Removing the Source Term – Thorium Nitrate Disposal at the Nevada Test Site

W. H. Hermes
Oak Ridge National Laboratory*
P.O. Box 2008; Oak Ridge, TN 37831-6153
Tel: (865) 574-9568; Fax: (865) 574-0382
E-mail: **hermeswh@ornl.gov**

Health Physics Society
2007 Midyear Topical Meeting
Decontamination, Decommissioning, and Environmental Cleanup
January 21–24, 2006
Knoxville, Tennessee

---

*Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.

Removing the Source Term —Thorium Nitrate Disposal at the Nevada Test Site

W. H. Hermes and J. W. Terry, Oak Ridge National Laboratory

Abstract

The combined efforts of several federal agencies resulted in the successful retirement of more than seven million pounds of thorium nitrate, a low-level radioactive source material, from three original sources and contained in over 21,000 drums. Thorium nitrate was originally acquired during the period 1957 to 1964 by the Department of Energy's (DOE's) predecessor agency, the Atomic Energy Commission, and later retained by the National Defense Stockpile. Project cooperating agencies included the Department of Energy, Oak Ridge National Laboratory, National Nuclear Security Administration, Nuclear Regulatory Commission, and the Defense Logistics Agency/Defense National Stockpile Center. Chemical conversion was avoided by special characterization testing, which saved tens of millions of dollars. This paper presents a general summary of the project steps and accomplishments and the execution of the thorium nitrate source term handling and removal from the Defense National Stockpile Center (DNSC) depots (primarily Phase 3 of a 4-phase program). At the onset of the project, the DNSC managed the thorium nitrate inventory at two of their depots—approximately five million pounds at Curtis Bay, Maryland, and another two million pounds at Hammond, Indiana. The Phase 3 portion of the project culminated in eleven months of cross country shipments of three to four days duration to the Frenchman Flats area of DOE's site in the Nevada desert; a remote facility slightly larger than the state of Rhode Island, where the containers were placed in specially designated pits and buried under ~21 ft of top cover. This paper emphasizes how radiological requirements were defined, met, and optimized during this project.

Key Words: source term, thorium nitrate, NTS, Nevada Test Site

Introduction

Oak Ridge National Laboratory (ORNL), operated by UT Battelle, LLC, executed the disposition of about 3.2 million kg (7 million lb) of hydrated thorium nitrate for the Defense Logistics Agency (DLA)/Defense National Stockpile Center (DNSC). The thorium nitrate was stored in more than 21,000 drums, located in four warehouses near two large population centers in the eastern United States (Curtis Bay, Maryland, near Baltimore; and Hammond, Indiana, near Chicago). Following its production, the thorium nitrate had been in the custody of the DLA/DNSC and predecessor government agencies for decades under strict accountability rules. The stockpile was licensed as source material by the Nuclear Regulatory Commission (NRC) and was never in contact with or near a nuclear reactor, which would have permitted the formation of reactor products such as transuranics.

To satisfy the programmatic requirements of DNSC, the thorium nitrate hydrate source material was transported to the Nevada Test Site (NTS) where the U. S. Department of Energy (DOE) assumed possession and disposed of it. NTS is located in the Nevada desert and is slightly larger than the state of Rhode Island. In an earlier phase of this project, disposition of the thorium nitrate without treatment was determined to be preferable to all other alternatives (i.e., long-term storage without treatment, long-term storage with treatment, and disposal with treatment). The option assessment phase is documented in ORNL/TM-2001/14 (Hermes, Terry, et al. 2001). Following detailed analysis, the cost for treating the thorium nitrate was estimated to be in excess of $60M.

After the disposition path was determined, chemical and physical characterizations were performed to demonstrate that the thorium nitrate would meet the NTS waste acceptance criteria (WAC). Both trucks and trains were considered as the cross-country conveyances. Controlling the load and monitoring its location during truck transport outweighed any reductions in costs or risks that could be attributed to rail transport. Truck transport required 3–4 days from the storage depot to NTS.

General Considerations

The existing drums would not meet quality requirements for radiological transport. The preferred transport configuration was a 20-ft cargo container, and the thorium nitrate payload load plan maximized the permissible number of drums loaded into the container and hauled on a flatbed trailer. The cargo container was utilized as the waste package, eliminating the need for drum-handling operations at NTS. Handling the drums would increase the dose to NTS workers and trigger follow-on contamination surveys needed for release of the cargo container from NTS after its content was delivered. New cargo containers were used, which had to pass three documented inspections and meet all quality requirements.

The process complied with U. S. Department of Transportation (DOT) regulations and met objectives for achieving optimal compliance with the as low as reasonably achievable (ALARA) principle, for throughput and costs, and for strict compliance with the NTS WAC and NRC requirements.

The thorium nitrate source material was processed into its present chemical form over 40 years ago, and three ore bodies were utilized with varying thorium-uranium elemental ratios. The countries that produced the stockpile to meet the Atomic Energy Commission (AEC) requirements were the United States, France, and India. Chemical processing to produce the thorium nitrate was performed over a 7-year period from 1957–1964. Because of this history, the ingrowth of daughter products made variable increases to the gamma-ray dose rate from each drum. Without optimization, the cargo containers of DNSC's thorium nitrate transported over the highways would be dose-rate limited rather than weight limited.

Isotopic Activity and Packaging

For the purposes of documenting isotopic activity ranges and final waste form activities associated with the thorium nitrate, several assumptions were made to allow independent review and provide justification for development of radiological parameters cited on the NTS waste profile.

The thorium nitrate stockpile was created in the United States (Hammond and Curtis Bay) from three different monazite sand ore body feed stocks. The final storage configuration involved numerous drum types, the result of over-packing campaigns that were required because of the failure of the original packaging materials. The packaging material failure mode and detailed drum and inventory descriptions are documented in ORNL/TM-2000/163 (Hermes, Terry, et al. 2000) and ORNL/TM-2003/53 (Hylton, Hermes, Terry, et al. 2003). The drum configurations with the approximate number per drum type are provided in Table 1, with example photos of each type shown in Fig. 1.

The thorium nitrate drums were packaged into cargo containers, and the wooden pallets upon which the drums were stored in the warehouses were used in part as material for blocking and bracing. Different loading configurations were studied to maximize the number of drums per cargo container; the configurations depended on the origin of the thorium nitrate material and the drum size in which it was stored. An example load plan schematic is shown in Fig. 2, and loaded drums and the maximum payload per shipment are shown in Fig. 3.

Because each cargo container had the potential to have drums from different origins and different lots, a conservative approach was used to calculate the activities to ensure compliance with DOT regulations and NTS WAC requirements. The highest specific activity found in a given lot of material, as determined by characterization/radiological analyses, was used to determine the activity for each drum of a specific type. The activity of the cargo was then the sum of the calculated activity for the individual drums. Accordingly, the calculated activity for the cargo was always a conservative bounding number. Activity-basis values were derived and calculated for each element (e.g., drum, pallet) that entered a cargo container. These basis values were used in the NTS WAC package storage and disposal request (PSDR) to calculate the activity concentration and plutonium-equivalent grams of the cargo for shipment of the thorium nitrate to NTS. The weight of natural uranium and thorium was a required parameter. Table 2 contains the data that was needed for calculations to ensure there were no exceedences.

Special effort was required to efficiently manage on-site handling that was specific to the need for mixing foreign and domestic drums to meet the DOT dose restrictions, including a maximum 10 mR/hr dose rate at 2 m from the package. The primary cause of higher dose rates was specifically identified to be the natural ore used for the French source-material production. This ore had the highest ^{238}U content, resulting in the highest ^{230}Th concentration. Use of external dose modeling techniques was somewhat effective. Data obtained from 2-m measurements made on the loaded cargo containers with use of ion chambers was utilized to optimize the load plans.

Summary of Confirmatory Sampling of Thorium Nitrate

To facilitate disposal of the thorium nitrate stockpile at NTS, a confirmatory sampling was conducted. Typical descriptive information is given in Fig. 4. The available analytical results from the 1960s did not include many of the parameters required by the waste profile. Therefore, during the sampling and analysis campaigns of 2001 and 2002, gamma and alpha spectrometry data were obtained for radiological characterization. The results were compiled and analyzed in ORNL/TM-2003/54 (Mattus, Hermes, and Terry 2003). Results were obtained for alpha and gamma spectrometry as well as the associated minimum detectable activities (MDAs). The laboratory reported the results in pCi/g of material. In order to compare these numbers with those found in Table E.1 of NTS WAC (2003), each was converted from pCi/g to Bq/m^3. In this calculation, the bulk density (1.887 g/cm^3), as measured by Southwest Research Institute (SWRI), was used. The analytical requirements were defined in harmony with NTS to optimize the use of the NTS radioactive waste burial area performance assessment model(s) during the evolution of the NTS probabilistic performance assessment model.

Nuclides of Concern—Process Knowledge

The thorium nitrate stockpile was a source material that was manufactured for the U.S. government and stored by the government since 1957. The thorium nitrate material was produced predominantly to be nuclear-grade material (over 90% of stockpile), and it had to meet stringent purity criteria. The Indian source was of a grade suitable for gas mantle production. The entire stockpile was processed from monazite sands, which are minerals made of phosphates of rare earths and thorium. The ores typically contain 50–58 wt % rare earths and 4–8 wt % thorium, all in the forms of oxides (Hermes, Terry, et al. 2000). The predominant thorium isotope is ^{232}Th with a relative abundance of nearly 100%. From historical data, it was known that the French thorium nitrate contained the highest concentration of uranium because monazite ore from the Malagasy Republic is richer in uranium than average monazite sands found elsewhere in the world. Emission of ^{222}Rn (progeny of ^{230}Th and ^{238}U) is a constraint on waste burial at NTS. The potential emissions from the thorium nitrate stockpile were modeled deterministically in ORNL/TM-2003/52 (Terry and Hermes 2003).

Resource Conservation and Recovery Act Limits

Thorium nitrate was listed as an oxidizer in the DOT hazardous materials transport table. As an oxidizer, thorium nitrate would be a Resource Conservation and Recovery Act (RCRA) hazardous waste exhibiting the characteristic of ignitability and not suitable for disposal at NTS. All lots were sampled and analyzed for RCRA metals and determined to be well below regulatory limits. Using methods specified by DOT and accepted by the U.S. Environmental Protection Agency, ORNL took samples of each lot, and SWRI conducted laboratory tests of each lot of thorium nitrate to determine whether it was an oxidizer. The thorium nitrate was determined not to be an oxidizer; it did not possess the ignitability characteristic.

Dealing with Pressurized Drums

NTS would not accept pressurized drums (NTS WAC 2003) and originally specified that all potentially pressurized drums must be vented. The gas of concern was CO_2, for which theoretical assessment and chemical analysis had determined to potentially be present in the drums. The drum headspace pressure was required to be <1.5 atmospheres (absolute) at 20°C upon receipt of shipment at NTS. A method was developed to quantify pressure within the drums, and compliance was demonstrated for two problematic drum types: 30- and 55-gallon drums at Curtis Bay Depot that contained material of domestic origin. Program technical documentation had to be maintained by ORNL (i.e., UT-Battelle, LLC, as the shipper/certifier) to assure only drums in compliance with this requirement were shipped throughout the entire program.

Drumhead deflection was utilized to quantify the pressure inside the drums of concern. This test method minimized dose to the workers and complied with Occupational Safety and Health Act (OSHA) requirements. Stainless steel inspection tools were designed to measure drumhead deflection. This flat tool was placed on top of the drumhead. If any surface of the tool touched the lid (see Fig. 5), then the drum had to be vented and the escaping gas filtered using a high-efficiency particulate absolute (HEPA) filter. Special drum handling, inspection, venting, HEPA filtering, and data acquisition were completed in a specially designed inspection chamber located outside the warehouses and away from any significant radiation field. The drum lids were tightened prior to venting. The defined methodology for the drumhead deflection basis was traced back to test data obtained at ORNL and documented and approved to meet the WAC criteria. The field implementation was accomplished in concert with meeting ALARA. Physical protection was always used to separate the operator from a potential venting occurrence. Over 16,000 drums had to be handled and inspected, with ~12% requiring venting. The added dose due to the extra handling and operator contact associated with the venting operation was about 1mR per drum, so a savings of ~14 R was achieved by applying this individual drum assessment method rather than venting each drum.

Other ALARA Operational Considerations

The drum-packed Curtis Bay Depot buildings were found to have roughly 60 mR/hr area dose rates. The dose rates within the stacked drums approached 100 mR/hr. Temporary shielding was used both inside and outside the warehouses to minimize dose. Platooning and cross training were implemented to minimize the dose to the forklift operators. In addition to the external dose, the potential existed for internal dose from inhaling loose contamination. Loose contamination was present at the Curtis Bay Depot in two buildings on limited floor, pallet, and drum surface areas. This contamination came from domestic thorium nitrate and was removed as soon as possible. Continuous airborne monitoring was conducted.

Accountability and Records

To satisfy NRC requirements, source material accountability had to be ensured. The accountability requirements evolved to controlling load configurations and entering the designated information into a data acquisition system that recorded package number, drum type, drum number, lot number, material origin, building location, and a digital photo of each drum. Odd drums or containers that were not fully identified were segregated and characterized at the end of the routine loading campaign. Each lot of material was considered a separate mass balance, with the result that all source material was accounted for. The original estimate for cargo container requirements was 266; experience verified these calculations. Records exist to identify the contents of each of these 266 packages, including the number of bags of personal protective equipment, wooden pallets, over 21,000 drums, and the internal arrangement of each cargo container. Figure 6 shows an example of three French lots that were sampled and recorded during the early characterization phases. The number of records in ORNL's electronic records system for this project exceeds 25,000, including those required for characterization, accountability, operating procedures, NTS certification, loading, maintenance of quality requirements, package certification, and transport.

Fig. 7 shows an example bill of lading for a shipment of thorium nitrate to NTS. The bill of lading defines the material shipped as LSA-1 with a primary DOT hazard class of 7 (radioactive) and a secondary DOT hazard class of 8 (corrosive). The package number code (THC195) is derived from TH (thorium nitrate), C (Curtis Bay), and 195 (195^{th} cargo container). Similarly, the shipment number code (THL05195) is derived from TH (thorium nitrate), L (low-level material), 05 (year shipped), and 195 (195^{th} cargo container). The photo in Fig. 8 shows an example of blocking and bracing for a mixed load. The individual drums and pallets of drums are blocked and braced within the cargo container to substantially reduce the potential for large movements during normal transportation events such as starting, stopping, going around curves, and opening the cargo container doors.

The tie-down design was done in conjunction with finite element analysis calculations to ensure that a conservative force balance was present for all design conditions. Figure 9 depicts the finished package-trailer tie-down arrangement. QUALCOM tracked shipments en route, and ORNL managed emergency response and routine telephone contact.

Operational Considerations

Routine operations were well planned and executed (see Fig. 10), but some rather large uncertainties warranted concern. The concerns with the greatest potential for impacting operations were typically associated with unexpected events, such as bad weather, or with occurrences that could not be enumerated in advance, such as the number of drums that had to be vented each day. These concerns applied only to operations at Curtis Bay. Operations at Hammond were conducted during the summer, and there were no pressurized drums at Hammond.

Snowfall had the potential to derail operations for several days (see Fig. 11). Fortunately, no spectacular snowfalls occurred during loading operations at Curtis Bay. The only times when snowfall exceeded 1 inch occurred during weekends. Judicious application of deicers and traction-enhancing materials allowed outdoor operations to continue. Wind and rain, however, had more of an impact on operations productivity.

Figure 12 shows a plot of the number of drums vented versus the number of drums loaded for the first 48 days of operations. This is clearly an example of the classic scatter plot. The correlation coefficient was computed to be less than 0.25. This chart presents data from an evaluation of the loading rate as a function of the number of drums needing to be vented. Over the remaining 8 months of this 11-month project, loading performance increased with operations experience and load plan maturity.

The 1000-yr performance assessment by NTS dictated the need for an extra 5 ft of cover to be applied to the material because of the long-term ^{222}Rn emanation and effects; the total depth of cover was calculated to be 21 ft. These calculations resulted in the need to build dedicated trenches in the Area 5 Radioactive Waste Management Site (Frenchman Flats area) for the thorium nitrate disposal; the general scheme is depicted in Fig. 13.

Key Milestones, Accomplishments, and Participating Agencies and Organizations

Key milestones and accomplishments are provided in Fig. 14. An overview of the schedule and teaming arrangements are in Figs. 15 and 16. With the accountable source term eliminated, Phase 4, decommissioning and disposal (D&D), activities are in process and compatible with the present co-occupants of Curtis Bay Depot (Fig. 17).

Phase 4 - Decommissioning and Disposal

Phase 4 (D&D) is under way, and the DNSC is in the process of cleaning up low-activity radioactive contamination at both facilities: Curtis Bay Depot, Curtis Bay, Maryland and Hammond Depot, Hammond, Indiana. These facilities were previously used for storing commodities regulated as source material (as defined at 10 CFR 40.4) by the NRC. All of the stockpiles of commodities containing source material have been removed from the Curtis Bay and Hammond Depots. At the Curtis Bay Depot, the commodities containing source material (columbium/tantalum, thorium nitrate, tungsten ore and concentrates, thorium hydroxide, thorium oxide, monazite sand, uranium pitchblende ore, and sodium sulfate) were previously stored in 16 of the original 59 warehouses. Since the mid 1980s, over 19,000 drums of thorium nitrate were stored in three warehouses. Previously, the thorium nitrate stockpile was stored for short periods in six other warehouses on the site. At the Hammond Depot, the commodities containing source material (columbium/tantalum, thorium nitrate, monazite sands, sodium sulfate, and tungsten ore and concentrates) were previously stored in two of the three warehouses on the site. Cleanup of any residual contamination from storage, handling, repackaging and rewarehousing of the commodities containing source material is one task DNSC must complete before the depots can be closed.

References

Hermes WH, Terry JW, et al., Executive Summary Report for the Thorium Nitrate Stockpile Stewardship and Disposition Project, Oak Ridge National Laboratory, ORNL/TM-2001/14, 2001.

Hermes WH, Terry JW, et al., Thorium Nitrate Material Inventory Definition Report, Oak Ridge National Laboratory, ORNL/TM-2000/163, 2000.

Hylton TD, Hermes WH, Terry JW, et al., Thorium Nitrate Stockpile Drum Characterization Report, Oak Ridge National Laboratory, ORNL/TM-2003/53, 2003.

Mattus CH, Hermes WH, and Terry JW, Analytical Characterization of the Thorium Nitrate Stockpile, Oak Ridge National Laboratory, ORNL/TM-2003/54, 2003.

Nevada Test Site Waste Acceptance Criteria (NTS WAC), DOE/NV-325 Rev. 5, prepared by U.S. Department of Energy, National Nuclear Security Administration, Nevada Site Office, Waste Management Division, Las Vegas, Nev., 2003.

Terry JW and Hermes WH, Potential Radon Emissions from the Thorium Nitrate Stockpile, Oak Ridge National Laboratory, ORNL/TM-2003/52, 2003.

Table 1. Summary of drum packing configurations for thorium nitrate

Drum designation	Number of drums	Typical thorium nitrate weight per container (lb)	Typical container weight (lb)	Estimated total thorium nitrate weight (lb)	Estimated total container weight (lb)
MD-1	15,682	200	272	3,136,000	4,266,000
MD-2 French	1,868	726	791	1,356,000	1,478,000
MD-2 Indian	727	633	672	460,000	489,000
MD-3	184	200	312	37,000	57,000
MD-4	753	200	212	151,000	160,000
MD-5 French	33	726	941	24,000	31,000
MD-5 Indian	33	633	721	21,000	24,000
IN-1	2,308	825	1,008	1,904,000	2,326,000
TOTAL	21,588			7,089,000	8,831,000

Table 2. Activity values to meet U.S. Department of Transportation regulations

	CB Domestic	CB French	CB Indian	CB Pallets	CB PPE	HMD Domestic	HMD Pallets	HMD PPE
Total Activity (Bq)	1.87E+08	1.18E+09	6.91E+08	1.12E+07	7.77E+06	7.49E+08	1.12E+07	7.77E+06
Th-232 (Bq)	1.67E+08	5.54E+08	5.88E+08	1.00E+07	6.95E+06	6.79E+08	1.00E+07	6.95E+06
Th-230 (Bq)	1.67E+07	6.07E+08	9.24E+07	1.00E+06	6.95E+05	6.19E+07	1.00E+06	6.95E+05
Ra-226 (Bq)	2.93E+06	1.67E+07	1.03E+07	1.76E+05	1.29E+05	7.83E+06	1.76E+05	1.29E+05
U (natural)	1.29E+03	1.67E+05	4.39E+03	0.00E+00	0.00E+00	1.95+03	0.00E+00	0.00E+00
Waste Volume (m^3)	0.048	0.174	0.173	0.003	0.002	0.198	0.003	0.002
Waste Weight (kg)	90.72	329.31	327.04	5.44	3.99	374.21	5.44	3.99
Waste weight (lbs)	200	726	721	12	8.8	825	12	8.8
Total activity sum of isotopes	1.87E+08	1.18E+09	6.91E+08	1.12E+07	7.77E+06	7.49E+08	1.12E+07	7.77E+06

Figure Captions

Fig. 1. Various drum types used at the Curtis Bay and Hammond sites.

Fig. 2. Typical load plan of foreign and domestic drum mixes.

Fig. 3. Loaded drums and the maximum pounds per load.

Fig. 4. Typical physical and chemical information describing thorium nitrate shipments.

Fig. 5. Checking drums for pressure and venting drums.

Fig. 6. Samples of thorium nitrate from three French lots.

Fig. 7. Example of a bill of lading for a shipment of thorium nitrate to NTS.

Fig. 8. Example of blocking and bracing for a mixed load.

Fig. 9. Example of the finished package-trailer tie-down arrangement.

Fig. 10. Operations on drums and cargo containers: venting, storing, and loading.

Fig. 11. Possible disruptive snowfall.

Fig. 12. Early productivity experiences showing little impact of venting drums.

Fig. 13. Cargo containers of thorium nitrate in a dedicated trench at Nevada Test Site Area 5.

Fig. 14. Key milestones and accomplishments.

Fig. 15. Schedule for shipments to Nevada Test Site.

Fig. 16. Teaming arrangements for shipping thorium nitrate to Nevada Test Site.

Fig. 17. Present day co-occupants of Curtis Bay Depot.

Fig. 1

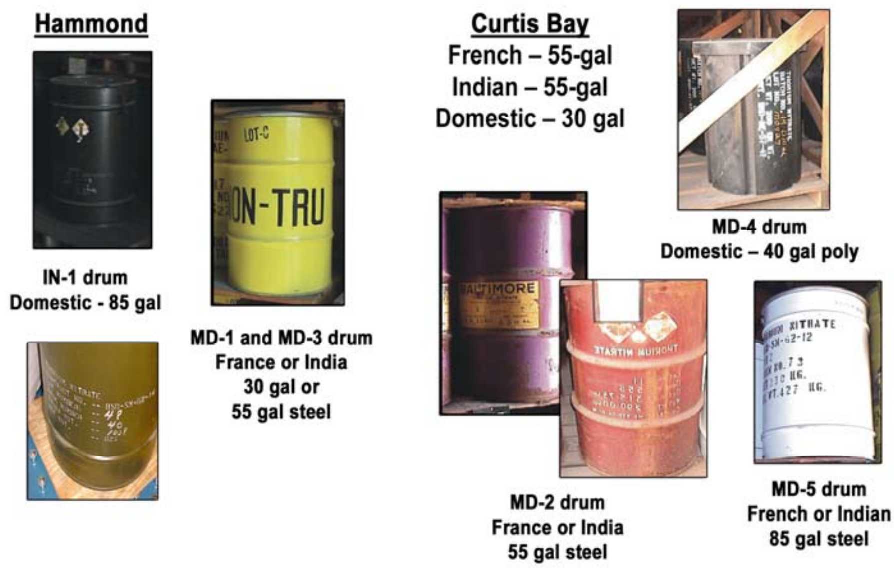
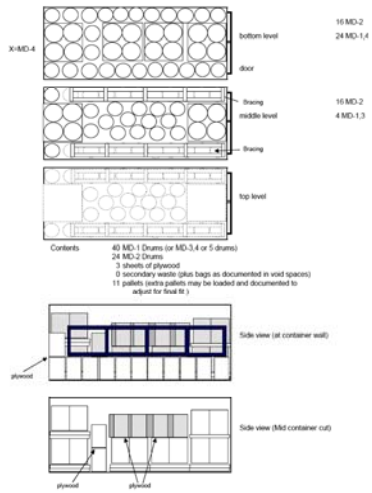
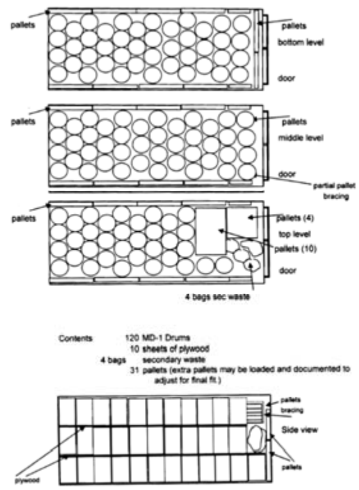

Hammond
IN-1 drum
Domestic - 85 gal
MD-1 and MD-3 drum
France or India
30 gal or
55 gal steel
Curtis Bay
French – 55-gal
Indian – 55-gal
Domestic – 30 gal
MD-4 drum
Domestic – 40 gal poly
MD-2 drum
France or India
55 gal steel
MD-5 drum
French or Indian
85 gal steel

Fig. 2



40-24 load plan



913-1 load plan

Fig. 3


Maximum pounds per load:
Domestic 25,400
French with domestic 25,420
Indian with domestic 25,220
Cargo container 4,700

Fig. 4

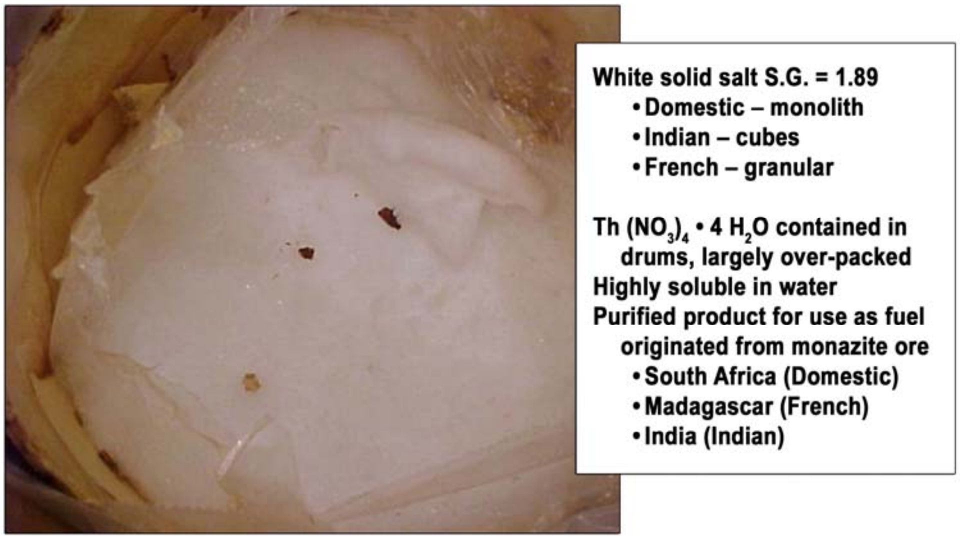

White solid salt S.G. = 1.89
• Domestic – monolith
• Indian – cubes
• French – granular
Th $(NO_3)_4 \cdot 4\ H_2O$ contained in drums, largely over-packed
Highly soluble in water
Purified product for use as fuel originated from monazite ore
• South Africa (Domestic)
• Madagascar (French)
• India (Indian)

Fig. 5

Fig. 6

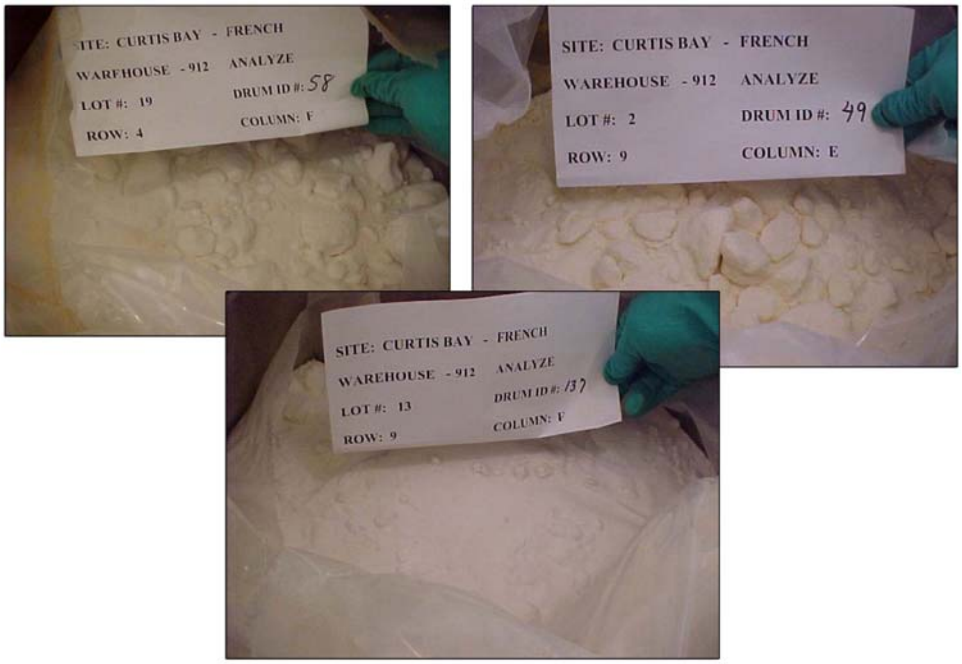

ITE: CURTIS BAY - FRENCH
WAREHOUSE - 912 ANALYZE
LOT #: 19 DRUM ID #: 58
ROW: 4 COLUMN: F
SITE: CURTIS BAY - FRENCH
WAREHOUSE - 912 ANALYZE
LOT #: 2 DRUM ID #: 49
ROW: 9 COLUMN: E
SITE: CURTIS BAY - FRENCH
WAREHOUSE - 912 ANALYZE
LOT #: 13 DRUM ID #: 137
ROW: 9 COLUMN: F

Fig. 7

STRAIGHT BILL OF LADING

CARRIER: T.A.G. Transport, Inc.
Carrier No.: 642202

Shipment No.: **THL05195**
Date: May 6, 2005
Package No.: THC195 (SN# FLZU 201602-4)

Received, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described below in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said carrier agrees to carry to its usual place of delivery. If on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said routes to destination and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all Bill of Lading terms and conditions in the governing classification on the date of shipment. The shipper hereby certifies that he is familiar with all the Bill of Lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consignee: Bechtel Nevada for U.S. Department of Energy Waste Management Nevada Test Site – Zone 2 Mercury, Nevada 89023	Shipper: U.S. Department of Defense in care of UT-Battelle, LLC Curtis Bay Depot 710 East Ordnance Road Baltimore, Maryland 21226-1786
Route: See attached NTS Routing Information and Maps	Truck and Trailer Number: T-9909 (82159HY TN) / 84812 (T674330 TN)

No. Pkgs.	HM	Description of Material	Weight (Kg)	Class	Charges	Subject to section 7 of conditions of applicable Bill of Lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:
1 – 20' ISO Container	RQ	Radioactive material, low specific activity (LSA-I), 7 (8), UN2912; Th(natural), U(natural), Th-230, Ra-226 as a solid/salt; Activity: 0.026 TBq; Labels: Radioactive Yellow–III; TI= 19.8; EXCLUSIVE USE SHIPMENT; TID # RNC0996	16,001 Kg (35,275 lb)			The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.
						If freight charges are to be pre-paid, write or stamp here "TO BE PREPAID". N/A

Attachments: Exclusive Use Instructions; ERG #162; NTS Routes; HP Readings for Package and Vehicle

Additional information:
In case of an emergency, call:
Oak Ridge National Lab Communications Center - (865) 574-6606
Hazardous Substance National Response Center: (800) 424-8802
Technical Contact: Bill Hermes or Jim Terry

If Delayed in Transit Notify:
ORNL Communications Center: (865) 574-6606

NTS Scheduled Arrival Date / Time: May 10, 2005 @ 0700 hrs PST

DOE/NRC 741 Form Reference Not Required

Label(s) applied: Radioactive Yellow-III Corrosive

Placard(s) required: Radioactive

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 U.S. Department of Transportation.	Carrier Arrival/Initials	Departed Site/Initials	Destination Arrival / Initials	Destination Departure / Initials
	S.B.	S.B.		
	Date 5-6-05	Date 5-6-05	Date	Date
	Time	Time	Time	Time

Shipper: U.S. DOD in care of UT-Battelle, LLC
Contract:
Per: Bill Hermes Date: 5/06/2005
On behalf of USDOD

The additions on the face hereof and the terms and conditions are hereby noted:
Carrier: T.A.G.
Per: [signature] Date: 5-6-05

Page 1 of 1

Fig. 8

Fig. 9

Fig. 10

Fig. 11

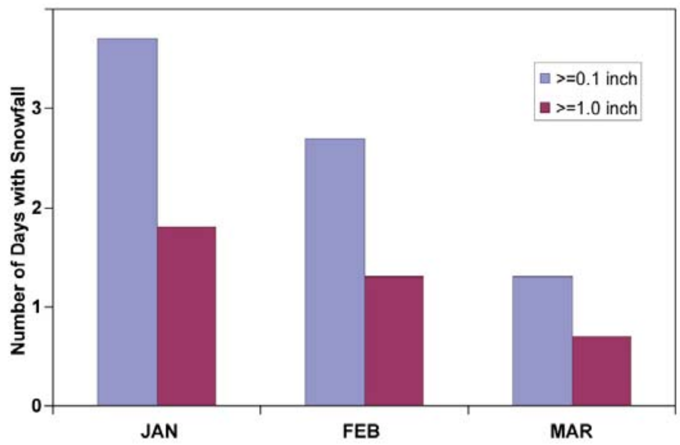


Fig. 12

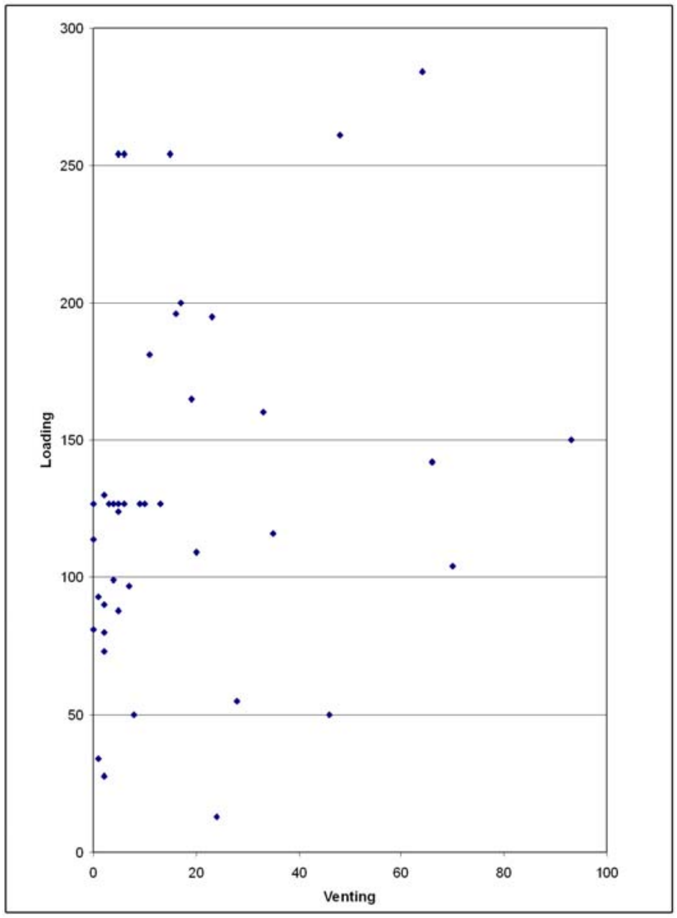


Fig. 13

Fig. 14

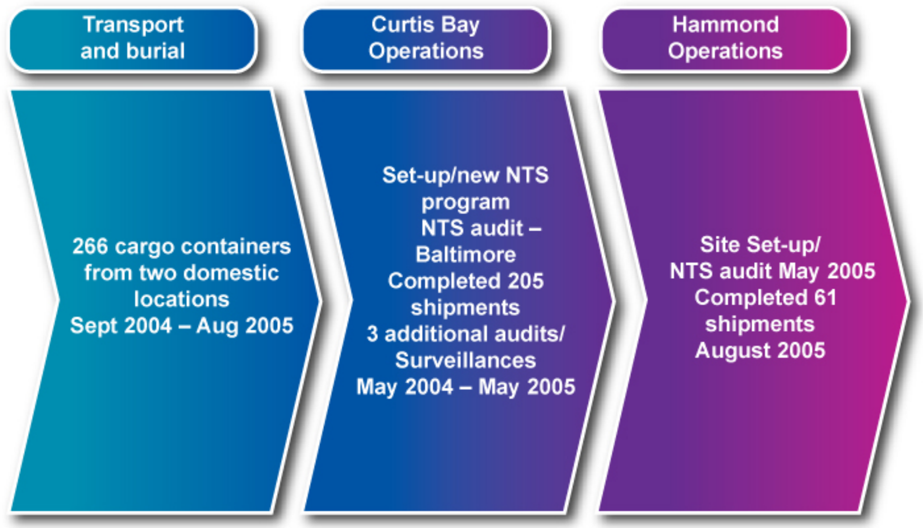

Transport and burial
Curtis Bay Operations
Hammond Operations
266 cargo containers from two domestic locations
Sept 2004 – Aug 2005
Set-up/new NTS program
NTS audit – Baltimore
Completed 205 shipments
3 additional audits/ Surveillances
May 2004 – May 2005
Site Set-up/
NTS audit May 2005
Completed 61 shipments
August 2005

Fig. 15


2000
DNSC/DOE-ORO
Approve Work For Others
Interagency-Agreement
2001
Inventory and options
2002
Characterization
DNSC decision
2003
NEPA Environmental Assessment
MOU signed by DNSC/NNSA
2004
UT-Battelle NTS Program approval target met
Shipments begin 9/2004
2005
Shipments completed August 2005
Preliminary Phase IV work begun
2006
MARSSIM Process
Deconstruction & Decommission Start

Fig. 16

Agencies and Organizations Working Together

Department of Energy – Oak Ridge Operations

Defense Logistics Agency / Defense National Stockpile Center

UT-Battelle, LLC for Oak Ridge National Laboratory
–Nuclear Science & Technology Division
–Environmental Sciences Division
–Records, Training, SBMS Division

Department of Transportation
Nuclear Regulatory Commission
Environmental Protection Agency / State of Nevada / NEPA
National Nuclear Security Agency (NNSA – NSO)
(DOE & Bechtel-Nevada)
Nevada Test Site Waste Acceptance Criteria (NTS WAC)
Radiological Waste Acceptance Program
UT-Battelle New Generator Program Approved August 2004
Subcontractors
RWE-Nukem
Southwest Research Institute
Quality Waste Solutions

Fig. 17