RAIL/TRUCK INTERMODAL TRANSPORTATION TO THE NEVADA TEST SITE

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ABSTRACT

This paper provides a summary of the planning, execution, and lessons learned from the first ever shipment of low-level radioactive waste (LLW) to the U.S. Department of Energy (DOE) Nevada Test Site (NTS) via intermodal shipping methods. On September 17, 2003, the DOE Portsmouth Gaseous Diffusion Plant (PORTS) at Piketon, Ohio became the first DOE site to complete a shipment of LLW to the NTS using a combined rail/truck shipping method. The shipment demonstrated the viability of the shipping method, the overall cost effectiveness and also provided early lessons that will help other DOE sites to quickly take advantage of the intermodal shipping opportunity.

SITE BACKGROUND

The 3,700-acre DOE PORTS facility is located in southern Ohio near Piketon, Ohio, approximately 22 miles north of Portsmouth, Ohio. The PORTS was constructed in the early 1950s to provide increased uranium enrichment capacity for national defense programs. The enrichment operations were designed to provide the higher end of U.S. government uranium enrichment capabilities, with typical product enrichments of between 4 and 5 percent for commercial uses and higher enrichments for U.S. Navy propulsion reactors. The primary structures at PORTS are three massive gaseous diffusion plant buildings containing a total of about 1,700 separation stages. The site also includes a more recent vintage gas centrifuge enrichment facility constructed in the late 1970s and early 1980s in which limited testing of gas centrifuge equipment occurred, but abandoned for potentially more economic processes prior to completion of construction.

In the late 1980s, PORTS became subject to a site cleanup decree under the State of Ohio Resource Conservation and Recovery Act (RCRA) Corrective Action Program. Since that time, the site has completed environmental investigations and formal decision-making with the State of Ohio, instituted cleanup activities at most release sites, and initiated disposition of legacy wastes. Uranium enrichment activities are currently shutdown, and the plant is being maintained in cold standby. The primary mission of the DOE and its management and integration contractor, Bechtel Jacobs Company LLC (BJC), is remediation of the contaminated land and groundwater and disposition of legacy wastes, including both LLW, and mixed (both under the RCRA and the Toxic Substances and Control Act) low-level radioactive waste. A next generation gas centrifuge enrichment process will be installed and tested at PORTS over the next several years. A decision on decontamination and dismantlement of the old gaseous diffusion plant facilities has not yet been made.

PROJECT BACKGROUND

Prior to FY 2003, PORTS utilized the Envirocare of Utah facility almost exclusively for disposal of its LLW and mixed waste. There had been limited disposal at the DOE Hanford site. In FY 2003, PORTS undertook developing an NTS waste certification program because of recognized future needs for disposal of classified waste streams, disposal of higher enrichment wastes, and the high cost of disposal of certain bulk wastes.

Concurrent with the development of the NTS waste certification program, BJC and its subcontractors, Pro2Serve Technical Solutions, and MHF Logistical Solutions (MHF-LS), initiated planning for intermodal shipments to the NTS in the Spring of 2003. A large waste stream comprised of radioactively contaminated scrap metal from a PORTS site process equipment upgrade in the mid-1970s was chosen as the demonstration waste stream for both the initial shipment from PORTS to the NTS and for the proposed intermodal shipments to the NTS. As part of the initial NTS program development, this waste stream was profiled so that the needs of both objectives could be met.

The baseline PORTS approach for managing the scrap metal employed torch-cutting operations for size-reduction of the massive equipment and packaging and handling in B-25 style boxes for disposal. The loaded B-25 boxes were then placed on trucks and shipped cross-country to the Envirocare of Utah low-level waste disposal facility in Clive, Utah. Because of the method used for size reduction, this project sustained one of the higher injury rates at PORTS. A major PORTS goal for the project was to migrate the operation to a larger container (with associated bulk materials handling) to take advantage of improved safety, productivity, and cost efficiencies. The opportunity existed to integrate the migration to larger containers with deployment of an innovative transportation approach. Bulk handling, transportation, and disposal of this waste stream would reduce safety concerns for the operations personnel and improve the efficiency and costs of the size reduction, packaging, transportation and disposal.

The viability of reusable end-dumping intermodal shipping containers had been previously demonstrated for LLW by the authors and others. Similar containers were also already in service transporting contaminated scrap metals to the NTS, although not via intermodal shipment methods. Therefore, PORTS developmental efforts were most heavily concentrated on implementing rail shipment of the intermodal containers and on debugging the physical and paperwork processes associated with trans-loading of the containers to trucks (since the NTS can only receive waste via truck shipments).

Lowered Risks

Safety and cost were the two primary drivers for the pursuit of bulk rail shipments for PORTS. Since rail shipments have historically provided an overall safer shipping method than trucks and since many of DOE's stakeholder groups have advocated use of rail shipment over truck shipments, PORTS began to utilize rail shipments in both the Envirocare and NTS disposal programs.

According to data provided by the U.S. Department of Transportation (DOT) Bureau of Transportation Statistics (BTS) (1) as summarized in Table I, there are approximately 135 – 175 truck accidents for every train accident annually in the United States. Overall, railcar miles are about one third of truck miles annually (2) (as summarized in Table II), although rail transport ton-miles (1.466 trillion) for freight exceeds inter-city truck freight ton-miles (1.142 trillion) by 28 percent based on 2000 data, the latest data year available (3). From a transportation accidents perspective, truck transportation has a significantly higher incidence rate per ton-mile, as calculated from the presented data; 3.8×10^{-4} accidents per ton-mile for trucks versus 2.0×10^{-6} accidents per ton-mile for rail (trucks accounting for approximately 190 times as many accidents per ton-mile). These results are significant considering the large volumes of DOE waste that must be transported to the limited disposal facilities available to DOE, that are often at great distances from the waste generating sites.

Table I Transportation accidents by year by mode[a]

Mode	1996	1997	1998	1999	2000	2001
Large Trucks[b]	378,000	421,000	392,000	452,000	438,000	409,000
Railroad	2,443	2,397	2,575	2,768	2,983	2,987

[a] See Ref. 1.
[b] Large trucks are consider those over 10,000 pounds gross vehicular weight.

Table II U.S. Vehicle Miles by Year by Mode in Millions[a]

Mode	1996	1997	1998	1999	2000	2001
Combination Trucks[b]	118,899	124,584	128,359	132,384	135,020	135,400
Class I Rail Freight Car-Miles	31,715	31,660	32,657	33,851	34,590	34,243

[a] See Ref. 2.
[b] The category is specific to trucks with separate hauling unit and trailer unit(s).

PROJECT TRANSPORTATION PLANNING

PORTS on-site activities with intermodal containers began with the mobilization of a container fleet to the PORTS. Each container had to be inspected versus design and functional criteria and then prepared for initial filling. A paved parking lot sized area was designated for managing the incoming containers, and used for container inspection and preparation. Containers with minor flaws were repaired locally to meet acceptance criteria, without causing significant delay to the project.

The intermodal container utilized at PORTS (Fig. 1.) has a 25.4 cubic yard internal capacity and comes equipped with a lightweight aluminum lid on rollers for ease of use. The PORTS fleet used a side-hinged rear door design to provide optimal emptying at the NTS. The design also utilizes a bottom flapper secondary tailgate closure mechanism to provide maximum seal assurance where load stresses are highest.

Fig. 1 PORTS intermodal in transit, showing design features.

Prior to filling each container a woven plastic liner of approximately 16 mils thickness was installed to meet NTS preferences. NTS waste certification activities and field oversight were performed in accordance with the NTS waste acceptance criteria (NTSWAC) (4) in a manner similar to any other container. Containers were filled, manifested, and placed onto articulating bulk commodity (ABC) railcars capable of carrying the intermodals in double-stacked configuration up to 177 tons (Fig. 2.). Because of material handling limitations at the NTS and over-the road considerations for the truck transport portion of the trip to the NTS, individual container loads were limited to 20 tons gross. The intermodal containers can be loaded to approximately 30 tons if the container is transported wholly by rail, but the weight limit on the ABC railcars is limiting. PORTS was typically able to ship seven or eight containers per ABC, at times being limited to seven containers by center of gravity criteria for loading of the ABCs.

Fig. 2 ABC loaded with intermodal containers at PORTS

Transport of the filled and loaded containers utilized existing PORTS rail spurs connected to the Norfolk Southern Railroad. The loaded railcars were shipped approximately 1800 miles from Piketon, Ohio to Cisco, Utah. In order for the material to be transported to the final destination, a 700-mile truck trip was required for the last leg to the NTS. Four trucks and trailers were utilized to perform the 700-mile trip from Cisco to NTS.

Cisco, Utah is a sparsely populated cattle and mining town about 55 miles west of Grand Junction, Colorado. It was selected as the intermodal trans-load location based on the availability of an existing trans-load facility previously developed by MHF-LS to support bulk shipments to the White Mesa Mill at Blanding, Utah. Due to limited local infrastructure the site had to be essentially self-supporting, providing its own fueling capabilities and repair facilities. The facility can process about twenty trucks per day. The facility inspects incoming railcars, containers, trucks, and trailers; off-loads containers (Fig. 3.); loads trucks; verifies shipping paperwork (both inbound and out-bound); loads empty containers back onto railcars; and performs routine maintenance on all transportation equipment, including trucks and trailers.

Fig. 3 Off-loading an intermodal container at the MHF-LS Cisco trans-load facility.

PROJECT CHRONOLOGY

Intermodal containers for the initial NTS rail shipment from PORTS were first packaged August 20th by scrap metal project personnel. The project had revised existing procedures and documentation to support the NTS and intermodal containers programs in late spring and had been audited by NTS personnel in late May.

The initial rail shipment of intermodal containers from PORTS left the site July 30th, 2003 for the Envirocare of Utah disposal facility in Clive, Utah. On September 3rd, an initial shipment of eight intermodal containers for disposal at the NTS left PORTS (shown in Fig. 2.). Each container was managed as a separate shipment to facilitate the follow-on truck shipment portion of the journey. A shipping papers package (consisting of a Bill of Lading, an exclusive use package, NTS directions, routing guidance, emergency instructions, and associated NTS waste certification paperwork) was developed for each shipment at PORTS and delivered by express mail to the MHF-LS trans-load facility at Cisco, Utah for use with the truck shipments. A copy of the respective Bill of Lading was attached to each intermodal container as supplemental information.

On September 15th the first railcar of NTS-bound waste was pulled onto the Cisco rail siding by Union Pacific personnel. On September 16th four intermodal containers were trans-loaded from the ABC railcar to four chassis-style trailer/truck combinations, using a reachstacker intermodal handler device (as illustrated in Fig. 3.). The loaded trucks left Cisco that afternoon and arrived at the NTS in the late morning of September 17th. The containers were off-loaded at Area 3 of the NTS by NTS operations personnel.

At the time of arrival of the PORTS waste at NTS Area 3, the critical dumping equipment (a standard roll-off box truck) was out of service for upgrades to meet service requirements, so PORTS containers were staged at NTS Area 3. Upon completion of the upgrades NTS personnel subsequently loaded the containers onto the roll-off box truck (Fig. 4.) and dumped the contents of the containers at Area 3. NTS personnel performed surveys and sealed containers for the return shipment of the containers under 49 CFR 173.428 as radioactive material, excepted package—empty packaging (rad empty). During subsequent deliveries of containers to the NTS, emptied intermodal containers at Area 3 were picked up and returned to the Cisco site for a return by rail to PORTS for reuse.

Fig. 4 PORTS intermodal containers staged at NTS area 3

Shipment Tracking

The shipments were tracked utilizing the different methods applicable to the mode of conveyance. Trucks were tracked utilizing satellite communications systems designed for over-the-road shipments. The communications network is manned 24 hours a day, 365 days a year. Each truck has the required system hardware installed. The driver of the truck can also be contacted by cellular phone. The railcars and individual containers were tracked each day as part of the MHF-LS daily tracking system. At the beginning of each day every railcar was located and verified through ExpressTrace® software, interfaced with all the major U.S. railroads by computer link. Each railcar and intermodal container is marked with reporting marks that are tracked by the railroads. Matches to MHF-LS equipment in use on the PORTS project were down-loaded into the MHF-LS system. A daily "Railcar Locator Report" was then generated for and transmitted to PORTS personnel by MHF-LS. The report also indicated railcar estimated time to destination.

INTERMODAL SHIPPING ISSUES

Throughout the project, there were unknowns to detail and issues to resolve. Issues arose as early as the waste profiling process and continued to arise in various facets of the project until the completion of the effort. Issues ranged from interpretations of NTSWAC as applied to reusable intermodal containers, to development of enhanced logistics for container and paperwork movements. The following identifies a number of the issues and their respective path forward.

In discussions with NTS personnel, a liner was to be required for the intermodal containers. Since no formal requirement or specification for liners existed in the NTSWAC, the optimal liner thickness was not known. The purpose of the liners was not fully understood by PORTS personnel (whether primarily to aid in releasing the load from the container or to provide improved dust suppression during the unloading operations or to minimize contamination of the intermodal containers). Based on discussions with NTS site personnel, a 16 mil thick liner was selected and employed. NTS experience with the lined loads is expected to result ultimately in more specific guidance for this process.

Transportation logistics providers were found to need support in integrating DOE and NTS requirements into their business practices. Lack of familiarity with the additional NTS paperwork requirements included with shipping papers added to logistics challenges. More importantly, there were additional radiological release criteria requirements, especially for the trans-loading operations, based on DOE requirements.

The logistics for the shipping papers, waste certification paperwork, and NTS notifications was challenging. Initial advance notification to NTS of the shipment precedes arrival of the waste at the NTS by up to three weeks, due to the rail portion of the transport. Estimated time of arrival (ETA) updates are required by the NTS. Names, license numbers, and other trucking particulars are required in advance by the NTS. Answers to these questions are not known at the time the rail shipments depart from PORTS, and are not known until arrival at the trans-load facility and deployment of the vehicles by the trucking company. Therefore, the trans-load facility must play a significant additional role in creation and transmittal of this information. With increased levels of security, the timing of the information transfer to the NTS is also critical to assure that the drivers are admitted to the site upon arrival there.

The process for return of the containers had to be developed based on two key factors: NTS is not equipped to decontaminate containers after emptying, and NTS is not the shipper of record for the return of the containers. The containers are returned as rad empty since they cannot be decontaminated to free release levels. The transportation logistics subcontractor has to prepare the shipping papers for the return trip. NTS surveys the containers and provides that information prior to preparation of the return papers. The papers are then provided to the trucker on departure to NTS for pickup of the empty containers.

CONCLUSIONS

These efforts have not only resulted in decreased unit costs for disposition of the PORTS scrap metal, but have also set an example that can be utilized by other waste generators to improve the cost effectiveness of their low-level waste handling and transportation. The improved processes reduced PORTS project costs by:

- Minimizing the amount of down-sizing required for the metal and by achieving an overall increased cutting/loading throughput,
- Avoiding the cost of one-time use containers in favor of high integrity reusable shipping containers,
- Utilizing rail transportation (a more cost effective transportation method) to the extent practical, and
- Accessing the significantly lower disposal unit rates at the NTS for this type of bulk waste.

Through the intermodal shipments and pre-cursor activities, the PORTS team has developed a body of knowledge that can be of use to others intending to ship via intermodal methods. Issues addressed during the planning and execution include coordination with the NTS, acclimation with rail shipping practices, management of shipping papers and waste certification records, equipment limitations, and accommodation of operations issues at the NTS and at the PORTS. Each area has been documented for the benefit of others.

Lowered Costs

Table III provides a categorical approach to comparing the cost of the PORTS baseline approach for the scrap metal waste (B-25 containers by truck to the NTS for one-time use and burial) to the bulk waste reusable intermodal approach for the same waste stream. Unit costs demonstrate a $25.00 per cubic foot reduction for the intermodal approach.

Table III Comparison of baseline versus intermodal costs

Cost Element	Gross Cost	Cost per CF
Materials Prep/Packaging/Handling		
Baseline Approach – B-25s (10/02 - 4/03 Craft Labor => 1,629 tons in 563 boxes) Container inspection, absorbent installation, waste sizing (cut small), waste packaging, closure, weighing, labeling, and handling	$1,020,266	$18.88
Intermodal Approach (7/03 - 9/03 Craft Labor => 1991 tons in 143 IMs) Container inspection, liner installation, absorbent installation, waste packaging (larger pieces), liner & container closure, weighing, labeling, and handling	$553,123	$4.03
Container Costs		
Baseline Approach – B-25 Boxes, New, Purchase	$623.54	$6.50
Intermodal Approach – Rental Fees One-time mobilization fee = $425, One-time demobilization fee = $250. Assume 5 uses per container.	$675	$0.14
Trans-Load Radiological Support Costs		
Additional radiological survey support @ $1,760 per intermodal container		$1.83
Transportation Costs		
Rate for B-25s to the NTS (MHF-LS) – (Truck, One-Way, Up to 7 per Truck)	$6,170	$9.18
Rate for Intermodals to NTS (MHF-LS) (Train/Truck, Two-Way, 7 per railcar) (Train/Truck, Two-Way, 8 per railcar)	 $29,356 $32,120	 $4.37 $4.18
Demurrage Costs		
Intermodals per contract assumptions (@90+ days, railcars = $48/day and boxes = $13.50/day). Assumes 40 days per PORTS-NTS-PORTS cycle per box/railcar.	$814	$0.85
NTS Disposal Costs		
Baseline – B-25s (@ $6.50/CF external)	$624	$6.50
Intermodals (@ $6.50/CF internal, converted to external basis)	$4,485	$4.67
Totals		
Baseline – B-25s to NTS by truck		$41.05
Intermodals to NTS As 7 per railcar & 1 per truck to NTS As 8 per railcar & 1 per truck to NTS		 $15.89 $15.71

LESSONS LEARNED

A series of informal lessons learned was determined from the experiences on this initial intermodal waste shipping project, as summarized below.

Pre-determining routing of the railcars during rail transit is generally outside of the shipper's control (excluding the use of unit trains). This fact creates difficulty in estimating date and time of arrival of wastes at the NTS at the time of waste shipment. It also complicates determining if various state licenses, notifications, and/or fees will apply to radioactive materials shipments. While in transit, the containers and transport vehicles can generally be well tracked, so the issue is a temporary one. The pre-existing relationship between the logistics provider and the various potential states along the route was found to be particularly valuable to PORTS in this area. NTS personnel demonstrated a willingness to work with PORTS on the forecast arrival time issues.

Vehicles and equipment released to general commerce under DOT radiological standards will not necessarily meet DOE standards for release. This is especially important for the return of the empty containers and subsequent release of trucks and trailers into general commerce. It is essential to survey the truck and trailer both before loading and after unloading to assure that it meets criteria to return to general commerce.

Maintaining communications with NTS is critical to a successful intermodal shipping campaign. These communications can be enhanced by using a single point of contact on both ends. Additionally, routine and consistent communications are critical for coordinating shipping with the logistics subcontractor.

Transportation logistics companies will generally need support from DOE to achieve initial success in the DOE NTS arena. Limited experience in dealing with the enhanced requirements of the NTS exists in the logistics industry. Key areas of focus are release criteria, NTSWAC, shipping papers/exclusive use agreements, and pre-notifications.

Radiological survey support is critical to success. BJC deployed a team of radiological control technicians to Cisco to provide this survey support at the trans-load facility in a manner consistent with DOE and PORTS requirements.

Finally, optimum tamper indicating device (TID) placement is needed on the intermodal containers, since most are not designed to accommodate TID placement. PORTS found that the initial TID placement strategy still allowed for opening of the container without destroying the seal, but trial and error efforts in the field resulted in improved locations for placement of the TIDs.

PATH FORWARD FOR PORTS

Based on the experience gained, PORTS has begun the evaluation of additional waste streams for intermodal transportation. In fiscal 2004 PORTS expects to ship additional scrap metal waste to the NTS in MHF-LS intermodal containers. PORTS also expects to begin shipping other waste streams in intermodal-style containers (such as cargo containers) to the NTS via intermodal shipping methods. Although cargo container shipments will be one-way, the lessons from the use of ABCs and the management of paperwork and logistics at the Cisco trans-load facility will be directly applicable.

PORTS is also continuing to refine the experience costs associated with intermodal shipment of wastes and will share the cost analysis approach and results with others on request.

REFERENCES

1 U. S. Department of Transportation, Bureau of Transportation Statistics, "Table 2-3, Transportation Accidents by Mode," http://www.bts.gov/publications/national_transportation_statistics/2002/html/table_02_03.html (2002).

2 U. S. Department of Transportation, Bureau of Transportation Statistics, "Table 1-32, U.S. Vehicle-Miles (Millions)," http://www.bts.gov/publications/national_transportation_statistics/2002/html/table_01_32.html (2002).

3 U. S. Department of Transportation, Bureau of Transportation Statistics, "U.S. Domestic Freight Ton-Miles by Mode: 1980 – 2000," http://www.bts.gov/press_releases/2003/bts001_03.html (2003).

4 U. S. Department of Energy, National Nuclear Security Administration, Nevada Site Office, "Nevada Test Site Waste Acceptance Criteria, DOE/NV–325–Rev. 5," (2003).