incident. The carrier also has contractors available for containment and cleanup as necessary. The FCP will provide technical assistance via the 24-hour emergency response telephone number. DOE will advise and provide support as requested by the local response authority (49 CFR 174.750). Local response personnel including police, firefighters, and emergency responders, typically are the first to arrive on the scene of an incident. They must be provided with the technical information needed by first responders to accurately identify the hazards involved in the incident. Information contained in the shipping papers includes source terms, health and safety concerns, and recommended protective actions. The information is consistent with the DOT, Research and Special Programs Administration publication, North American Emergency Response Guidebook, Guide 162.

The following is an overview of the emergency response responsibilities of the motor carriers, DOE, individual states, and the FCP to support local authorities at an accident scene.

1. Carriers
   - Trained in accordance with DOT Emergency Response Guidebook and the carrier's respective Emergency Response Plans
   - Stabilize situation
   - Provide notification of incident to carrier home office
   - Provide notification to FCP/DOE

2. Carrier Emergency Response Organization
   - Make appropriate additional notification (local authorities, DOE, etc.)
   - Dispatch Emergency Response Personnel to the scene to support On-Scene Commander
   - Mobilize strategically positioned emergency response subcontractors, if necessary
   - Responsible for Recovery Actions

3. Local Authorities
   - Typically function as the On-Scene Commander

4. State Emergency Response Organizations
   - Each state possesses an Emergency Response Organization capable of responding to radiological emergencies

5. DOE Regional Radiological Assistance Teams
   - Eight Radiological Assistance Teams across the United States
   - Provide On-Scene Commanders with support in terms of radiological monitoring, communications, and information coordination during an emergency
   - Consist of DOE and contracted personnel possessing expertise in health physics, public information, and communications

The FCP TEP is activated when the carrier or the local response organizations contacts the FCP to notify DOE that an incident has occurred. The 24-hour emergency phone number provided on the bill of lading, as required by 49 CFR 172.604, Emergency Response Telephone Number, is a direct telephone line to the FCP Communications Center.

The FCP Communications Center provides communication capability for the FCP, monitors conditions, and makes notifications as required. The FCP Communication Center establishes and maintains direct communication with the On-Scene Commander and the FCP Assistant Emergency Duty Officer (AEDO) until the Emergency Operations Center (EOC) is activated.

The FCP EOC is activated at the direction of the AEDO or Emergency Duty Officer (EDO) for events categorized at the emergency level, including transportation events and for non-emergency events at the discretion of the EDO. The EOC officially becomes operational when the Emergency Director or Deputy Emergency Director arrives at the EOC, determines that sufficient personnel are available to manage the response, and declares the EOC operational. The combined efforts of EOC staff members provide support, guidance, and direction to the On-Scene Commander in the field. The EOC staff assumes responsibilities such as making protective action recommendations, providing notifications, and obtaining necessary resources, as required by the specific circumstances of the event.

5.3.1 Motor Carriers

Motor carriers maintain Emergency Response Plans (ERP), which outline the procedures the carrier's employees must take in the event of an incident. The plan includes notification responsibilities, emergency response procedures for personnel on the scene, environmental considerations, and additional precautions to take in the event of an incident. DOE, as the shipper, will be notified by the carrier immediately should an incident occur. Both the carrier and DOE will initiate emergency procedures upon notification.

6.0 WASTE DISPOSAL

6.1 INTRODUCTION

This section discusses disposal of Silo 3 material at the NTS and the related regulatory and waste acceptance information.

6.2 SILO 3 MATERIAL QUANTITIES/CHARACTERISTICS

Silo 3 contains approximately 5,100 yd3 of material that was generated at the FCP during uranium extraction operations in the 1950s. Samples collected from Silo 3 indicate the presence of significant activity and concentrations of the radionuclides within the uranium decay series, confirming prior process knowledge. The predominant radionuclide of concern identified within Silo 3 is Th-230, a radionuclide produced from the natural decay of Uranium-238. Approximately 450 curies of Th-230 are distributed within the Silo 3 material. (Note: The 450 curies is a mean inventory value. The 95% upper confidence limit inventory value is approximately 530 curies. For most determinations, the upper confidence limit values are used for conservatism.)

The Silo 3 material is classified as 11e.(2) by-product material under the Atomic Energy Act (AEA), of 1954, as amended, because the material resulted from the processing of uranium ore concentrate and is specifically exempt, as defined, from regulation as solid waste under the Resource Conservation and Recovery Act (RCRA), 40 CFR 261.4(a)(4), Identification and Listing of Hazardous Waste, Exclusions. Since Silo 3 material is not a solid waste, requirements under RCRA are not applicable.

The current approach is for disposal of conditioned Silo 3 material. The conditioning process, which results in a minimal volume increase, will reduce material dispersability and reduce the mobility of certain RCRA metals contained in the material.

6.3 DISPOSAL OF SILO 3 MATERIAL

At this time, the NTS is the viable option for disposing of conditioned or unconditioned Silo 3 material. The current revision (Revision 5) of the NTS WAC allows management and disposal of untreated Silo 3 material at the NTS as 11e.(2) material.

6.3.1 Nevada Test Site

This section provides information pertinent to disposal of Silo 3 material at the NTS. This section will describe regulatory requirements, the NTS waste acceptance, and the receipt of waste at the NTS.

Silo 3 material is proposed for shipment and disposal after conditioning. Radionuclide concentrations, as well as other parameters of interest, will be determined to ensure the conditioned material offered for disposal meets the NTS WAC. Only material that meets the disposal facility WAC will be accepted for transportation and disposal under this plan.

Once the Silo 3 Project receives verification that the material meets the disposal facility WAC and the trucks carrying the material have been surveyed and approved for release, the Silo 3 material will be released for shipment from the FCP.

6.3.1.1 Regulatory Information

The DOE, Nevada Operations Office, and Nevada Test Site Waste Acceptance Criteria (NTSWAC) establish the requirements for disposition of waste at the NTS. Additionally, the NTSWAC, DOE/NV-325, Revision 5, requires that packaging and shipments to the NTS be performed in accordance with DOE Order 435.1, "Radioactive Waste Management", 40 CFR, and 49 CFR.

6.3.1.2 NTS Waste Acceptance

DOE/Nevada Operations Office requires that prior to generator approval to ship waste to the NTS, they must develop a certification program to ensure waste is compliant with the requirements of the NTSWAC. The process used by DOE/Nevada Operations Office for approval of a generator's certification program includes program reviews and evaluations of implementation at the generator's facility.

Once the generator has an approved program, a waste profile must be developed and submitted for each waste stream that is shipped for burial at the NTS. These profiles provide the NTS with an understanding of the characterization and quantities of the material. If the profiles as stated are approved, the generator is then notified in writing of the authorization and packaging and shipment may commence. Acceptance of Silo 3 material is addressed in Profile ONLO000000133.

The FCP's Waste Certification Official and designees, in accordance with the Waste Certification Program Plan, PL-3067, will provide oversight of any packaging and shipping operations that are performed to ensure and document that requirements have been met for waste disposal at the NTS. If requirements are met, then the waste packages, the documentation packages, and the transport vehicles are "certified" in accordance with the NTSWAC and Fluor Fernald requirements and released for transport to the NTS.

The NTS performed a Performance Assessment per DOE Order 435.1 on Area 5, which established volumetric radionuclide concentration limits. Informal review indicates conditioned Silo 3 material meets the limits and could be disposed in Area 5.

6.3.1.3 Receipt of Waste at the NTS

Once the waste generator has received approval to ship and has performed certification activities to release shipments for disposal, the generator must notify the NTS Manager to arrange for transfer of the waste and accompanying records.

Prior to shipment, certain records must be sent electronically. Pre-notification information includes time of departure, estimated time of arrival; carrier, trailer, and security seal numbers; description of load; waste type; and a copy of the Package Storage and Disposal Request.

Once the shipment arrives at the NTS (Mercury location), the driver must provide a copy of the completed proper shipping papers with shippers certification, original Package Storage Disposal Request, and an appropriate Waste Certification Statement signed by the Waste Certification Official or an alternate designee (Alternate Waste Certification Official). Once these documents are reviewed and accepted, the shipment may be unloaded at the disposal location.

The NTS proposes to dispose of the soft-sided containers of Silo 3 material in Area 5.

7.0 REFERENCES

Code of Federal Regulations, 10 CFR 835,"Occupational Radiation Protection"

Code of Federal Regulations, 10 CFR Chapter 1,"Nuclear Regulatory Commission"

Code of Federal Regulations, 40 CFR 261.4, "Identification and Listing of Hazardous Waste, Exclusions"

Code of Federal Regulations, 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan"

Code of Federal Regulations, 41 CFR 101-40, "Transportation and Traffic Management"

Code of Federal Regulations, 49 CFR 171-180, "Hazardous Materials Regulations"

Code of Federal Regulations, 49 CFR 107, "Hazardous Materials Program Procedures"

Code of Federal Regulations, 49 CFR 350-399, "Federal Motor Carrier Safety Administration"

Code of Federal Regulations, 49 CFR 397, Subpart D, "Routing of Class 7 (Radioactive) Materials"

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U.S. Department of Energy, 1996 "Packaging and Transportation Safety," DOE Order 460.1A, October 1996

U.S. Department of Energy, 1996, "Comprehensive Emergency Management," DOE-460.1A, August 1996

U.S. Department of Energy, 1996, "Packaging and Transportation Safety," DOE-460.1A, October 1996

U.S. Department of Energy, 1999, "Radioactive Waste Management," DOE-435.1, July 1999

U.S. Department of Energy, 2003, "Safety Basis Requirements," 10 CFR 830, Subpart B, , January 2003

APPENDIX A-1
SILO 3 MATERIAL LSA DETERMINATION (CURRENT REGULATIONS)

The table below represents the source term for the Silo 3 material, as well as the LSA classification and packaging determinations.

Column 1 identifies each radionuclide present in the Silo 3 material.

Columns 2 and 4 identify the activity concentration for each radionuclide in terabecquerels per gram (TBq/g) and becquerels per gram (Bq/g), respectively. Column 3 identifies the total activity of each radionuclide in terabecquerels (TBq). The values in Columns 3 were arrived at by taking the activity concentration per radionuclide multiplied by the net weight in grams of material.

49 CFR 173.403 defines radioactive material as any material having a specific activity greater than 70 Bq per gram. As demonstrated in the table, this material has a specific activity greater than 70 Bq/g; therefore, the Silo 3 material meets the definition of Class 7 radioactive material.

Column 7 identifies the A2 values prescribed by 49 CFR 173.435. As permitted by 49 CFR 173.433, certain parent nuclide values already include the contributions from daughter nuclides with half-lives less than 10 days and considered to be in secular equilibrium with their parent nuclide. In these cases, the decay chain is treated as a single nuclide rather than a mixture.

The definition of LSA-II solid material found at 173.403 *LSA material* requires that the activity is distributed throughout and the average specific activity of the material is less than 10^{-4} A_2/g. This limit is identified in Column 5. Column 6 contains the result of the unity calculation per nuclide for LSA-II and is derived by the following:
Column 2, "Activity Concentration (TBq/g)" divided by Column 5, "LSA-II (2)(ii) Limits 10^{-4} A2/g"

If the sum of Column 6 exceeds 1, then the radioactive material cannot be shipped as LSA-II material. As shown in the table, the sum of the LSA-II unity calculation does not exceed 1; therefore, it can be classified and shipped as LSA-II material. At this point, it has been determined the Silo 3 material meets the DOT definitions of radioactive and LSA-II material.

Column 8 contains the result of the A2 unity calculation per nuclide and is derived by the following: Column 3, "Total Activity (TBq)" divided by Column 7, "A2 Limits (TBq)"

If the sum of Column 8 exceeds 1, thereby exceeding an A2 quantity, the material cannot be shipped in an excepted package as permitted by 173.427(b)(3). As shown in the table, the sum of the A2 unity exceeds 1; therefore, the Silo 3 material must and will be packaged in a Type IP-2 packaging, subject to the limitations of Table 8, as required by 49 CFR 173.427 (b)(1). Per Table 9, the activity limit for the conveyance is unlimited for LSA-II non-combustible solids.

Project: Silo 3 Transportation & Disposal Plan - Appendix A-1
Container: Non-Bulk IP-2 Bag
Weight/Unit: 4400 Lbs.
Net Weight: 4400.0 Lbs. **Net Wt. (Gms.):** 1,995,796.0

1	2	3	4	5	6	7	8
Radionuclide	Activity Concentration (TBq/g)	Total Activity (TBq)	Activity Concentration (Bq/g)	LSA-II (2)(ii) Limits 10^{-4} A2/g	LSA-II Unity	A2 Limits (TBq)	A2 Unity
Ac-227	3.078E-11	6.144E-05	3.078E+01	2.000E-09	1.539E-02	2.000E-05	3.072E+00
Ac-228	2.808E-11	5.605E-05	2.808E+01	Daughter	0.000E+00	Daughter	0.000E+00
Bi-210	1.288E-10	2.570E-04	1.288E+02	Daughter	0.000E+00	Daughter	0.000E+00
Bi-211	3.078E-11	6.144E-05	3.078E+01	Daughter	0.000E+00	Daughter	0.000E+00
Bi-212	2.808E-11	5.605E-05	2.808E+01	Daughter	0.000E+00	Daughter	0.000E+00
Bi-214	1.288E-10	2.570E-04	1.288E+02	Daughter	0.000E+00	Daughter	0.000E+00
Fr-223	4.255E-13	8.492E-07	4.255E-01	Daughter	0.000E+00	Daughter	0.000E+00
Pa-231	3.078E-11	6.144E-05	3.078E+01	6.000E-09	5.131E-03	6.000E-05	1.024E+00
Pa-234m	6.216E-11	1.241E-04	6.216E+01	Daughter	0.000E+00	Daughter	0.000E+00
Pb-210	1.288E-10	2.570E-04	1.288E+02	9.000E-07	1.431E-04	9.000E-03	2.855E-02
Pb-211	3.078E-11	6.144E-05	3.078E+01	Daughter	0.000E+00	Daughter	0.000E+00
Pb-212	2.808E-11	5.605E-05	2.808E+01	Daughter	0.000E+00	Daughter	0.000E+00
Pb-214	1.288E-10	2.570E-04	1.288E+02	Daughter	0.000E+00	Daughter	0.000E+00
Po-210	1.288E-10	2.570E-04	1.288E+02	2.000E-06	6.438E-05	2.000E-02	1.285E-02
Po-211	8.399E-14	1.676E-07	8.399E-02	Daughter	0.000E+00	Daughter	0.000E+00
Po-212	1.798E-11	3.589E-05	1.798E+01	Daughter	0.000E+00	Daughter	0.000E+00
Po-214	1.288E-10	2.570E-04	1.288E+02	Daughter	0.000E+00	Daughter	0.000E+00
Po-215	3.078E-11	6.144E-05	3.078E+01	Daughter	0.000E+00	Daughter	0.000E+00
Po-216	2.808E-11	5.605E-05	2.808E+01	Daughter	0.000E+00	Daughter	0.000E+00
Po-218	1.288E-10	2.570E-04	1.288E+02	Daughter	0.000E+00	Daughter	0.000E+00
Ra-223	3.078E-11	6.144E-05	3.078E+01	3.000E-06	1.026E-05	3.000E-02	2.048E-03
Ra-224	2.808E-11	5.605E-05	2.808E+01	Daughter	0.000E+00	Daughter	0.000E+00
Ra-226	1.288E-10	2.570E-04	1.288E+02	2.000E-06	6.438E-05	2.000E-02	1.285E-02
Ra-228	2.808E-11	5.605E-05	2.808E+01	4.000E-06	7.021E-06	4.000E-02	1.401E-03
Rn-219	3.078E-11	6.144E-05	3.078E+01	Daughter	0.000E+00	Daughter	0.000E+00
Rn-220	2.808E-11	5.605E-05	2.808E+01	Daughter	0.000E+00	Daughter	0.000E+00
Rn-222	1.288E-10	2.570E-04	1.288E+02	Daughter	0.000E+00	Daughter	0.000E+00
Th-227	3.078E-11	6.144E-05	3.078E+01	1.000E-06	3.078E-05	1.000E-02	6.144E-03
Th-228	2.808E-11	5.605E-05	2.808E+01	4.000E-08	7.021E-04	4.000E-04	1.401E-01
Th-230	2.005E-09	4.002E-03	2.005E+03	2.000E-08	1.003E-01	2.000E-04	2.001E+01
Th-231	2.842E-12	5.671E-06	2.842E+00	Daughter	0.000E+00	Daughter	0.000E+00
Th-232	2.808E-11	5.605E-05	2.808E+01	Unlimited	0.000E+00	Unlimited	0.000E+00
Th-234	6.216E-11	1.241E-04	6.216E+01	2.000E-05	3.108E-06	2.000E-01	6.203E-04
Tl-207	3.078E-11	6.144E-05	3.078E+01	Daughter	0.000E+00	Daughter	0.000E+00
Tl-208	1.010E-11	2.016E-05	1.010E+01	Daughter	0.000E+00	Daughter	0.000E+00
U-234	6.216E-11	1.241E-04	6.216E+01	1.000E-07	6.216E-04	1.000E-03	1.241E-01
U-235	2.842E-12	5.671E-06	2.842E+00	Unlimited	0.000E+00	Unlimited	0.000E+00
U-238	6.216E-11	1.241E-04	6.216E+01	Unlimited	0.000E+00	Unlimited	0.000E+00
TOTALS			3.977E+03		1.224E-01		2.444E+01
RESULTS	RADIOACTIVE			LSA-II		>A2	

173.433 - A_2 values include contributions from daughter nuclides with half-lives less than 10 days:	
Parent	Daughter
Ac-227	Fr-223
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Bi-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m
U-235	Th-231

APPENDIX A-2
SILO 3 MATERIAL LSA DETERMINATION (HM-230, EFF. OCTOBER 1, 2004)

The table below represents the source term for the Silo 3 material, as well as the LSA classification and packaging determinations. On January 26, 2004 Research and Special Programs Administration (RSPA) issued a final rule [Docket No. RSPA-99-6283 (HM-230)] amending the requirements in the Hazardous Material Regulations (HMR) pertaining to the transportation of radioactive material. The purpose of this rulemaking initiative is to harmonize requirements of the HMR with international standards for radioactive materials as well as to disseminate other Department of Transportation (DOT)-initiated requirements. The mandatory compliance date is October 1, 2004. RSPA is authorizing a voluntary compliance date of February 25, 2004.

Column 1 identifies each radionuclide present in the Silo 3 material.

Columns 2 and 4 identify the activity concentration for each radionuclide in terabecquerels per gram (TBq/g) and becquerels per gram (Bq/g), respectively. Columns 3 and 5 identify the total activity of each radionuclide in terabecquerels (TBq) and becquerels (Bq), respectively. The values in Columns 3 and 5 were arrived at by taking the activity concentration per radionuclide multiplied by the net weight in grams of material.

The radionuclide specific limits shown in Columns 6 and 8 are prescribed by 49 CFR 173.436. 49 CFR 173.436 Footnote (b) specifies the progeny that have been taken into consideration when assigning the activity concentration and consignment limits of the parent. The table provides a list of these parent/progeny relationships included in Silo 3 material.

Column 7 contains the result of the unity calculation per nuclide for the activity concentration limit for exempt material (ACEM) and is derived by the following:
Column 4, "Activity Concentration (Bq/g)" divided by Column 6, "ACEM [Activity Concentration Limit for Exempt Material] (Bq/g)"

Column 9 contains the result of the unity calculation per nuclide for the activity limit for exempt consignment (ALEC) and is derived by the following:
Column 5, "Total Activity (Bq)" divided by Column 8, "ALEC [Activity Limit for Exempt Consignment] (Bq)"

If the sum of either column is less than or equal to 1, then the material is not regulated as Class 7 radioactive material. As demonstrated in the table, the sum of each unity calculation individually exceeds 1; therefore, the Silo 3 material meets the definition of Class 7 radioactive material.

Column 10 identifies the applicable LSA-I limit, which is 30 times the ACEM. Column 11 contains the result of the unity calculation per nuclide for LSA-I and is derived by the following:
Column 4, "Activity Concentration (Bq/g)" divided by Column 10, "LSA-I(1)(iv) 30x Activity Concentration Limit (Bq/g)"

If the sum of Column 11 exceeds 1, then the radioactive material cannot be shipped as LSA-I material. As shown in the table, the LSA-I unity calculation greatly exceeds 1; therefore, it does not meet the definition of LSA-I.

Column 14 identifies the A2 values prescribed by 49 CFR 173.435. 49 CFR 173.435, Footnote (a), indicates that certain A2 values already include the contributions from daughter nuclides with half-lives less than 10 days and considered to be in secular equilibrium with their parent nuclide. The table provides a list of these parent/daughter relationships included in Silo 3 material.

The definition of LSA-II solid material found at 173.403 *LSA material* requires that the activity is distributed throughout and the average specific activity of the material is less than 10^{-4} A_2/g. This limit is identified in Column 12. Column 13 contains the result of the unity calculation per nuclide for LSA-II and is derived by the following:
Column 2, "Activity Concentration (TBq/g)" divided by Column 12, "LSA-II (2)(ii) Limits 10^{-4} A2/g"

If the sum of Column13 exceeds 1, then the radioactive material cannot be shipped as LSA-II material. As shown in the table, the sum of the LSA-II unity calculation does not exceed 1; therefore, it can be classified and shipped as LSA-II material. At this point, it has been determined the Silo 3 material meets the DOT definitions of radioactive and LSA-II material.

Column 15 contains the result of the A2 unity calculation per nuclide and is derived by the following:
Column 3, "Total Activity (TBq)" divided by Column 14, "A2 Limits (TBq)"

If the sum of Column 15 exceeds 1, thereby exceeding an A2 quantity, the material cannot be shipped in an excepted package as permitted by 173.427(b)(4). As shown in the table, the sum of the A2 unity exceeds 1; therefore, the Silo 3 material must and will be packaged in a Type IP-2 packaging, subject to the limitations of Table 6, as required by 49 CFR 173.427 (b)(1). Per Table 5, the activity limit for the conveyance is unlimited for LSA-II Non-combustible Solids.

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Project: Silo 3 Transportation & Disposal Plan - Appendix A-2
Container: Non-Bulk IP-2 Bag
Weight/Unit: 4400 Lbs.
Net Weight: 4400.0 Lbs. Net Wt (Gms): 1,995,796.0

					49 CFR 173.436 [HM-230]				49 CFR 173.403 [HM-230]				49 CFR 173.435 [HM-230]	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Radionuclide	Activity Concentration (TBq/g)	Total Activity (TBq)	Activity Concentration (Bq/g)	Total Activity (Bq)	ACEM [Activity Concentration Limit for Exempt Material] (Bq/g)	ACEM Unity	ALEC [Activity Limit for Exempt Consignment] (Bq)	ALEC Unity	LSA-I (1)(iv) 30X Activity Concentration Limit (Bq/g)	LSA-I Unity	LSA-II (2)(ii) Limits 10^{-4} A2/g	LSA-II Unity	A2 Limits (TBq)	A2 Unity
Ac-227	3.078E-11	6.144E-05	3.078E+01	6.144E+07	1.000E-01	3.078E+02	1.000E+03	6.144E+04	3.000E+00	1.026E+01	9.000E-09	3.420E-03	9.000E-05	6.827E-01
Ac-228	2.808E-11	5.605E-05	2.808E+01	5.605E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-210	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-211	3.078E-11	6.144E-05	3.078E+01	6.144E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-212	2.808E-11	5.605E-05	2.808E+01	5.605E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-214	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Fr-223	4.255E-13	8.492E-07	4.255E-01	8.492E+05	1.000E+01	4.255E-02	1.000E+04	8.492E+01	3.000E+02	1.418E-03	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pa-231	3.078E-11	6.144E-05	3.078E+01	6.144E+07	1.000E+00	3.078E+01	1.000E+03	6.144E+04	3.000E+01	1.026E+00	4.000E-08	7.696E-04	4.000E-04	1.536E-01
Pa-234m	6.216E-11	1.241E-04	6.216E+01	1.241E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pb-210	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	5.000E-06	2.575E-05	5.000E-02	5.140E-03
Pb-211	3.078E-11	6.144E-05	3.078E+01	6.144E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pb-212	2.808E-11	5.605E-05	2.808E+01	5.605E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pb-214	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-210	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	2.000E-06	6.438E-05	2.000E-02	1.285E-02
Po-211	8.399E-14	1.676E-07	8.399E-02	1.676E+05	1.000E-01	8.399E-01	1.000E+03	1.676E+02	3.000E+00	2.800E-02	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-212	1.798E-11	3.589E-05	1.798E+01	3.589E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-214	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-215	3.078E-11	6.144E-05	3.078E+01	6.144E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-216	2.808E-11	5.605E-05	2.808E+01	5.605E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-218	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Ra-223	3.078E-11	6.144E-05	3.078E+01	6.144E+07	1.000E+02	3.078E-01	1.000E+05	6.144E+02	3.000E+03	1.026E-02	7.000E-07	4.398E-05	7.000E-03	8.777E-03
Ra-224	2.808E-11	5.605E-05	2.808E+01	5.605E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Ra-226	1.288E-10	2.570E-04	1.288E+02	2.570E+08	1.000E+01	1.288E+01	1.000E+04	2.570E+04	3.000E+02	4.292E-01	3.000E-07	4.292E-04	3.000E-03	8.566E-02
Ra-228	2.808E-11	5.605E-05	2.808E+01	5.605E+07	1.000E+01	2.808E+00	1.000E+05	5.605E+02	3.000E+02	9.361E-02	2.000E-06	1.404E-05	2.000E-02	2.802E-03
Rn-219	3.078E-11	6.144E-05	3.078E+01	6.144E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Rn-220	2.808E-11	5.605E-05	2.808E+01	5.605E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Rn-222	1.288E-10	2.570E-04	1.288E+02	2.570E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Th-227	3.078E-11	6.144E-05	3.078E+01	6.144E+07	1.000E+01	3.078E+00	1.000E+04	6.144E+03	3.000E+02	1.026E-01	5.000E-07	6.157E-05	5.000E-03	1.229E-02
Th-228	2.808E-11	5.605E-05	2.808E+01	5.605E+07	1.000E+00	2.808E+01	1.000E+04	5.605E+03	3.000E+01	9.361E-01	1.000E-07	2.808E-04	1.000E-03	5.605E-02
Th-230	2.005E-09	4.002E-03	2.005E+03	4.002E+09	1.000E+00	2.005E+03	1.000E+04	4.002E+05	3.000E+01	6.685E+01	1.000E-07	2.005E-02	1.000E-03	4.002E+00
Th-231	2.842E-12	5.671E-06	2.842E+00	5.671E+06	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Th-232	2.808E-11	5.605E-05	2.808E+01	5.605E+07	1.000E+01	2.808E+00	1.000E+04	5.605E+03	3.000E+02	9.361E-02	Unlimited	0.000E+00	Unlimited	0.000E+00
Th-234	6.216E-11	1.241E-04	6.216E+01	1.241E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	3.000E-05	2.072E-06	3.000E-01	4.135E-04
Tl-207	3.078E-11	6.144E-05	3.078E+01	6.144E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Tl-208	1.010E-11	2.016E-05	1.010E+01	2.016E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
U-234	6.216E-11	1.241E-04	6.216E+01	1.241E+08	1.000E+01	6.216E+00	1.000E+05	1.241E+03	3.000E+02	2.072E-01	6.000E-07	1.036E-04	6.000E-03	2.068E-02
U-235	2.842E-12	5.671E-06	2.842E+00	5.671E+06	1.000E+01	2.842E-01	1.000E+04	5.671E+02	3.000E+02	9.472E-03	Unlimited	0.000E+00	Unlimited	0.000E+00
U-238	6.216E-11	1.241E-04	6.216E+01	1.241E+08	1.000E+01	6.216E+00	1.000E+04	1.241E+04	3.000E+02	2.072E-01	Unlimited	0.000E+00	Unlimited	0.000E+00
TOTALS						2.406E+03		6.818E+05		8.025E+01		2.627E-02		6.043E+00
RESULTS					RADIOACTIVE ? (T/F): TRUE				Not LSA-I		LSA-II		>A2	

173.436, Footnote (b) - Parent nuclides and their progeny included in secular equilibrium are listed in the following:	
Parent	Progeny
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
U-235	Th-231
U238	Th-234, Pa-234m

173.435, Footnote (a) - A_2 values include contributions from daughter nuclides with half-lives less than 10 days.:	
Parent	Daughter
Ac-227	Fr-223
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Bi-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m
U-235	Th-231

APPENDIX B

TRANSPORTATION RISK EVALUATION FOR SILO 3 REMEDIAL ACTION

APPENDIX B
TRANSPORTATION RISK EVALUATION

As supporting backup for the Silo 3 Proposed Plan, this attachment provides an evaluation of the short-term radiological risks accompanying the transportation of Silo 3 material from the FCP to an off-site disposal facility.

OBJECTIVES AND APPROACH

The transportation risks were evaluated to permit a technical comparison of the proposed shipping routes for transporting Silo 3 material to the Nevada Test Site (NTS).

The radiological risks to the public and workers during transportation were calculated using the RADTRAN5 computer model and code developed by Sandia National Laboratories. RADTRAN5 estimates radiation doses to populations from routine (accident-free) transportation, dose risk from potential transportation accidents, and maximum exposed individual dose estimates. Calculation of accident-free population dose considers persons residing adjacent to the route, persons in vehicles sharing the route, and persons at stops. Potential dose risks are also calculated for populations that are downwind from hypothetical releases associated with accidents of varying severity. Dose risk from an accident includes the conditional probability of an accident of a particular severity. The population dose risk units are reported in person-rem.

To permit a fair comparison of the three proposed routes, the mode of transportation was assumed to be direct truck shipments from the FEMP to the NTS by either an ISO container or van–type truck shipment. For all the evaluations, this attachment provides a detailed discussion of the model input parameters, key assumptions, and the model outputs that in turn support the short-term risk assessment findings in the Proposed Plan.

KEY ASSUMPTIONS FOR THE MODEL

This section summarizes the model assumptions and inputs based on the Silo 3 final design concepts, coupled with regulatory-based and weight-based transportation requirements for safe waste transport.

It was assumed that the Silo 3 material would be loaded into soft-sided containers that are then placed into ISO containers or van-type trucks. For purposes of this model, it was assumed that seven soft-sided containers would be placed into the ISO container and that each truck shipment would consist of one ISO container . For direct truck shipment, it was assumed that eight soft-sided containers would be placed into a van-type truck. It should be noted that an ISO container may be able to hold eight soft-sided containers per shipment.

Based on the conditioned waste volume, the currently approved remedy will require an estimated 1910 soft-sided containers. With seven soft-sided containers per ISO container, 273 truck shipments will be required to transport the Silo 3 material to the NTS. With eight soft-sided containers per van-type truck, 239 truck shipments will be required to transport the Silo 3 material to the NTS.

Proposed Transportation Routes

Southern Route No. 1 to NTS. This truck route to NTS consists of traveling State Route (SR) 128 in Ohio to the Interstate (I)-74 interchange then heading west on I-74 to I-275 west/south to I-75 and I-71 south. Trucks would then travel south on I-71 to the I-64 interchange in Louisville, Kentucky. Trucks would then travel on I-64 through western Indiana and Illinois to the I-44 interchange in St. Louis, Missouri. Trucks would then continue on I-44 to the I-40 interchange in Oklahoma City, Oklahoma. Shipments would travel west on I-40 through Oklahoma, Texas, New Mexico and Arizona into Needles, California. Shipments would then proceed north on United States (US) 95 into Nevada, to west on Nevada State Route 164 to Nipton Road in California to I-15. Shipments would then proceed north on I-15 to west on Nevada State Route 160 to east on US95 to the NTS.

This route would pass through the following major cities: Louisville, Kentucky; St. Louis Missouri; Oklahoma City, Oklahoma; Tulsa, Oklahoma; Santa Fe, New Mexico, and the outskirts of Las Vegas, Nevada. Truck routes would use interstate bypasses, where such bypasses exist.

Southern Route No. 2 to NTS. This route would follow the same route as the Southern Route No. 1 to the NTS until the shipments reach I-15 in California. For the alternative route shipments would head southwest on I-15 to Baker, California then proceed north on California State Route 127 to Nevada State Route 373 to east on US 95 to the NTS. This route would pass through the same major cities as Southern Route No. 1 with the exception of Las Vegas. The alternative route would avoid the outskirts of Las Vegas.

Northern Route to NTS. The northern truck route to the NTS consists of traveling State Route (SR) 128 in Ohio to the I-74 interchange then heading northwest on I-74 to the I-70 interchange in Indianapolis, Indiana. Trucks would then travel on I-70 through western Indiana and Illinois to the I-270 bypass north of St. Louis, Missouri. Trucks would then continue on I-70 through Missouri, Kansas, and into Colorado. In Colorado, shipments would take I-70 to I-270, avoiding Denver, to west on I-76 to north on I-25 to the I-80 interchange just west of Lincoln, Nebraska. Trucks would then continue on I-80 west through Nebraska, Wyoming, Utah, into Nevada. In Nevada, trucks would continue on I-80 to south on Alternate US93 to US6 to Tonopah, Nevada. In Tonopah, shipments would take US95 to the NTS.

This route would pass through the following major cities: Indianapolis, Indiana; St. Louis Missouri; Kansas City, Missouri; St. Joseph, Missouri; Lincoln, Nebraska; Cheyenne, Wyoming; and Salt Lake City, Utah. Truck routes would use interstate bypasses, where such bypasses exist.

RISK EVALUATION – MODEL INPUTS

The US DOT requires carriers to utilize routes that minimize radiological risk when transporting radioactive material (DOT Class 7 hazardous material). When determining radiological risk, the DOT regulation 49 CFR Part 397.101(a)(2) requires the carrier to consider available information, such as, accident rates, population densities, and transit time.

RADTRAN5 relies on various parameters, which are defined by the user, for calculating dose. This information relates to the radioactive material, the package, the vehicle, and the route. It includes parameters for the number of shipments, the number of containers per shipment, the radionuclide content of the container, the radiation dose associated with the container, and the radiation dose associated with the shipment. Table 1 presents the user-defined package-specific and vehicle-specific parameters associated with the proposed transportation routes. Where possible, "standard" RADTRAN5 values for parameters were used if they were not specific to the radioactive material, package, vehicle, or route.

TABLE 1
PACKAGE-SPECIFIC AND VEHICLE-SPECIFIC PARAMETERS FOR RADTRAN5 ANALYSIS

PARAMETER	DIRECT TRUCK ISO CONTAINER	DIRECT TRUCK VAN
Number of Shipments	273	239
Number of Containers per Shipment	7	8
Characteristic Package Dimension (m)	2.42	2.42
Dose Rate 1 m from Vehicle (mrem/hr)	3.1	4.0
Characteristic Vehicle Dimension (m)	7.08	7.08
Number of Crew Members	2	2
Average Distance from Package to Crew Members (m)	4.9	4.9
Crew View Package Dimension (m)	3.56	3.56

Table 2 presents the radionuclide input parameters for RADTRAN5. For purposes of the modeling, the radionuclide chains were broken down into sub-chains of the main radionuclides: Ac-227, Pa-231, Pb210, Ra-226, Th-228, Th-230, U-235, and U-238. Table 3 then provides the radionuclide content per ISO container for both alternatives. As stated previously, it is assumed that seven - 3 yd^3 soft-sided containers are placed in a ISO container for flat-bed truck shipment and eight – 3 yd^3 soft-sided containers are placed in a van-type truck for direct truck shipment.

TABLE 2
RADIONUCLIDE PARAMETERS

Radionuclide	U-238	U-235	Th-232	Th-230	Ac-227	Ra-226	Pa-231	Pb-210
Half-life (days)	1.63E+12	2.57E+11	5.11E+12	2.81E+07	7.95E+03	5.84E+05	1.20E+07	8.14E+03
Photon Energy (meV/dis)	2.37E-02	2.69E-02	2.68E+00	1.55E-03	4.27E-01	1.72E+00	1.50E-02	4.81E-03
Cloud Shine DCF (rem-m³/Ci-sec)	3.17E-03	2.62E-02	4.18E-01	6.44E-05	5.41E-02	2.98E-01	4.70E-03	2.13E-04
Ground Shine DCF (rem-m²/Ci-sec)	9.56E-06	5.33E-05	7.27E-04	2.40E-07	1.24E-04	4.44E-04	1.30E-05	1.13E-06
CEDE Inhalation DCF (rem/Ci)	2.51E+08	1.23E+08	7.91E+08	2.85E+08	6.61E+08	1.40E+08	8.58E+08	2.30E+07
CEDE Inhalation DCF to gonads (rem/Ci)	1.92E+04	1.05E+04	3.03E+06	6.48E+05	4.22E+07	4.61E+06	1.13E+04	2.67E+06
One Year Lung DCF (rem/Ci)	1.25E+09	6.13E+08	3.29E+09	6.66E+08	1.42E+09	6.76E+08	1.66E+09	2.33E+06
One Year Marrow DCF (rem/Ci)	3.14E+05	1.59E+05	1.69E+08	1.55E+08	1.58E+08	2.84E+06	6.39E+08	9.22E+06

TABLE 3
RADIONUCLIDE CONTENTS FOR TRANSPORTATION OPTIONS

Radionuclide	Raw Material pCi/g	Curies per Truck	
		ISO Container	Van
Ac-227	925	1.19E-02	1.22E-02
Pa-231	627	8.06E-02	8.29E-02
Pb-210	3,480	4.48E-02	4.60E-02
Ra-226	3,870	4.98E-02	5.12E-02
Th-228	747	1.08E-02	1.11E-02
Th-230	60,200	7.74E-01	7.96E-01
U-235	117	2.29E-03	2.35E-03
U-238	1,780	1.50E-02	1.55E-02

RADTRAN5 requires data that expresses the likelihood of accidents of a given severity for urban, suburban, and rural population areas. These conditional probabilities are called "severity fractions" in RADTRAN, and there is an indexed "severity category" corresponding to each severity fraction. For each accident severity category, the user inputs data on the fraction of material that could be expected to be released from a container during an accident, the fraction of material released that can become airborne, and the fraction of airborne material that can become respirable. The accident release fractions for Silo 3 material is presented in Table 4. No credit was taken for any reduction in dispersability that may have resulted from the addition of additives to control

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dispersion. The airborne release fraction of 0.01 is the interim "bounding value" recommended for powders by the American Society of Mechanical Engineers (ASME) in their Peer Review of DOE-HDBK-3010-94 *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities.* The respirable fraction is the calculated mean fraction, of Silo 3 material, that has a particle size of less than 10 μm.

TABLE 4
ACCIDENT RELEASE FRACTIONS

Severity Category	Release Fraction	Airborne Fraction	Respirable Fraction
1	0.0	N/A	N/A
2	0.0	N/A	N/A
3	3.125E-02	1.0E-02	3.6E-01
4	6.25E-02	1.0E-02	3.6E-01
5	1.25E-01	1.0E-02	3.6E-01
6	2.50E-01	1.0E-02	3.6E-01
7	5.00E-01	1.0E-02	3.6E-01
8	1	1.0E-02	3.6E-01

RISK EVALUATION – MODEL RESULTS

As stated previously, RADTRAN5 estimates the dose-risk to the public resulting from accident-free transport of radiological material and dose-risk to populations that are downwind from hypothetical releases associated with accidents of varying severity.

Tables 5 and 6 present data on the estimated dose received by the maximally exposed individual and the cumulative dose received by the public resulting from accident-free transport of Silo 3 material, respectively. Table 6 also presents the estimated exposed population, which includes the population residing adjacent to the route, the population sharing the route, and the population at or near the rest stops.

TABLE 5
ESTIMATED DOSE TO MAXIMUM EXPOSED INDIVIDUAL (REM) –
ACCIDENT FREE TRANSPORT

Route	ISO CONTAINER	Van
Direct Truck to NTS	4.76E-05	5.37E-05

TABLE 6
ESTIMATED CUMULATIVE DOSE TO EXPOSED POPULATION – ACCIDENT FREE TRANSPORT

Route	ISO CONTAINER		Van	
	Dose (person-rem)	Population	Dose (person-rem)	Population
Southern Route No. 1	3.81	7.18E+05	4.34	7.18E+05
Southern Route No. 2	1.56	5.78E+05	1.75	5.78E+05
Northern Route	3.72	6.76E+05	4.30	6.76E+05

For determining the incremental lifetime cancer risk (ILCR), the cumulative dose was evenly distributed amongst the exposed population to provide an average dose per individual. This was determined to be a reasonably exposed individual for calculating the ILCR compared to using the maximum exposed individual. The maximum exposed individual assumes one person is standing in the same spot for all shipments and is exposed to all shipments without the benefit of shielding, even from a building. This is not a realistic scenario to expect during transportation of the Silo 3 material and is considered inconsistent with the intent of the definition of a reasonably exposed individual presented in the NCP. Therefore, the ILCR was calculated using an even distribution of the cumulative dose over the exposed population.

The risk from exposure to ionizing radiation is measured in latent cancer fatalities (LCF), which is the number of potential cancer fatalities estimated as a result of radiation exposure. An incremental lifetime cancer risk (ILCR) - the increased potential of an individual developing a cancer over a lifetime as a result of exposure - can be determined by comparing the potential number of cancers against the total exposed population. LCFs are calculated by Eq.1.

$LCF = H_E \bullet CRF$ (Eq. 1)

where,

H_E = collective effective dose equivalent for exposed population
LCF = latent cancer fatalities
CRF = cancer risk factor, LCF/person-rem

The cancer risk factor for members of the public is 5×10^{-4} per rem. These values are used in the RADTRAN5 computer model and are from the latest edition of ICRP-30.

Table 7 presents the estimated ILCRs calculated for the reasonably exposed individual resulting from the dose received during accident-free transportation. The dose to the reasonably exposed individual was calculated by evenly distributing the cumulative dose over the exposed population to derive an average dose.

TABLE 7
ILCR FOR REASONABLY EXPOSED MEMBER OF PUBLIC – ACCIDENT FREE TRANSPORT

Route	ISO CONTAINER		Van	
	Dose (person-rem)	ILCR	Dose (person-rem)	ILCR
Southern Route No. 1	5.31E-06	2.65E-09	6.04E-06	3.02E-09
Southern Route No. 2	2.70E-06	1.35E-09	3.03E-06	1.51E-09
Northern Route	5.50E-06	2.75E-09	6.36E-06	3.18E-09

RADTRAN5 also calculates the dose risk to the public based on exposure from a hypothetical accident. Dose risk from an accident includes the conditional probability of an accident of a particular severity. The population dose risk units are reported in person-rem. As with accident-free transportation, the resulting dose-risk is a cumulative dose over an exposed population. The cumulative dose is determined from the sum of the product of the probability of an accident occurring and the resulting dose to the public from the accident. As stated previously, there are eight classes of severity for accidents ranging from high probability, low consequence accidents (Severity Class 1) to low probability, high consequence accidents (Severity Class 8). Class 1 and 2 accidents do not result in any exposure to the public because the container remains intact. Classes 3 through 8 result in increased exposure do to the increased amount of material released from the package, which at a Severity Class 8 is a total loss of containment of all packages in the ISO container. Tables 8 through 13 present the estimated risk to the population resulting from a hypothetical accident for each treatment and transportation alternative. The tables present the probability of a specific severity category accident occurring, the dose-risk to the exposed population resulting from the accident, and the ILCR assuming an even distribution of dose across the exposed population.

TABLE 8
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT SOUTHERN ROUTE NO. 1 TO THE NTS VAN

Population Distribution
(Persons under the plume footprint for a single accident)

Suburban	3.17E+05
Rural	2.00E+04
Urban	2.48E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	9.08E-03	3.72E-02	1.72E-04	8.94E-01	5.65E-02	4.51E+00	1.41E-09	1.41E-09	9.08E-10
4	2.08E-03	8.52E-03	3.94E-05	4.63E-01	4.37E-01	9.01E+00	7.31E-10	1.09E-08	1.82E-09
5	2.73E-04	2.49E-03	4.60E-06	3.58E+00	2.27E-01	1.80E+01	5.64E-09	5.66E-09	3.63E-09
6	7.15E-05	1.37E-03	9.05E-07	7.16E+00	4.52E-01	3.60E+01	1.13E-08	1.13E-08	7.26E-09
7	2.76E-06	1.21E-04	7.00E-08	1.43E+01	9.01E-01	7.21E+01	2.26E-08	2.25E-08	1.45E-08
8	2.44E-07	2.39E-05	6.16E-09	2.86E+01	1.81E+00	1.44E+02	4.51E-08	4.52E-08	2.91E-08

TABLE 9
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT SOUTHERN ROUTE NO. 2 TO THE NTS VAN

Population Distribution
(Persons under the plume footprint for a single accident)

Suburban	3.79E+05
Rural	2.04E+04
Urban	2.52E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	7.01E-03	4.00E-03	1.52E-04	1.07E+00	5.73E-03	4.57E+00	1.41E-09	1.40E-10	9.07E-10
4	1.60E-03	9.16E-04	3.48E-05	2.14E+00	1.15E-01	9.17E+00	2.83E-09	2.81E-09	1.82E-09
5	2.11E-04	2.68E-04	4.06E-06	3.42E+01	1.84E+00	1.47E+02	4.51E-08	4.51E-08	2.91E-08
6	5.52E-05	1.47E-04	7.98E-07	8.55E+00	4.60E-01	3.67E+01	1.13E-08	1.13E-08	7.29E-09
7	2.13E-06	1.30E-05	6.18E-08	1.71E+01	9.15E-01	7.33E+01	2.26E-08	2.24E-08	1.45E-08
8	1.88E-07	2.57E-06	5.44E-09	3.43E+01	1.84E+00	1.47E+02	4.52E-08	4.50E-08	2.91E-08

TABLE 10
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT NORTHERN ROUTE TO THE NTS VAN

Population Distribution
(Persons under the plume footprint for a single accident)

Suburban	4.62E+05
Rural	1.19E+04
Urban	2.93E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	9.12E-03	3.99E-02	8.45E-05	1.30E+00	3.36E-02	5.33E+00	1.41E-09	1.41E-09	9.09E-10
4	2.09E-03	9.14E-03	1.93E-05	2.61E+00	6.75E-02	1.07E+01	2.82E-09	2.84E-09	1.82E-09
5	2.74E-04	2.68E-03	2.25E-06	5.22E+00	1.35E-01	2.14E+01	5.65E-09	5.66E-09	3.65E-09
6	7.18E-05	1.47E-03	4.44E-07	1.04E+01	2.69E-01	4.26E+01	1.13E-08	1.13E-08	7.26E-09
7	2.77E-06	1.30E-04	1.80E-08	2.09E+01	5.38E-01	8.56E+01	2.26E-08	2.26E-08	1.46E-08
8	2.45E-07	2.56E-05	3.02E-09	4.16E+01	1.08E+00	1.71E+02	4.51E-08	4.55E-08	2.92E-08

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TABLE 11
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT SOUTHERN ROUTE NO. 1 TO THE NTS ISO CONTAINER

Population Distribution
(Persons under the plume footprint for a single accident)

Suburban	3.17E+05
Rural	2.00E+04
Urban	2.48E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	1.04E-02	4.25E-02	1.97E-04	8.67E-01	5.48E-02	4.37E+00	1.37E-09	1.37E-09	8.81E-10
4	2.37E-03	9.73E-03	4.50E-05	1.75E+00	1.10E-01	6.56E+00	2.76E-09	2.75E-09	1.32E-09
5	3.12E-04	2.85E-03	5.23E-06	3.49E+00	2.20E-01	1.76E+01	5.51E-09	5.50E-09	3.55E-09
6	8.16E-05	1.56E-03	1.03E-06	6.97E+00	4.41E-01	3.51E+01	1.10E-08	1.10E-08	7.09E-09
7	3.15E-06	1.38E-04	8.00E-08	1.40E+01	8.77E-01	7.01E+01	2.20E-08	2.19E-08	1.41E-08
8	2.78E-07	2.73E-05	7.04E-09	2.79E+01	1.76E+00	1.40E+02	4.40E-08	4.40E-08	2.83E-08

TABLE 12
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT SOUTHERN ROUTE NO. 2 TO THE NTS ISO CONTAINER

Population Distribution
(Persons under the plume footprint for a single accident)

Suburban	3.79E+05
Rural	2.04E+04
Urban	2.52E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	8.01E-03	4.57E-03	1.74E-04	1.04E+00	5.58E-02	4.44E+00	1.37E-09	1.37E-09	8.81E-10
4	1.83E-03	1.05E-03	3.97E-05	2.08E+00	1.11E-01	8.92E+00	2.75E-09	2.73E-09	1.77E-09
5	2.41E-04	3.06E-04	4.64E-06	3.32E+01	1.79E+00	1.42E+02	4.38E-08	4.39E-08	2.83E-08
6	6.30E-05	1.68E-04	9.12E-07	8.33E+00	4.47E-01	3.56E+01	1.10E-08	1.10E-08	7.07E-09
7	2.43E-06	1.48E-05	7.06E-08	1.67E+01	8.92E-01	7.12E+01	2.20E-08	2.19E-08	1.41E-08
8	2.15E-07	2.93E-06	6.21E-09	3.33E+01	1.79E+00	1.43E+02	4.39E-08	4.38E-08	2.83E-08

TABLE 13
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT NORTHERN ROUTE TO THE NTS ISO CONTAINER

Population Distribution
(Persons under the plume footprint for a single accident)

Suburban	5.44E+05
Rural	1.04E+04
Urban	3.26E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	1.04E-02	4.56E-02	9.65E-05	1.27E+00	3.27E-02	5.18E+00	1.37E-09	1.37E-09	8.84E-10
4	2.39E-03	1.04E-02	2.21E-05	2.54E+00	6.59E-02	1.04E+01	2.74E-09	2.77E-09	1.77E-09
5	3.13E-04	3.06E-03	2.58E-06	5.08E+00	1.31E-01	2.07E+01	5.50E-09	5.51E-09	3.54E-09
6	8.20E-05	1.68E-03	5.07E-07	1.02E+01	2.62E-01	4.14E+01	1.10E-08	1.10E-08	7.07E-09
7	3.17E-06	1.48E-04	2.06E-08	2.03E+01	5.24E-01	8.30E+01	2.20E-08	2.20E-08	1.42E-08
8	2.80E-07	2.93E-05	3.45E-09	4.07E+01	1.05E+00	1.66E+02	4.41E-08	4.40E-08	2.83E-08

For the hypothetical accident scenario, the highest ILCR to the reasonably maximum exposed individual occurs as a result of a Severity Category 8 accident. The highest ILCR resulting from a Severity Category 8 accident occurs in rural and suburban areas for each proposed route and shipping option. For shipping Silo 3 material by ISO container, the highest ILCR is estimated to be 4.41E-08. For shipping Silo 3 material by van-type truck, the highest ILCR is estimated to be 4.55E-08.

For each accident severity category, RADTRAN5 also calculates the maximum individual downwind doses at the mean downwind centerline distance for each isopleth. The individual doses calculated are a sum of the cloudshine, inhalation, and groundshine exposure pathways. The calculated values can be used to determine whether Federal exposure guidelines might be exceeded and, if so, at what distances from the accident site. The DOE limits for annual exposure are a total effective dose equivalent for an occupational worker of 5 rem and 0.1 rem for occupational workers who are minors and members of the public. These limits are typically applied to routine operations at DOE facilities and not to accidents.

In addition, RADTRAN5 is typically used only to estimate dose to members of the public during an accident and not to hazardous material responders. The accident-scenario dose levels calculated by RADTRAN5 for members of the public assume that evacuation requires 24 hours. These same 24-hour dose levels can be applied to first responders wearing no personal protective equipment, or can be interpolated based on a reasonable time of exposure to first responders before they don the appropriate protective equipment. Based on the doses calculated by RADTRAN5, there would not be any exposures resulting from an accident involving shipment of Silo 3 material by either van or ISO container that would exceed Federal exposure limits for occupational workers.

Assuming a 24-hour exposure without any personal protective equipment, an occupational worker, or first responder would be exposed to 100% of the external dose associated with the released material and be exposed to 100% of the respirable material released. It must be recognized that although the very conservative assumptions described here assume a 24-hour exposure without any personal protective equipment, first responders are trained to assure that the proper protective equipment is in place prior to approaching an accident scene, and to immediately establish controlled access to the accident to prevent access by workers and members of the public without protective equipment. Further, the actual likelihood that a 24-hour period would be required for a member of the public to be evacuated from the accident site is extremely small.

For shipments of Silo 3 material, occupational workers who are minors and members of the public could receive a 24-hour dose in excess of Federal exposure limits as a result of accidents involving van-type truck shipments if within 33 meters (108 feet) for Severity Class 3, 68 meters (223 feet) for Severity Classes 4 and 5, 105 meters (345 feet) for Severity Class 6, 244 meters (801 feet) for Severity Class 7, and 369 meters (1211 feet) for Severity Class 8. Occupational workers who are minors and members of the public also could receive a 24-hour dose in excess of Federal exposure limits as a result of accidents involving ISO container truck shipments if within 33 meters (108 feet) for Severity Class 4, 68 meters (223 feet) for Severity Class 5, 105 meters (345 feet) for

Severity Class 6, 244 meters (801 feet) for Severity Class 7, and 369 meters (1211 feet) for Severity Class 8. Tables 14 and 15 present the maximum individual 24-hour doses resulting from Severity Category 3 and higher accidents calculated by RADTRAN5 for van-type truck shipments and ISO container truck shipments. Severity Categories 1 and 2 are not included because they do not result in a release of any material or any dose exposures. For truck shipments the dose to the maximum exposed individual would be the same regardless of location of the accident, rural, suburban, or urban setting, and regardless the proposed transportation route to the NTS. Because there are seven soft-sided containers per ISO container compared to eight per van, there is a slight difference in the 24-hour dose received by the maximum exposed individual between the two modes of transport.

TABLE 14
MAXIMUM INDIVIDUAL 24-HOUR DOSE – HYPOTHETICAL ACCIDENT
EIGHT CONTAINERS IN A VAN

Centerline (meters)	Severity Category 3	Severity Category 4	Severity Category 5	Severity Category 6	Severity Category 7	Severity Category 8
33	1.01E-01	2.02E-01	4.04E-01	8.08E-01	1.62E+00	3.23E+00
68	5.07E-02	1.01E-01	2.03E-01	4.06E-01	8.12E-01	1.62E+00
105	2.46E-02	4.93E-02	9.86E-02	1.97E-01	3.94E-01	7.89E-01
244	9.52E-03	1.91E-02	3.81E-02	7.63E-02	1.53E-01	3.05E-01
369	4.57E-03	9.15E-03	1.83E-02	3.66E-02	7.32E-02	1.46E-01
561	2.18E-03	4.36E-03	8.72E-03	1.74E-02	3.49E-02	6.97E-02
1020	8.26E-04	1.65E-03	3.31E-03	6.62E-03	1.32E-02	2.65E-02
1630	3.91E-04	7.83E-04	1.57E-03	3.13E-03	6.26E-03	1.25E-02
2310	1.82E-04	3.64E-04	7.29E-04	1.46E-03	2.91E-03	5.83E-03
4270	6.87E-05	1.38E-04	2.75E-04	5.50E-04	1.10E-03	2.20E-03
5470	3.13E-05	6.27E-05	1.25E-04	2.51E-04	5.02E-04	1.00E-03
11100	1.49E-05	2.98E-05	5.95E-05	1.19E-04	2.38E-04	4.76E-04
13100	5.49E-06	1.10E-05	2.20E-05	4.40E-05	8.80E-05	1.76E-04
21300	2.59E-06	5.19E-06	1.04E-05	2.07E-05	4.15E-05	8.30E-05
40500	1.18E-06	2.37E-06	4.74E-06	9.47E-06	1.89E-05	3.79E-05
70000	6.31E-07	1.27E-06	2.53E-06	5.06E-06	1.01E-05	2.02E-05
89900	3.85E-07	7.72E-07	1.54E-06	3.09E-06	6.17E-06	1.23E-05
121000	2.52E-07	5.05E-07	1.01E-06	2.02E-06	4.04E-06	8.07E-06

TABLE 15
MAXIMUM INDIVIDUAL 24-HOUR DOSE – HYPOTHETICAL ACCIDENT
SEVEN CONTAINERS IN A ISO CONTAINER

Centerline (meters)	Severity Category 3	Severity Category 4	Severity Category 5	Severity Category 6	Severity Category 7	Severity Category 8
33	9.81E-02	1.97E-01	3.93E-01	7.86E-01	1.57E+00	3.14E+00
68	4.93E-02	9.87E-02	1.97E-01	3.95E-01	7.89E-01	1.58E+00
105	2.39E-02	4.79E-02	9.59E-02	1.92E-01	3.84E-01	7.67E-01
244	9.26E-03	1.85E-02	3.71E-02	7.42E-02	1.48E-01	2.97E-01
369	4.44E-03	8.89E-03	1.78E-02	3.56E-02	7.12E-02	1.42E-01
561	2.12E-03	4.24E-03	8.48E-03	1.70E-02	3.39E-02	6.78E-02
1020	8.03E-04	1.61E-03	3.22E-03	6.44E-03	1.29E-02	2.57E-02
1630	3.80E-04	7.61E-04	1.52E-03	3.05E-03	6.09E-03	1.22E-02
2310	1.77E-04	3.54E-04	7.09E-04	1.42E-03	2.83E-03	5.57E-03
4270	6.68E-05	1.34E-04	2.68E-04	5.35E-04	1.07E-03	2.14E-03
5470	3.04E-05	6.10E-05	1.22E-04	2.44E-04	4.88E-04	9.76E-04
11100	1.44E-05	2.89E-05	5.79E-05	1.16E-04	2.32E-04	4.63E-04
13100	5.34E-06	1.07E-05	2.14E-05	4.28E-05	8.56E-05	1.71E-04
21300	2.52E-06	5.04E-06	1.01E-05	2.02E-05	4.03E-05	8.07E-05
40500	1.15E-06	2.30E-06	4.61E-06	9.21E-06	1.84E-05	3.69E-05
70000	6.14E-07	1.23E-06	2.46E-06	4.92E-06	9.84E-06	1.97E-05
89900	3.75E-07	7.50E-07	1.50E-06	3.00E-06	6.00E-06	1.20E-05
121000	2.45E-07	4.91E-07	9.82E-06	1.96E-06	3.93E-06	7.85E-06

FINDINGS AND CONCLUSIONS

The short-term transportation risk evaluation produced the following findings and conclusions:

- Both transportation alternatives meet the 1 x 10^{-6} ILCR threshold condition established by the Silo 3 ROD OU4 for both accident-free and hypothetical accidents for all proposed transportation routes.
- Although both alternatives meet the 1 x 10^{-6} threshold established by the Silo 3 ROD OU4 there is a slight increase in risk with the van-type shipments. This is due to the increased amount of material in the van that could be released during an accident resulting in greater exposure. The differences in radiological risk between the two modes -- even with this conservative approach -- are considered inconsequential, since both meet the 1 x 10^{-6} acceptance target.
- There is no significant difference in risk between shipping seven soft-sided containers and eight soft-sided containers per shipment by either ISO container or van.

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