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BULK DEBRIS LOADING

EXPERIENCE AND RECOMMENDATIONS

For:
Brookhaven National Laboratory

By:
MHF Logistical Solutions

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1. Purpose

The following is provided by MHF Logistical Solutions Inc., Technical Services Group in response to a request for 'The Review and Recommendation of Transportation of Bulk Debris from Brookhaven Laboratory (BNL) High Flux Beam Reactor (HFBR) and Brookhaven Graphite Research Reactor (BGRR). As requested, the focus of this document is to "Provide a nuclear industry review of the transportation of radioactive bulk debris experiences specifically for heavy and hard components such as steel and concrete. Additionally, based on industry experiences and the latest techniques and transportation packages available, provide recommendations for the optimal mode and packaging of heavy and hard radioactive debris by truck and train."

The format of this report is first to present an overview and summary description of the issues related to packaging bulk debris in general, with additional discussion shipping debris by rail and truck modes specifically. The overview and summary presents the result of accumulated experience with bulk material shipping in the form of qualitative recommendations for packaging selection and shipment preparation.

The appendices to this report provide additional reference information and experience, specifically:

Appendix I	Presents a Transportation Improvement Review Sponsored by the DOE's EM Program, focusing on rail shipment improvements
Appendix II	Provides Federal Motor Carrier Safety Administration Cargo Securement Rules
Appendix III	Includes Learned from the DOE's Occurrence Reporting Processing System applicable to debris loading of intermodal containers
Appendix IV	Provides Intermodal Container Inspection and Bulk Debris Loading information and advice, including lessons learned from MHF shipping experience
Appendix V	Includes some additional photos of two incidents of the results of improper loading.

2. Overview

The analysis provided in this document is based on the experience MHF Logistical Solutions, Inc. has had with the transportation of radioactive debris as well as researched documents from industry groups such as: DOE Lessons Learned, AAR loading requirements and the Federal Motor Carrier Safety Administration 'Cargo Securement Rules'. MHF Logistical Solutions, Inc. has a great deal of industry specific experience in transloading and shipping debris that has included that which was processed down to a fine material up to multifaceted forty ton shield blocks.

The basic requirements for the transport of any material are dictated by the modal choice and material being shipped. The areas of importance include: dynamics involved with the actual transportation, the structural integrity of the vehicle, and in the instance of shipping radioactive material, the package itself.

Both the trucking and rail industries have identified the restraint values required to transport material (see appendix II for detailed trucking requirements). Due to the dynamic forces encountered during transport, rail requires the use of restraints to equal 3g's longitudinally, 2g's vertically and 2g's horizontally. The trucking industry requires restraints to equal 0.8 g deceleration in the forward direction; 0.5 g acceleration in the rearward direction; and 0.5 g acceleration in a lateral direction. In the shipment of debris the integral strength of the vehicle plays an important role in meeting these restraint values as the walls of the vehicle are often utilized in part or wholly to restrain the load. If the makeup of the debris is such that it could potentially shift and puncture the walls during transport, then additional measures are necessary. These restraint values must be met at all times regardless of whether the material is shipped in a container or how the material is packaged.

The requirement to maintain the integrity of the package in the shipment of radioactive material requires that additional barriers often must be installed to protect the package from being breached. These additions may include, but are not limited to: geo-textile felt, plywood, dimensional lumber and fine materials such as soils. The use of these materials will be discussed in greater detail in later sections.

In all cases care must be taken to eliminate moisture and condensation from accumulating in the package. Desiccants or absorbents of some type should be applied appropriately.

3. Transportation via Truck

The options for trucking debris fall into three basic categories: dump trailers, intermodal containers on flatbeds and a combination of soft sided packages within trailers and containers.

The general choice to truck within the Nuclear Industry is based on: length of haul, origin constraints, and the amount of material to be transported. Considering the amount of material involved in this project and the origin having direct rail access, movement via rail intuitively would be the logical modal choice.

The requirement to package radioactive material to meet DOT regulations eliminates much of the general advantages of trucking in dump trailers or tri-axles. If utilizing a container on flatbed, then the economic advantage is again shifted to rail with origin rail access available.

When examining the restraint values required for over-the-road shipments for heavy and hard debris, the structural integrity of the truck is a detriment and the addition of plywood and lumber are often needed to be confident that the walls of the vehicle will not be punctured. If the material is sized appropriately, then it can be loaded safely into a truck or container without the addition of material to reinforce the walls. The specific requirements are detailed in Appendix II.

The requirements for inspection of each vehicle dictated by DOT regulations and FMSCA rules (Appendix II). Inspection of each conveyance is integral to complying with ‘Best Practices’ noted by industry groups.

4. Transportation via Rail

The choices available for transportation via rail fall within two categories based on car type. The first option is to utilize gondolas which allows for various packaging options. Package options include: Super Load Wrapper™s, Lift Liners™, liner with tarp, and gondola with hard lids. The choice of packaging is dependent first on the material itself and secondly on the site's ability to stage and load directly into a gondola.

Gondola Options

Super Load Wrapper™

If the material can be processed and sized properly to load directly into a gondola with a Super Load Wrapper™, then this is a very efficient and cost effective manner to transport by rail. In our experience this method of packaging has been utilized more often than any other.

To avoid damage to the Super Load Wrapper™ the gondola must be carefully inspected for sharp protrusions which could cause damage during loading and transit. Softening material must be applied to these areas. Care must also be taken when loading, generally material in excess of 18 inches cubed should be avoided. If sharps are present, then they must be oriented or softened so as not to damage the package. Geo-textile, felt, fiberboard and plywood may be utilized to protect the liner system during loading also. There are sites that have chosen to utilize two Super Load Wrapper™s as an added precaution with much success. To protect the bottom of the package soil or like material can be spread on the floor to a depth of 6-12 inches. Car and load preparation are detailed in Appendix III.

Lift Liner™ Systems

The Lift Liner™ as a package is durable and allows for more flexibility at the loading site. The debris can be loaded into the Lift Liners™ at any location, stored, placed on a truck, transported to the rail siding and lifted into the gondola. If the requirements of the site are best served by this system, then the material can be processed sufficiently to be transported via Lift Liners™. When utilizing soft sided packaging such as the Lift Liner™ packaging system for concrete debris the follow guide lines should be considered:

- The use of an added geo textile liner
- Extreme care in loading, placing soil in the bottom helps cushion during loading
- Pieces greater the 20 inches should be placed in the center
- No rebar over 12 inches, smaller or none at all is better
- No sharps or points greater then an inch protruding from the concrete.

Attention to the inspection of the gondola for damage to the walls and floor which could damage the liner system is important. If there are instances found, then appropriate repairs must be made and/or softening material must be properly applied.

Liner and Tarp
The use of a gondola with a liner and tarp option allows for excellent protection from sharps and rubble causing damage to the tarp because it is raised above the load by tarp bows. This combination has not thus far been used as a 'DOT Package'.

The liner provides additional protection to the railcar against contamination and the tarp provides a barrier against the elements. If the material is properly sized to allow for the use of a 'car roller' or normal dig out, then this may provide a viable option. The cost of the packaging and the labor to install it are both economical.

Gondola and Hard Lid
The final option is to utilize a gondola with a hard lid, which together comprise the package. With this option a liner is normally installed to minimize contamination to the railcar and facilitate unloading.

This option provides the most durable package. The walls of a gondola and a steel lid together acting as the package are more structurally sound than all other options. The amount of material processing required is dependent on the destination's ability to off-load large pieces more than it is a function of protecting the package.

This choice does not eliminate the need to properly place and secure large pieces for transport. There are many options to eliminate the shifting of the load during transport. Soil and finer debris may be utilized to stabilize the load and in the instance of large and/or sharp objects in close proximity to the walls of the gondola lumber and plywood should be utilized for protection. It must also be noted that large objects should not be placed in such a manner as to allow them to shift upward toward the lid during transport.

The use of a hard lid requires a staging area for the lids and requires extra steps to inspect and maintain the lids and gaskets as well as a crane or forklift to remove and install them.

Intermodal Containers on Flatcars
This method of transportation is excellent if utilized properly. Structural integrity is second only to a gondola and hard lid. It offers a great amount of flexibility at the site in that it can be loaded away from the rail siding, stored if needed and trucked to the siding for loading onto the flatcar.
It does require heavy equipment to unload and load the containers onto the flatcar.

Loading concerns are similar to those discussed in the gondola and hard lid section. The walls, floor, and lid must be protected from large or pointed objects during loading and transport. Of particular concern is the protection of the aluminum lid. A liner is again utilized to protect against contamination. Generally, when loading larger pieces into intermodal container plywood panels are constructed and placed to protect the walls, door and floor.

The inspection of the container lid and door gaskets is critical. There are specific recommendations for intermodal container inspection and maintenance to be found in Appendix IV.

5. Conclusions, Risks and Recommendations

The message which is constant throughout the industry is that in order to be successful transporting radioactive material, planning, adherence to procedures, and constant inspections are all of critical importance.

The overriding concern when transporting radioactive material is to comply with the packaging requirements. The risks associated with damage to the packaging are directly related to the size, weight and shape of the material shipped. While not always practical, the lowest risk option is to process the material to a point where it is smaller, lighter, and has fewer sharp edges. Processing the material also allows for a denser load by eliminating void space, and consequently reduces transportation costs.

The option chosen more often in this industry is to keep processing more to a minimum and provide protection for the packaging during loading and transit. These measures, as noted above, involve the use of softeners in the form of everything from duct tape to geo-textile to providing a layer of fine material such as soil to cushion the debris. The modal choice is often a result of economic analysis and site operational considerations. Projects which are shipping large volumes of material over greater distances with direct rail access at the origin find the economics of rail transport are the deciding factor in choosing their means of transportation. Economics aside, the rail option has proven to be safer than over-the-road trucking.

The choice in rail options may not be limited to a single package type. Large pieces of material which would be loaded by crane would be best served to be transported by a gondola with hard lid. The gondola allows for the objects to be easily placed strategically and the integral strength of the walls and floor require much less bracing against to protect them as the package. If additional protection is needed, it is generally sufficient to place plywood or lumber between the object and the car wall. Voids within the load can be filled with smaller debris to help stabilize the objects as well as to better utilize the car's capacity.

Objects which are comprised of many sharp edges such as concrete with imbedded steel and rebar are also well served by utilizing gondolas and hard lids. Some orientation of the sharps may be required or in some cases plywood may be needed to protect the car ends. Again, soil and finer debris can be added to the load for economy and stabilization. The preferred method of loading would be to utilize a crane or an excavator in order to better lower the material into the railcar.

Intermodal containers allow for top and end loading. They have the advantages of allowing loading away from the rail site, allowing for a safe storage package and the choice of being transported by truck and rail. They are best utilized with smaller sized debris. The package is hard sided also which is an advantage, but generally requires more effort to protect the walls and lid from sharp and heavy objects. This can be accomplished by protecting the walls and door with plywood barriers as well as orienting potentially damaging object away from the front, lid and door of the container where the greatest impacts occur during transportation. Debris should be loaded only to a level 18” from the bulkheads. Caution should also be taken to load in a manner such that large components will not become lodged in the container during unloading. Please refer to Appendix for additional requirements.

If the make up of the debris is of a yet smaller dimension and has fewer sharps within it, then the use of a Super Load Wrapper^{TM} may be appropriate. It is fabricated with an internal weave and is almost 20mils thick making it an option for packaging much of the debris shipped in this industry. As discussed above the Super Load Wrapper^{TM} can be fortified with the use of geo-textile and felt to protect against punctures and abrasions. The load will need to be inspected prior to closing the package in order to insure that there are no sharp objects oriented so as to cause damage to the package in transport. Such objects can be removed, re-oriented or softened. Once this has been accomplished the package can be closed securely and transported confidently.

Should the versatility of Lift Liners^{TM}, which are similar to intermodal containers, be advantageous and the material being loaded conducive to this type of package it can be shipped within a gondola with other Lift Liners^{TM} as DOT packaging or loaded in a gondola within another package (Super Load Wrapper^{TM} or Hard Lid) along with loose debris. In the later instance it would not be the DOT package, but could provide stability to the load and protection to the walls of the gondola or intermodal container.

Any of the options noted in this section have proven to be safe and reliable modes for the transportation of radioactive material when utilized properly. The keys to the successful transportation of radiological debris are in the detail with which the plan is prepared and the manner with which the resultant procedures are followed.

Appendix I – Transportation Improvement Review on Rail Shipments

Transportation Improvement Review on Rail Shipments

May 18 – 19, 2005

Oak Ridge, TN

Eric Huang
Office of Transportation
Office of Logistics and Waste Disposition Enhancements
Office of Environmental Management

Executive Summary

The 1½-day of transportation improvement review on rail shipments was successfully conducted with considerable information presented, discussed, and valuable experience exchanged among all participants. Participants include representatives from Headquarters (Office of Transportation, EM-11), 7 generator/shipper sites, 3 suppliers, 2 rail carriers, and 2 receiver sites. Activities include a loading operation observation tour; sessions of presenting and sharing experiences and lessons learned from the perspectives of generators, shippers, suppliers, rail carriers, and receivers; and a brainstorming session of best practices for a safe and compliant rail shipment.

Five generator/shipper sites presented each site's scope of rail shipping campaign, loading practices, and lessons learned. A summary of these presentations is included in the report for future reference. A brainstorming session was held to discuss and identify best practices during each of the four phases of rail shipments. Participants also voted top best practices for each of the four phases of rail shipments as listed below.

Best Practices During Planning Phase:

- Define transportation scope of work and include railcar specifications and other requirements (e.g., condition of railcars) in the sub-contract with railcar suppliers.
- Thorough options analyses related to waste/material characterization, packaging, conveyance, and disposal sites.
- Dedicated fleets with hard covers when there is long lead time to procure.
- Define training needs (e.g., loading, securing, on-site railcar safety inspection, DOT compliance, etc.) and ensure training program is in place.
- Fully utilize lessons learned from others.

Best Practices During Pre-Loading Phase:

- Thorough inspection (e.g., moisture, holes in empty railcars).
- Compile all relevant documents/procedures.

Best Practices During Loading Phase:

- Define critical activities and perform multiple-step inspections during loading operations and maintain records (e.g., checklists).
- Use adequate combination of layers of load/material/waste to avoid punctures to liner/intermodal.
- Prefer covered area for loading or avoid performing loading operations during inclement weather conditions and use tarps (or hard covers) to prevent rain/snow from infiltrating railcars in transit.
- Perform as much preparatory work (e.g., install liners/wrappers) as possible prior to entering contaminated work area.

Best Practices During Post-Loading Phase:

- Inspect! Inspect! Inspect! (e.g., package is closed properly, loaded waste does not cause package to fail in transit, all documentation, etc.).
- Take pictures of outside of railcars (e.g., placards).
- Take pictures before and after package closure.

Transportation Improvement Review on Rail Shipments

Date: May 18 – 19, 2005

Location: Doubletree Hotel, Oak Ridge, TN

Participants:

EM-11	Dennis Ashworth, Eric Huang, Ella McNeil
Fernald	Dave Lojek, Jeff Rowe
Savannah River	Dawn Gillas, Don McWhorter
Brookhaven	Terri Kneitel, Mike Clancy
Rocky Flats	Dave Hicks, Chip Padilla, Ken Lenarcic
Oak Ridge	Brady Lester, Mike West, Tammy Pressnell, Larry Cannon Dana Willaford, Carolyne Thomas, EddieHolden, Dave Hoglund
Portsmouth	John Saluke, Scott Kelley
Paducah	Wesley Bass
Envirocare	Dan Owen
MHF	Ken Grumski
Cavanagh Services Group	Sue Rice
Boston Transit Group	Pierre Lamy
CSX	David Jones, Romano DeSimone
UP	Rodger Dolson
WCS	Mike Lauer

A transportation improvement review of rail shipments led by the Office of Transportation (EM-11) was conducted at Oak Ridge, TN during May 18-19, 2005. The 1½-day of transportation improvement review on rail shipments was successfully conducted. Considerable information related to rail shipments were presented, discussed, and valuable experience exchanged among all participants. Participants include representatives from Headquarters (Office of Transportation, EM-11), 7 generator/shipper sites, 3 suppliers, 2 rail carriers, and 2 receiver sites. Activities of the review include a loading operation observation tour near the East Tennessee Technology Park (ETTP) site; discussion sessions of presenting and sharing valuable experiences and lessons learned from the perspectives of generators, shippers, suppliers, rail carriers, and receivers; and a brainstorming session of best practices for a safe and compliant rail shipment.

I. Rail Shipping Practices at Generator/Shipper Sites

Five generator/shipper sites presented each site's scope of rail shipping campaign, loading practices, and lessons learned. Information of these presentations is summarized and included below for future reference.

A. Brookhaven National Laboratory

- Brookhaven National Laboratory began class 7 (radioactive) rail shipment in May 2004.
- Annual class 7 shipment forecast for FY 06-08 between 50 and 100 railcars.
- Current loading practices (resulting from lessons learned of previous incidents) including:
  - Inspect and survey railcars prior to use, patch any holes greater than two inches.
  - Use Geotextile liners.
  - Use Super Load Wrapper™.
  - Use double-wrapper for debris and use soil around debris to avoid puncture.
  - Use absorbent inside the package.
  - Prepare railcars before entering contaminated area.
  - Perform and document detailed waste verification (e.g., receipt inspection of railcar, moisture content and pH of soil, weight, color).
  - Use covers on all railcars.
  - Complete loading process of a railcar in one day, otherwise use temporary covers.
  - DOE reviews all waste management and railcar shipment checklists prior to shipment.

B. Fernald Closure Project

- Fernald Closure Project (FCP) began class 7 (radioactive) rail shipment in April 1999.
- DOE-owned assets include:
  - 190 dedicated (plus 65 leased) railcars with hard covers.
  - 4 locomotives on-site.
- Use 60-car unit trains for shipment to Envirocare of Utah.
- Key components of success of the FCP rail shipment campaign:
  - Training of all personnel involved.
  - Retraining periodically.
  - Utilize the dedicated fleet with consistent railcar type, capacity, and age.
  - Use of unit train with dedicated fleets.
  - Taking advantage of unit train to optimize rail shipping schedule.
- Key lessons learned by FCP:
  - Diligence.
  - Inspections to ensure every aspect of shipping are compliant.
  - Contact with railroads.
  - Contact with the disposal site.

C. Oak Ridge Site

- Bechtel Jacobs Company (BJC) scope is to ship 2,500 containers (1,600 B-25 boxes and 900 drums) of moisture-laden materials (e.g., soils, sludge, resins) for drying and disposal at Envirocare of Utah.
- Challenges from the characteristics of waste include:
  - Moisture coalesces into free liquid at top of box due to vibration and settling of matrix in transit; breach in top of box releases liquids.
  - Moist material under pressure releases liquids through a fissure or breach at the bottom of box.
- Loading practices resulting from lessons learned of previous incidents including:
  - Conduct 100% visual inspection of containers and content.
  - Remove containers with visible free liquids.
  - Add absorbent to top of all containers to address coalesced moisture.
  - Package in multiple barriers with absorbent to solidify liquid from any potential release point.
  - Use rubber matting on gondola floor.
  - Use double layers of Super Load Wrapper™.
  - Use rubber matting inside Super Load Wrapper™.
  - Use straps outside the wrappers to secure boxes.
  - Use wooden bracing at the end of railcars to avoid boxes shifting.
  - Use tarp to cover the railcar to avoid precipitation into the car in transit.
  - The BJC Transportation Specialist reviews the paperwork, oversees loading operations, inspects rail equipments, and verifies compliance with DOT requirements.
  - The BJC QA/QC Engineer oversees the work effort and verifies compliance with the work package.

D. Rocky Flats

- Scope is to ship demolished building rubbles in gondola cars and rail intermodal to Envirocare of Utah.
- Loading practices including:
  - Install Geotextile liners of bottom of car and top of waste material.
  - Install tarp and bow system.
- Challenges in the field including:
  - Leaking railcars.
  - Tarping problems as results of wear, not durable, and not being used as designed.
  - On-site logistics issues including railcar derailments, railcar accident with scissor lift, traffic crossing on-site track, movement operations, rail movement congestion due to poor planning on rail layout and track limitations.
  - Railcar operations issues including conduct of operations of Union Pacific different from Rocky Flats and railroad company determines its own priorities.

- Rocky Flats lessons learned including:

  - Railcars used as a containment system meets DOT requirements.
  - Railcars are not the most robust waste package available.
  - Rocky Flats had a number of lessons learned on rail shipping startup and this review would have been beneficial early on.
  - Rocky Flats would have done things differently – original plan of using 300 railcars over 12 months vs. 1500 railcars.

E. Savannah River Site

- Scope is to ship about 36,000 drums of depleted uranium trioxide to Envirocare of Utah.

- Loading practices including:

  - Use a polypropylene-coated fabric liner (wrapper) to line an entire railcar and use the liner as the shipping package since drums were in poor condition.
  - Use 66-ft, 110-ton mill gondola cars as conveyance.
  - Four drums placed on pallet and banded to pallet with four metal bands (horizontally and vertically).
  - Drums/pallets checked by radiation control and material accountability.
  - Assure car is dry before loading and load in clear day and complete in one day.
  - Clean debris from bottom of railcar and install tie down straps.
  - Line the railcar with wrapper followed by an inspection.
  - Load pallets from both ends. Place bands on four pallets. Load last pallets in the center.
  - Close wrapper by tucking down between drums and the wall of railcars and secure with ropes.
  - Use two-inch poly straps over plywood on each set of pallets, and ratchet tight to hold drums in place in transit.
  - Install ribs and cover railcars with tarps. The tarp is stretched and tied down.
  - Hazardous Material Transportation personnel perform final inspection for labeling, placarding, and manifest.
  - Radioactive Control Operator conducts final swipes per DOT requirements.
  - On-site engine arrives with empty railcars and picks up loaded railcars for delivery to the on-site rail yard, then moves to Mile Marker Zero (MMZ) at site boundry for CSX pick-up.
  - Security performs daily check at MMZ until CSX pick-up.

- Savannah River lessons learned including:
  - Some wrapper were damaged but no drums damaged and no material released.
  - Use layer of roofing felt on bottom of railcar and use another layer of a Geotextile fabric inside the wrapper as a sacrificial padding.
  - The result of this set of extra padding outside and inside of the wrapper was not successful with severe damages to the wrapper probably due to the high friction of the roofing felt.

- Use of two layers of fabric padding on the bottom of railcar, two wrappers on top of fabric, and two additional layers of padding on top of wrappers.
- Although successful, this extra padding combination is too costly and too much effort involved. The site decided to use different packaging method for shipping of remaining 55-gallon drums.
- Plan to use gondola cars with hard tops similar to those used by Fernald for 55-gallon drums.
- Using 85-gallon overpacks as the shipping package (drop tested) and shipped in wide boxcars with modifications for securement.
- Use risers and spacers to prevent closure rings from rubbing each other causing ring failure.

II. Summary of Best Practices

A brainstorming session was held to discuss and identify best practices during each of the four phases of rail shipments. Below is a summary of best practices for the various phases of rail shipping as a result of this session. The sequence of these best practices does not indicate the order of importance.

A. Best Practices During Planning Phase:

1. Thorough options analyses related to waste/material characterization, packaging, conveyance, and disposal sites.
2. Dedicated fleets with hard covers when there is long lead time to procure.
3. Use unit train when feasible (e.g., when large amount of waste going to the same receiver site and the shipper site has enough side lines to accommodate many railcars).
4. Interface with the rail carrier on capacity and load engineering aspects.
5. Interface with the receiver site and arrange site visits in advance of the first shipment.
6. Interface with state and local regulators in advance.
7. Use spray-on polymer liner (e.g., polyurea or other materials as appropriate) in railcars.
8. Careful planning for on-site track and other infrastructures (e.g., indoor loading area, installation of scaffolding, on-site upgrades, off-site transload area, use of intermodal vs. gondolas, etc.).
9. Define training needs (e.g., loading, securing, on-site railcar safety inspection, DOT compliance, etc.) and ensure training program is in place.
10. Define transportation scope of work and include railcar specifications and other requirements (e.g., condition of railcars) in the sub-contract with railcar suppliers.
11. While meeting minimum requirements to be DOT-compliant, prepare to be flexible when facing unfavorable situations.
12. Bring rail experts on-site for training (e.g., on-site railcars movements, inspections, etc.)
13. Request on-site representatives from receiver sites and suppliers.
14. Fully utilize lessons learned from others.
15. Plan more and direct oversight on support and infrastructure installation activities.
16. Plan site visits at other sites having rail shipping experiences.

B. Best Practices During Pre-Loading Phase:

1. Compile all relevant documents/procedures.
2. Thorough inspection (e.g., moisture, holes in empty railcars).
3. Pre-brief on all requirements before job begins.
4. Conduct dry runs.
5. Brief sub-contractor personnel on DOE packaging and transportation requirements.
6. Request assistance from the Association of American Railroad inspectors for on-site inspections.
7. Check on-site infrastructures (e.g., track, scaffolding, etc.).
8. Pay attention to rail scales (e.g., weight and balance).
9. Optimize on-site movement options.
10. Interface among project/waste/transportation groups to ensure all requirements are complied throughout the project.
11. Plug/seal drain holes if the railcars are used as the package and hard covers or tarps are used on the railcars.
12. Caulk/seal seam/weld.

C. Best Practices During Loading Phase:

1. Perform as much preparatory work (e.g., install liners/wrappers) as possible prior to entering contaminated work area.
2. Consider radioactive control practices.
3. Define critical activities and perform multiple-step inspections during loading operations and maintain records (e.g., checklists).
4. Check/verify moisture content of waste and condition of wastes in each package; verify the waste profile is compatible with the packaging concept.
5. Prefer covered area for loading or avoid performing loading operations during inclement weather conditions and use tarps (or hard covers) to prevent rain/snow from infiltrating railcars in transit.
6. Band containers both horizontally and vertically.
7. Pre-stage containers in loading order.
8. Use risers/spacers to avoid closure rings rubbing against each other.
9. Use non-skid pads on metal pallets.
10. Use adequate combination of layers of load/material/waste to avoid punctures to liner/intermodal.
11. Use absorbent inside wrapper.
12. Seal rivets to prevent moisture infiltration.

D. Best Practices During Post-Loading Phase:

1. Inspect! Inspect! Inspect! (e.g., package is closed properly, loaded waste does not cause package to fail in transit, all documentation, etc.).
2. Take pictures before and after package closure.
3. Take pictures of outside of railcars (e.g., placards).
4. Notify rail carriers regarding security seals.
5. Use impact detectors, if appropriate.

III. Top Best Practices for Each Phase of Rail Shipping

Participants also voted top best practices for each of the four phases of rail shipments. They are listed below under each of the four phases.

A. Best Practices During Planning Phase:

- Define transportation scope of work and include railcar specifications and other requirements (e.g., condition of railcars) in the sub-contract with railcar suppliers.
- Thorough options analyses related to waste/material characterization, packaging, conveyance, and disposal sites.
- Dedicated fleets with hard covers when there is long lead time to procure.
- Define training needs (e.g., loading, securing, on-site railcar safety inspection, DOT compliance, etc.) and ensure training program is in place.
- Fully utilize lessons learned from others.

B. Best Practices During Pre-Loading Phase:

- Thorough inspection (e.g., moisture, holes in empty railcars).
- Compile all relevant documents/procedures.

C. Best Practices During Loading Phase:

- Define critical activities and perform multiple-step inspections during loading operations and maintain records (e.g., checklists).
- Use adequate combination of layers of load/material/waste to avoid punctures to liner/intermodal.
- Prefer covered area for loading or avoid performing loading operations during inclement weather conditions and use tarps (or hard covers) to prevent rain/snow from infiltrating railcars in transit.
- Perform as much preparatory work (e.g., install liners/wrappers) as possible prior to entering contaminated work area.

D. Best Practices During Post-Loading Phase:

- Inspect! Inspect! Inspect! (e.g., package is closed properly, loaded waste does not cause package to fail in transit, all documentation, etc.).
- Take pictures of outside of railcars (e.g., placards).
- Take pictures before and after package closure.

Appendix II – Federal Motor Carrier Safety Administration

Federal Motor Carrier Safety Administration's Cargo Securement Rules

Background

On September 27, 2002, the Federal Motor Carrier Safety Administration (FMCSA) published new cargo securement rules. Motor carriers operating in interstate commerce must comply with the new requirements beginning January 1, 2004. The new rules are based on the North American Cargo Securement Standard Model Regulations, reflecting the results of a multi-year research program to evaluate U.S. and Canadian cargo securement regulations; the motor carrier industry's best practices; and recommendations presented during a series of public meetings involving U.S. and Canadian industry experts, Federal, State and Provincial enforcement officials, and other interested parties. The new rules require motor carriers to change the way they use cargo securement devices to prevent articles from shifting on or within, or falling from commercial motor vehicles. The changes may require motor carriers to increase the number of tiedowns used to secure certain types of cargo. However, the rule generally does not prohibit the use of tiedowns or cargo securement devices currently in use. Therefore, motor carriers are not required to purchase new cargo securement equipment or vehicles to comply with the rule. The intent of the new requirements is to reduce the number of accidents caused by cargo shifting on or within, or falling from, commercial motor vehicles operating in interstate commerce, and to harmonize to the greatest extent practicable U.S., Canadian, and Mexican cargo securement regulations.

Applicability of the New Rules

The new cargo securement rules apply to the same types of vehicles and cargo as the old rules, covering all cargo-carrying commercial motor vehicles (as defined in 49 CFR 390.5) operated in interstate commerce. This includes all types of articles of cargo, except commodities in bulk that lack structure or fixed shape (e.g., liquids, gases, grain, liquid concrete, sand, gravel, aggregates) and are transported in a tank, hopper, box or similar device that forms part of the structure of a commercial motor vehicle.

Performance Criteria

FMCSA has adopted new performance requirements concerning deceleration in the forward direction, and acceleration in the rearward and lateral directions, that cargo securement systems must withstand. Deceleration is the rate at which the speed of the vehicle decreases when the brakes are applied, and acceleration is the rate at which the speed of the vehicle increases in the lateral direction or sideways (while the vehicle is turning), or in the rearward direction (when the vehicle is being driven in reverse and makes contact with a loading dock). Acceleration and deceleration values are commonly reported as a proportion of the acceleration due to gravity (g). This acceleration is about 9.8 meters/second/second (32.2 feet/second/second), which means that the velocity of an object dropped from a high elevation increases by approximately 9.8 meters/second (32.2 feet/second) each second it falls. FMCSA requires that cargo securement systems be capable of withstanding the forces associated with following three deceleration/accelerations, applied separately:

1. 0.8 g deceleration in the forward direction;
2. 0.5 g acceleration in the rearward direction; and
3. 0.5 g acceleration in a lateral direction.

These values were chosen based on researchers' analysis of studies concerning commercial motor vehicle performance. The analysis indicated that the highest deceleration likely for an empty or lightly loaded vehicle with an antilock brake system, all brakes properly adjusted, and warmed to provide optimal braking performance, is in the range of 0.8-0.85 g. However, a typical loaded vehicle would not be expected to achieve a deceleration greater than 0.6 g on a dry road. The typical lateral acceleration while driving in a curve or on a ramp at the posted advisory speed is in the range 0.05-0.17 g. Loaded vehicles with a high center of gravity roll over at a lateral acceleration above 0.35 g. Lightly loaded vehicles, or heavily loaded vehicles with a lower center of gravity, may withstand lateral acceleration forces greater than 0.5 g. Generally, motor carriers are not required to conduct testing of cargo securement systems to determine compliance with the performance requirements. The new rules explicitly state that cargo immobilized or secured in accordance with the general securement rules, or the commodity-specific rules, are considered to meet the performance criteria.

Requirements for Securement Devices

The new rules require that all devices and systems used to secure cargo to or within a vehicle must be capable of meeting the performance criteria. All vehicle structures, systems, parts and components used to secure cargo must be in proper working order when used to perform that function with no damaged or weakened components that could adversely affect their performance. The cargo securement rules incorporate by reference manufacturing standards for certain types of tiedowns including steel strapping, chain, synthetic webbing, wire rope, and cordage. FMCSA has updated the rules to reference the November 15, 1999, version of the National Association of Chain Manufacturers (NACM) Welded Steel Chain Specifications. The agency notes that some of the working load limit values in the 1999 version differ slightly from the previous edition of this publication. Also, the 1999 version includes working load limits for a new grade of alloy chain, grade 100. The agency also changed its reference for synthetic webbing from the 1991 edition to the 1998 edition of the Web Sling and Tiedown Association's publication. Generally, the working load limits are the same as those in the 1991 publication. Changes in the references do not necessarily mean the older securement devices need to be replaced. Motor carriers are not required to replace tiedown devices purchased prior to January 1, 2004. If the tiedowns satisfied the old rules, the devices should also satisfy the new rules.

Proper Use of Tiedowns

The new regulations require each tiedown to be attached and secured in a manner that prevents it from becoming loose, unfastening, opening or releasing while the vehicle is in transit. All tiedowns and other components of a cargo securement system used to secure loads on a trailer equipped with rub rails must be located inboard of the rub rails whenever practicable. Also, edge protection must be used whenever a tiedown would be subject to abrasion or cutting at the point where it touches an article of cargo. The edge protection must resist abrasion, cutting and crushing.

Use of Unmarked Tiedowns

The new rules do not prohibit the use of unmarked tiedown devices. Although many of the participants in the public meetings and numerous commenters to the rulemaking proposal argued the rules should include such a prohibition, FMCSA believes it is inappropriate to prohibit unmarked tiedowns at this time. However, in view of the potential safety hazards of motor carriers misidentifying unmarked tiedowns, there is a provision that unmarked welded steel chain be considered to have a working load limit equal to that of grade 30 proof coil, and other types of unmarked tiedowns be considered to have a working load limit equal to the lowest rating for that type in the table of working load limits.

Unrated and Unmarked Anchor Points

FMCSAs cargo securement rules do not require rating and marking of anchor points. While the agency encourages manufacturers to rate and mark anchor points, the new rules do not include a requirement for ratings and markings.

Front End Structures on CMVs

FMCSA revised its rules concerning front-end structures or headerboards by changing the applicability of the requirements to cover CMVs transporting cargo that is in contact with the front-end structure of the vehicle. By contrast, the old rules required certain vehicles to be equipped with front-end structures regardless of whether the devices were used as part of a cargo securement system.

Summary of the new cargo rules

The new cargo securement rules include general securement rules applicable to all types of articles of cargo, with certain exceptions, and commodity-specific rules covering commodities that are considered the most difficult to determine the most appropriate means of securement. Requirements concerning securement, working load limits, blocking and bracing are applicable to all commodities being transported. The commodity-specific requirements take precedence over the general rules when additional requirements are given for a commodity listed in those sections. This means all cargo securement systems must meet the general requirements, except to the extent a commodity-specific rule imposes additional requirements that prescribe in more detail the securement method to be used.

General Rule

Cargo must be firmly immobilized or secured on or within a vehicle by structures of adequate strength, dunnage (loose materials used to support and protect cargo) or dunnage bags (inflatable bags intended to fill space between articles of cargo or between cargo and the wall of the vehicle), shoring bars, tiedowns or a combination of these.

Cargo Placement and Restraint

Articles of cargo that are likely to roll must be restrained by chocks, wedges, a cradle or other equivalent means to prevent rolling. The means of preventing rolling must not be capable of becoming unintentionally unfastened or loose while the vehicle is in transit. Articles of cargo placed beside each other and secured by transverse tiedowns must be:

1. Placed in direct contact with each other, or
2. Prevented from shifting towards each other while in transit.

Minimum Working Load Limit for Cargo Securement Devices and Systems

The aggregate working load limit of any securement system used to secure an article or group of articles against movement must be at least one-half the weight of the article or group of articles. The aggregate working load limit is the sum of: One-half the working load limit of each tiedown that goes from an anchor point on the vehicle to an attachment point on an article of cargo; and The working load limit for each tiedown that goes from an anchor point on the vehicle, through, over or around the cargo and then attaches to another anchor point on the vehicle.

Minimum Number of Tiedowns

The cargo securement system used to restrain articles against movement must meet requirements concerning the minimum number of tiedowns. This requirement is in addition to complying with rules concerning the minimum working load limit. When an article of cargo is not blocked or positioned to prevent movement in the forward direction, the number of tiedowns needed depends on the length and weight of the articles. There must be - one tiedown for articles 5 ft or less in length, and 1,100 lbs or less in weight; two tiedowns if the article is -

1. 5 ft or less in length and more than 1,100 lbs in weight; or
2. greater than 5 ft but less than 10 ft, regardless of weight.

In the following example, one tiedown is required because the article of cargo is 5 ft in length and does not exceed 1,100 lbs. If the article of cargo were greater than 5 ft in length but less than 10 ft, two tiedowns would be needed regardless of the weight. When an article of cargo is not blocked or positioned to prevent movement in the forward direction, and the item is longer than 10 ft in length, then it must be secured by two tiedowns for the first 10 ft of length, and one additional tiedown for every 10 ft of length, or fraction thereof, beyond the first 10 ft. An example of this is provided below. If an article is blocked, braced or immobilized to prevent movement in the forward direction by a headerboard, bulkhead, other articles that are adequately secured, or other appropriate means, it must be secured by at least one tiedown for every 10 ft of article length, or fraction thereof.

Special Rule for Special Purpose Vehicles

Generally, the basic rules concerning the minimum number of tiedowns do not apply to a vehicle transporting one or more articles of cargo such as, but not limited to, machinery or fabricated structural items (e.g., steel or concrete beams, crane booms, girders, and trusses, etc.) which, because of their design, size, shape or weight, must be fastened by special methods. However, any article of cargo carried on that vehicle must be secured adequately to the vehicle by devices that are capable of meeting the performance requirements and the working load limit requirements.

Commodity-Specific Securement Requirements

FMCSA has adopted detailed requirements for the securement of the following commodities: logs; dressed lumber; metal coils; paper rolls; concrete pipe; intermodal containers; automobiles, light trucks and vans; heavy vehicles, equipment and machinery; flattened or crushed vehicles; roll-on/roll-off containers; and large boulders. During public meetings concerning the development of the model regulations, participants said that these commodities cause the most disagreement between industry and enforcement agencies as to what is required for proper securement.

393.116 Logs

The rules for the transportation of logs are applicable to the transportation of almost all logs with the following exceptions:

1. Logs that are unitized by banding or other comparable means may be transported in accordance with the general cargo securement rules.
2. Loads that consist of no more than four processed logs may be transported in accordance with the general cargo securement rules.
3. Firewood, stumps, log debris and other such short logs must be transported in a vehicle or container enclosed on both sides, front, and rear and of adequate strength to contain them. Longer logs may also be transported in an enclosed vehicle or container.

393.118 - Dressed Lumber and Similar Building Products

The rules in this section apply to the transportation of bundles of dressed lumber, packaged lumber, building products such as plywood, gypsum board or other materials of similar shape. Lumber or building products that are not bundled or packaged must be treated as loose items and transported in accordance with the general cargo securement rules. For the purpose of this section, the term " bundle " refers to packages of lumber, building materials or similar products which are unitized for securement as a single article of cargo.

393.120 - Metal Coils

The rules in this section apply to the transportation of one or more metal coils which, individually or grouped together, weigh 2,268 kg (5,000 lbs) or more. Shipments of metal coils that weigh less than 2,268 kg (5,000 lbs) may be secured in accordance with the general cargo securement rules.

393.122 - Paper Rolls

The rules for securing paper rolls are applicable to shipments of paper rolls which, individually or together, weigh 2,268 kg (5,000 lbs) or more. Shipments of paper rolls that weigh less than 2,268 kg (5,000 lbs), and paper rolls that are unitized on a pallet, may either be secured in accordance with the rules in this section or the general cargo securement rules.

393.124 - Concrete Pipe

The rules in this section apply to the transportation of concrete pipe on flatbed trailers and vehicles and lowboy trailers. Concrete pipe that is bundled tightly together into a single rigid article with no tendency to roll, and concrete pipe loaded in a sided vehicle or container must be secured in accordance with the general rules.

393.126 - Intermodal Containers

The requirements for intermodal containers cover the transportation of these containers on container chassis and other types of vehicles. Intermodal containers are freight containers designed and constructed to permit them to be used interchangeably in two or more modes of transportation. Cargo contained within intermodal containers must be secured in accordance with the general cargo securement rules or, if applicable, the commodity-specific rules.

393.128 - Automobiles, Light Trucks and Vans

This portion of the new standards applies to the transportation of automobiles, light trucks, and vans which individually weight 4,536 kg (10,000 lbs) or less. Vehicles which individually are heavier than 4,536 kg (10,000 lbs) must be secured in the same manner as heavy vehicles, equipment and machinery (see the rules under /393.126).

393.130 - Heavy Vehicles, Equipment and Machinery

These requirements are applicable to the transportation of heavy vehicles, equipment and machinery which operate on wheels or tracks, such as front end loaders, bulldozers, tractors and power shovels and which individually weigh 4,536 kg (10,000 lbs) or more. Vehicles, equipment and machinery which is lighter than 4,536 kg (10,000 lbs) may be secured in accordance with these rules, the rules for automobiles, light trucks and vans, or the general freight requirements.

393.132 - Flattened or Crushed Vehicles

The transportation of vehicles such as automobiles, light trucks and vans that have been flattened or crushed is covered by these requirements. The transportation of automobiles that are flattened or crushed in a crash or accident, as opposed to being intentionally flattened or crushed in preparation for transportation to recycling facilities, is not subject to these requirements. However, vehicles damaged in a crash or accident are subject to the general cargo securement requirements.

393.134 - Roll-on/Roll-Off or Hook-lift Containers

These rules apply to the transportation of roll-on/roll-off or hook lift containers. A hook-lift container is defined in 49 CFR 393.5 as a specialized container, primarily used to contain and transport materials in the waste, recycling, construction/demolition and scrap industries, which is used in conjunction with specialized vehicles in which the container is loaded and unloaded onto a tilt frame body by an articulating hook-arm. Section 393.134 is not, however, applicable to the operation of hoist-type equipment (or hoist equipment) as described in American National Standards Institute (ANSI) publication ANSI 2245.1. Hoist-type equipment should be considered separate and distinct from roll-on/roll-off equipment and, therefore, not subject to 393.134. Containers transported on hoist-type equipment must be secured in accordance with the general securement rules.

393.136 - Large Boulders

The rules in this section are applicable to the transportation of any large piece of natural, irregularly shaped rock weighing in excess of 5,000 kg (11,000 lbs) or with a volume in excess of 2 cubic-meters on an open vehicle, or in a vehicle whose sides are not designed and rated to contain such cargo. Pieces of rock weighing more than 100 kg (220 lbs), but less than 5,000 kg (11,000 lbs) must be secured, either in accordance with this section, or in accordance with the general cargo securement rules, including: (1) rock contained within a vehicle which is designed to carry such cargo; or (2) secured individually by tiedowns, provided each piece can be stabilized and adequately secured. Rock which has been formed or cut to a shape and which provides a stable base for securement must also be secured, either in accordance with the provisions of this section or in accordance with the general securement rules.

PART 393 PARTS AND ACCESSORIES NECESSARY FOR SAFE OPERATION
Subpart I
Protection Against Shifting and Falling Cargo

393.100 Which types of commercial motor vehicles are subject to the cargo securement standards of this subpart, and what general requirements apply?

1. (a)Applicability. The rules in this subpart are applicable to trucks, truck tractors, semitrailers, full trailers and pole trailers.

2. (b)Prevention against loss of load. Each commercial motor vehicle must, when transporting cargo on public roads, be loaded and equipped, and the cargo secured, in accordance with this subpart to prevent the cargo from leaking, spilling, blowing or falling from the motor vehicle.
3. (c)Prevention against shifting of load. Cargo must be contained, immobilized or secured in accordance with this subpart to prevent shifting upon or within the vehicle to such an extent that the vehicles stability or maneuverability is adversely affected.

393.102 What are the minimum performance criteria for cargo securement devices and systems?

1. (a) Performance criteria. Cargo securement devices and systems must be capable of withstanding the following three forces, applied separately:
   1. 0.8 g deceleration in the forward direction;
   2. 0.5 g acceleration in the rearward direction; and
   3. 0.5 g acceleration in a lateral direction.
2. (b) Performance criteria for devices to prevent vertical movement of loads that are not contained within the structure of the vehicle. Securement systems must provide a downward force equivalent to at least 20 percent of the weight of the article of cargo if the article is not fully contained within the structure of the vehicle. If the article is fully contained within the structure of the vehicle, it may be secured in accordance with 393.106(b).
3. (c) Prohibition on exceeding working load limits. Cargo securement devices and systems must be designed, installed, and maintained to ensure that the maximum forces acting on the devices or systems do not exceed the working load limit for the devices under the conditions listed in paragraphs (a) and (b) of this section.
4. (d) Equivalent means of securement. Cargo that is immobilized or secured in accordance with the applicable requirements of 393.104 through 393.136, is considered as meeting the performance criteria of this section.

393.104 What standards must cargo securement devices and systems meet in order to satisfy the requirements of this subpart?

a. General. All devices and systems used to secure cargo to or within a vehicle must be capable of meeting the requirements of 393.102.
b. Prohibition on the use of damaged securement devices. All vehicle structures, systems, parts, and components used to secure cargo must be in proper working order when used to perform that function with no damaged or weakened components that will adversely effect their performance for cargo securement purposes, including reducing the working load limit, and must not have any cracks or cuts.
c. Vehicle structures and anchor points. Vehicle structures, floors, walls, decks, tiedown anchor points, headerboards, bulkheads, stakes, posts and associated mounting pockets used to contain or secure articles of cargo must be strong enough to meet the performance criteria of 393.102, with no damaged or weakened components that will adversely effect their performance for cargo securement purposes, including reducing the working load limit, and must not have any cracks or cuts.
d. Material for dunnage, chocks, cradles, shoring bars, blocking and bracing. Material used as dunnage or dunnage bags, chocks, cradles, shoring bars, or used for blocking and bracing, must not have damage or defects which would compromise the effectiveness of the securement system.
e. Manufacturing standards for tiedown assemblies. Tiedown assemblies (including chains, wire rope, steel strapping, synthetic webbing and cordage) and other attachment or fastening devices used to secure articles of cargo to, or in, commercial motor vehicles must conform to the following applicable standards:(refer to table on page 12)
f. Use of tiedowns.
   1. Tiedowns and securing devices must not contain knots.
   2. If a tiedown is repaired, it must be repaired in accordance with the applicable standards in paragraph (e) of this section, or the manufac-turers instructions.
   3. Each tiedown must be attached and secured in a manner that prevents it from becoming loose, unfastening, opening or releasing while the vehicle is in transit.
   4. All tiedowns and other components of a cargo securement system used to secure loads on a trailer equipped with rub rails, must be located inboard of the rub rails whenever practicable.
   5. Edge protection must be used whenever a tiedown would be subject to abrasion or cutting at the point where it touches an article of cargo. The edge protection must resist abrasion, cutting and crushing.

393.106 What are the general requirements for securing articles of cargo?

a. Applicability. The rules in this section are applicable to the transportation of all types of articles of cargo, except commodities in bulk that lack structure or fixed shape (e.g., liquids, gases, grain, liquid concrete, sand, gravel, aggregates) and are transported in a tank, hopper, box or similar device that forms part of the structure of a commercial motor vehicle. The rules in this section apply to the cargo types covered by the commodity-specific rules of 393.116 through 393.136. The commodity-specific rules take precedence over the general requirements of this section when additional requirements are given for a commodity listed in those sections.

b. General. Cargo must be firmly immobilized or secured on or within a vehicle by structures of adequate strength, dunnage or dunnage bags, shoring bars, tiedowns or a combination of these.
c. Cargo placement and restraint.
    1. Articles of cargo that are likely to roll must be restrained by chocks, wedges, a cradle or other equivalent means to prevent rolling. The means of preventing rolling must not be capable of becoming unintentionally unfastened or loose while the vehicle is in transit.
    2. Articles or cargo placed beside each other and secured by transverse tiedowns must either:
        i. Be placed in direct contact with each other, or
        ii. Be prevented from shifting towards each other while in transit.
d. (d) Minimum strength of cargo securement devices and systems. The aggregate working load limit of any securement system used to secure an article or group of articles against movement must be at least one-half times the weight of the article or group of articles. The aggregate working load limit is the sum of:
    1. One-half of the working load limit of each associated connector or attachment mechanism used to secure a part of the article of cargo to the vehicle; and
    2. One-half of the working load limit for each end section of a tiedown that is attached to an anchor point.

[67 FR 61225, Sept. 27, 2002, as amended at 68 FR 56208, Sept. 30, 2003]

Table to 393.104(e) Manufacturing Standards for Tiedown Assemblies

An assembly component of	**Must conform to**
(1)Steel strapping [1,2]	Standard Specification for Strapping, Flat Steel and Seals, American Society for Testing and Materials (ASTM) D3953-97, February 1998. [4]
(2)Chain	National Association of Chain Manufacturers' Welded Steel Chain Specifications, November 15, 1999. [4]
(3)Webbing	Web Sling and Tiedown Association's Recommended Standard Specification for Synthetic Web Tiedowns, WSTDA-T1, 1998. [4]
(4)Wire rope [3]	Wire Rope Technical Board's Wire Rope Users Manual, 2nd Edition, November 1985. [4]
(5)Cordage	Cordage Institute rope standard: i. PETRS-2, Polyester Fiber Rope, 3-Strand and 8-Strand Constructions, January 1993; [4] ii. PPRS-2, Polypropylene Fiber Rope, 3-Strand and 8-Strand Constructions, August 1992; [4] iii. CRS-1, Polyester/Polypropylene Composite Rope Specifications, 3-Strand and 8-Strand Standard Construction, May 1979; [4] iv. NRS-1, Nylon Rope Specifications, 3-Strand and 8-Strand Standard Construction, May 1979 [4]; and v. C-1, Double Braided Nylon Rope Specifications DBN, January 1984. [4]

Footnotes:
1. Steel strapping not marked by the manufacturer with a working load limit will be considered to have a working load limit equal to one-fourth of the breaking strength listed in ASTM D3953-97.
2. Steel strapping 25.4 mm (1 inch) or wider must have at least two pairs of crimps in each seal and, when an end-over-end lap joint is formed, must be sealed with at least two seals.
3. Wire rope which is not marked by the manufacturer with a working load limit shall be considered to have a working load limit equal to one- fourth of the nominal strength listed in the manual.
4. See 393.7 for information on the incorporation by reference and availability of this document.

393.108 How is the working load limit of a tiedown determined?

a. The working load limit (WLL) of a tiedown, associated connector or attachment mechanism is the lowest working load limit of any of its components (including tensioner), or the working load limit of the anchor points to which it is attached, whichever is less.

b. The working load limits of tiedowns may be determined by using either the tiedown manufacturer's markings or by using the tables in this section. The working load limits listed in the tables are to be used when the tiedown material is not marked by the manufacturer with the working load limit. Tiedown materials which are marked by the manufacturer with working load limits that differ from the tables, shall be considered to have a working load limit equal to the value for which they are marked.
c. Synthetic cordage (e.g., nylon, polypropylene, polyester) which is not marked or labeled to enable identification of its composition or working load limit shall be considered to have a working load limit equal to that for polypropylene fiber rope.
d. Welded steel chain, which is not marked or labeled to enable identification of its grade or working load limit shall be considered to have a working load limit equal to that for grade 30 proof coil chain.
e.
    1. Wire rope which is not marked by the manufacturer with a working load limit shall be considered to have a working load limit equal to one-fourth of the nominal strength listed in the Wire Rope Users Manual.
    2. Wire which is not marked or labeled to enable identification of its construction type shall be considered to have a working load limit equal to that for 6 x 37, fiber core wire rope.
f. Manila rope which is not marked by the manufacturer with a working load limit shall be considered to have a working load limit based on its diameter as provided in the tables of working load limits.
g. Friction mats which are not marked or rated by the manufacturer shall be considered to provide resistance to horizontal movement equal to 50 percent of the weight placed on the mat.

Tables to 393.108
[Working Load Limits (WLL), Chain]

WLL in kg (lbs)					
Size mm (inches)	**Grade 30 proof**	**Grade 43 high test**	**Grade 70 transport**	**Grade 80 alloy**	**Grade 100 alloy**
1.7 (1/4)	580 (1,300)	1,180 (2,600)	1,430 (3,150)	1,570 (3,500)	1,950 (4,300)
2.8 (5/16)	860 (1,900)	1,770 (3,900)	2,130 (4,700)	2,000 (4,500)	2,600 (5,700)
3.10 (3/8)	1,200 (2,650)	2,450 (5,400)	2,990 (6,600)	3,200 (7,100)	4,000 (8,800)
4.11 (7/16)	1,680 (3,700)	3,270 (7,200)	3,970 (8,750)	& nbsp;	& nbsp;
5.13 (1/2)	2,030 (4,500)	4,170 (9,200)	5,130 (11,300)	5,400 (12,000)	6,800 (15,000)
6.16 (5/8)	3,130 (6,900)	5,910 (13,000)	7,170 (15,800)	8,200 (18,100)	10,300 (22,600)
Chain Mark Examples:					
Example 1	3	4	7	8	10
Example 2	30	43	70	80	100
Example 3	300	430	700	800	1000

Synthetic Webbing	
Width mm (in)	**WLL kg (lbs)**
45 (1-3/4)	790 (1,750)
50 (2)	910 (2,000)
75 (3)	1,360 (3,000)
100 (4)	1,810 (4,000)

Wire Rope (6 x 37, Fiber Core)	
Diameter mm (in)	**WLL kg (lbs)**
7 (1/4)	640 (1,400)
8 (5/16)	950 (2,100)
10 (3/8)	1,360 (3,000)
11 (7/16)	1,860 (4,100)
13 (1/2)	2,400 (5,300)
16 (5/8)	3,770 (8,300)

20 (3/4)	4,940 (10,900)
22 (7/8)	7,300 (16,100)
25 (1)	9,480 (20,900)

Manila Rope WLL	
Diameter mm (in)	**WLL kg (lbs)**
10 (3/8)	90 (205)
11 (7/16)	120 (265)
13 (1/2)	150 (315)
16 (5/8)	210 (465)
20 (3/4)	290 (640)
25 (1)	480 (1,050)

Nylon Rope WLL	
Diameter mm (in)	**WLL kg (lbs)**
10 (3/8)	130 (278)
11 (7/16)	190 (410)
13 (1/2)	240 (525)
16 (5/8)	420 (935)
20 (3/4)	640 (1,420)
25 (1)	1,140 (2,520)

Polypropylene Fiber Rope WLL (3-Strand and 8-Strand Constructions)	
Diameter mm (in)	**WLL kg (lbs)**
10 (3/8)	180 (400)
11 (7/16)	240 (525)
13 (1/2)	280 (625)
16 (5/8)	420 (925)
20 (3/4)	580 (1,275)
25 (1)	950 (2,100)

Double Braided Nylon Rope WLL	
Diameter mm (in)	**WLL kg (lbs)**
10 (3/8)	150 (336)
11 (7/16)	230 (502)
13 (1/2)	300 (655)
16 (5/8)	510 (1,130)
20 (3/4)	830 (1,840)
25 (1)	1,470 (3,250)

Polyester Fiber Rope WLL (3-Strand and 8-Strand Constructions)	
Diameter mm (in)	**WLL kg (lbs)**
10 (3/8)	250 (555)
11 (7/16)	340 (750)
13 (1/2)	440 (960)
16 (5/8)	680 (1,500)

20 (3/4)	850 (1,880)
25 (1)	1,500 (3,300)

Steel Strapping WLL	
Width x thickness mm (in)	**WLL kg (lbs)**
31.7 x .74 (1-1/4 x 0.029)	540 (1,190)
31.7 x .79 (1-1/4 x 0.031)	540 (1,190)
31.7 x .89 (1-1/4 x 0.035)	540 (1,190)
31.7 x 1.12 (1-1/4 x 0.044)	770 (1,690)
31.7 x 1.27 (1-1/4 x 0.05)	770 (1,690)
31.7 x 1.5 (1-1/4 x 0.057)	870 (1,925)
50.8 x 1.12 (2 x 0.044)	1,200 (2,650)
50.8 x 1.27 (2 x 0.05)	1,200 (2,650)

393.110 What else do I have to do to determine the minimum number of tiedowns?

a. In addition to the requirements of 393.106, the minimum number of tiedowns required to secure an article or group of articles against movement depends on the length of the article(s) being secured, and the requirements of paragraphs (b) and (c) of this section.
b. When an article is not blocked or positioned to prevent movement in the forward direction by a headerboard, bulkhead, other cargo that is positioned to prevent movement, or other appropriate blocking devices, it must be secured by at least:
   1. One tiedown for articles 5 feet (1.52 meters)or less in length, and 1,100 lbs (500 kg) or less in weight;
   2. Two tiedowns if the article is:
      i. 5 feet (1.52 meters)or less in length and more than 1,100 lbs (500 kg) in weight; or
      ii. Longer than 5 feet (1.52 meters)but less than or equal to 10 feet (3.04 meters) in length, irrespective of the weight.
   3. Two tiedowns if the article is longer than 10 feet (3.04 meters), and one additional tiedown for every 10 feet (3.04 meters) of article length, or fraction thereof, beyond the first 10 feet (3.04 meters) of length.
c. If an individual article is required to be blocked, braced or immobilized to prevent movement in the forward direction by a headerboard, bulkhead, other articles which are adequately secured or by an appropriate blocking or immobilization method, it must be secured by at least one tiedown for every 3.04 meters (10 feet) or article length, or fraction thereof.
d. Special rule for special purpose vehicles. The rules in this section do not apply to a vehicle transporting one or more articles of cargo such as, but not limited to, machinery or fabricated structural items (e.g., steel or concrete beams, crane booms, girders, and trusses, etc.) which, because of their design, size, shape, or weight, must be fastened by special methods. However, any article of cargo carried on that vehicle must be securely and adequately fastened to the vehicle.

393.112 Must a tiedown be adjustable?

Each tiedown, or its associated connectors, or its attachment mechanisms must be designed, constructed, and maintained so the driver of an in- transit commercial motor vehicle can tighten them. However, this requirement does not apply to the use of steel strapping.

393.114 What are the requirements for front end structures used as part of a cargo securement system?

a. Applicability. The rules in this section are applicable to commercial motor vehicles transporting articles of cargo that are in contact with the front end structure of the vehicle. The front end structure on these cargo-carrying vehicles must meet the performance requirements of this section.
b. Height and width.
   1. The front end structure must extend either to a height of 4 feet above the floor of the vehicle or to a height at which it blocks forward movement of any item of article of cargo being carried on the vehicle, whichever is lower.
   2. The front end structure must have a width which is at least equal to the width of the vehicle or which blocks forward movement of any article of cargo being transported on the vehicle, whichever is narrower.

c. Strength. The front end structure must be capable of withstanding the following horizontal forward static load:
    1. For a front end structure less than 6 feet in height, a horizontal forward static load equal to one-half (0.5) of the weight of the articles of cargo being transported on the vehicle uniformly distributed over the entire portion of the front end structure that is within 4 feet above the vehicles floor or that is at or below a height above the vehicle's floor at which it blocks forward movement of any article of the vehicle's cargo, whichever is less; or
    2. For a front end structure 6 feet in height or higher, a horizontal forward static load equal to four-tenths (0.4) of the weight of the articles of cargo being transported on the vehicle uniformly distributed over the entire front end structure.
d. Penetration resistance. The front end structure must be designed, constructed, and maintained so that it is capable of resisting penetration by any article of cargo that contacts it when the vehicle decelerates at a rate of 20 feet per second, per second. The front end structure must have no aperture large enough to permit any article of cargo in contact with the structure to pass through it.
e. Substitute devices. The requirements of this section may be met by the use of devices performing the same functions as a front end structure, if the devices are at least as strong as, and provide protection against shifting articles of cargo at least equal to, a front end structure which conforms to those requirements.

& sect;393.126 What are the rules for securing intermodal containers?

a. Applicability. The rules in this section apply to the transportation of intermodal containers. Cargo contained within an intermodal container must be secured in accordance with the provisions of & sect; & sect;393.100 through 393.114 or, if applicable, the commodity specific rules of this part.
b. Securement of intermodal containers transported on container chassis vehicle(s).
    1. Each intermodal container must be secured to the container chassis with securement devices or integral locking devices that cannot unintentionally become unfastened while the vehicle is in transit.
    2. The securement devices must restrain the container from moving more than 1.27 cm (1/2 in) forward, more than 1.27 cm (1/2 in) aft, more than 1.27 cm (1/2 in) to the right, more than 1.27 cm (1/2 in) to the left, or more than 2.54 cm (1 in) vertically.
    3. The front and rear of the container must be secured independently.
c. Securement of loaded intermodal containers transported on vehicles other than container chassis vehicle(s).
    1. All lower corners of the intermodal container must rest upon the vehicle, or the corners must be supported by a structure capable of bearing the weight of the container and that support structure must be independently secured to the motor vehicle.
    2. Each container must be secured to the vehicle by:
        i. Chains, wire ropes or integral devices which are fixed to all lower corners; or
        ii. Crossed chains which are fixed to all upper corners; and,
    3. The front and rear of the container must be secured independently. Each chain, wire rope, or integral locking device must be attached to the container in a manner that prevents it from being unintentionally unfastened while the vehicle is in transit.
d. (d) Securement of empty intermodal containers transported on vehicles other than container chassis vehicle(s). Empty intermodal containers transported on vehicles other than container chassis vehicles do not have to have all lower corners of the intermodal container resting upon the vehicle, or have all lower corners supported by a structure capable of bearing the weight of the empty container, provided:
    1. The empty intermodal container is balanced and positioned on the vehicle in a manner such that the container is stable before the addition of tiedowns or other securement equipment;
    2. The amount of overhang for the empty container on the trailer does not exceed 5 feet on either the front or rear of the trailer;
    3. The empty intermodal container must not interfere with the vehicle's maneuverability;
    4. The empty intermodal container is secured to prevent lateral, longitudinal, or vertical shifting.

& sect;393.134 What are the rules for securing roll-on/roll-off or hook lift containers?

a. Applicability. The rules in this section apply to the transportation of roll-on/roll-off or hook lift containers.

b. Securement of a roll-on/roll-off and hook lift container. Each roll-on/roll-off and hook lift container carried on a vehicle which is not equipped with an integral securement system must be:
    1. Blocked against forward movement by the lifting device, stops, a combination of both or other suitable restraint mechanism;
    2. Secured to the front of the vehicle by the lifting device or other suitable restraint against lateral and vertical movement;
    3. Secured to the rear of the vehicle with at least one of the following mechanisms:
        i. One tiedown attached to both the vehicle chassis and the container chassis;
        ii. Two tiedowns installed lengthwise, each securing one side of the container to one of the vehicle's side rails; or
        iii. Two hooks, or an equivalent mechanism, securing both sides of the container to the vehicle chassis at least as effectively as the tiedowns in the two previous items.
    4. The mechanisms used to secure the rear end of a roll-on/roll off or hook lift container must be installed no more than two meters (6 ft 7 in) from the rear of the container.
    5. In the event that one or more of the front stops or lifting devices are missing, damaged or not compatible, additional manually installed tiedowns must be used to secure the container to the vehicle, providing the same level of securement as the missing, damaged or incompatible components.

& sect;393.136 What are the rules for securing large boulders?

a. Applicability.
    1. The rules in this section are applicable to the transportation of any large piece of natural, irregularly shaped rock weighing in excess of 5,000 kg (11,000 lbs) or with a volume in excess of 2 cubic-meters on an open vehicle, or in a vehicle whose sides are not designed and rated to contain such cargo.
    2. Pieces of rock weighing more than 100 kg (220 lbs), but less than 5,000 kg (11,000 lbs) must be secured, either in accordance with this section, or in accordance with the provisions of & sect; & sect;393.100 through 393.114, including:
        i. Rock contained within a vehicle which is designed to carry such cargo; or
        ii. Secured individually by tiedowns, provided each piece can be stabilized and adequately secured.
    3. Rock which has been formed or cut to a shape and which provides a stable base for securement must also be secured, either in accordance with the provisions of this section, or in accordance with the provisions of & sect; & sect;393.100 through 393.114.

b. General requirements for the positioning of boulders on the vehicle.
    1. Each boulder must be placed with its flattest and/or largest side down.
    2. Each boulder must be supported on at least two pieces of hard wood blocking at least 10 cm x 10 cm (4 in x 4 in) side dimensions extending the full width of the boulder.
    3. Hardwood blocking pieces must be placed as symmetrically as possible under the boulder and should support at least three-fourths of the length of the boulder.
    4. If the flattest side of a boulder is rounded or partially rounded, so that the boulder may roll, it must be placed in a crib made of hardwood timber fixed to the deck of the vehicle so that the boulder rests on both the deck and the timber, with at least three well-separated points of contact that prevent its tendency to roll in any direction.
    5. If a boulder is tapered, the narrowest end must point towards the front of the vehicle.

c. General tiedown requirements.
    1. Only chain may be used as tiedowns to secure large boulders.
    2. Tiedowns which are in direct contact with the boulder should, where possible, be located in valleys or notches across the top of the boulder, and must be arranged to prevent sliding across the rock surface.

d. Securement of a cubic shaped boulder. In addition to the requirements of paragraphs (b) and (c) of this section, the following rules must be satisfied:
    1. Each boulder must be secured individually with at least two chain tiedowns placed transversely across the vehicle.
    2. The aggregate working load limit of the tiedowns must be at least half the weight of the boulder.
    3. The tiedowns must be placed as closely as possible to the wood blocking used to support the boulder.

e. Securement of a non-cubic shaped boulder - with a stable base. In addition to the requirements of paragraphs (b) and (c) of this section, the following rules must be satisfied:
    1. The boulder must be secured individually with at least two chain tiedowns forming an " X " pattern over the boulder.

2. The aggregate working load limit of the tiedowns must be at least half the weight of the boulder.
3. The tiedowns must pass over the center of the boulder and must be attached to each other at the intersection by a shackle or other connecting device.

f. Securement of a non-cubic shaped boulder - with an unstable base. In addition to the requirements of paragraphs (b) and (c) of this section, each boulder must be secured by a combination of chain tiedowns as follows:
   1. One chain must surround the top of the boulder (at a point between one-half and two-thirds of its height). The working load limit of the chain must be at least half the weight of the boulder.
   2. Four chains must be attached to the surrounding chain and the vehicle to form a blocking mechanism which prevents any horizontal movement. Each chain must have a working load limit of at least one-fourth the weight of the boulder. Whenever practicable, the angle of the chains must not exceed 45 degrees from the horizontal.

Issue 2: & sect; 393.102(d) - Equivalent means of securement.

Agency Policy: The means of securing articles of cargo are considered to meet the performance requirements under & sect;393.102(a) if the cargo is:

1. Immobilized; or
2. Fills a sided vehicle that has walls of adequate strength, and each article of cargo within the vehicle is in contact with, or sufficiently close to a wall or other articles, so that it cannot shift or tip if those articles are also unable to shift or tip; or
3. Secured in accordance with the applicable requirements of & sect; & sect;393.104 through 393.136.

Discussion: Currently, & sect;393.102(d) states that loads that are immobilized, or secured in accordance with the applicable requirements of & sect; & sect;393.104 through 393.136 are considered to meet the performance requirements. Certain industry groups believe & sect;393.102(d) should be revised to provide a third option regarding equivalent means of securement that would satisfy the performance criteria. They believe that if the cargo fills a sided vehicle equipped with walls of adequate strength, and each article of cargo is positioned so it does not shift or tip inside the vehicle, the loading arrangement or securement system should be considered to satisfy the performance requirements under & sect;393.102. FMCSA intended the term " immobilized " to be construed to include what the industry recommends as a third option. However, the agency acknowledges that the absence of an explicit reference to situations in which the cargo fills a sided vehicle may result in inconsistent enforcement practices. Therefore, enforcement officials should construe the rule to mean that when cargo fills a sided vehicle with walls of adequate strength, it is considered to meet the performance criteria.

Appendix III - Department of Energy Lessons Learned

Title: **Intermodal Container Issues Impact Waste Disposal Costs**

Identifier: **2004-NV-NTSBN-006**

Date: **2003-12-17**

Lesson Learned Statement:

The use of intermodal containers to transport low-level radioactive waste to the Nevada Test Site (NTS) can decrease costs for generator facilities. However, the use of intermodal containers can also increase costs and present safety concerns for the receiving facility at the NTS. In addition, intermodal containers have been damaged during transport and offloading. Several activities were identified as contributing factors. Recommendations were developed to reduce or limit the damage and potential for personnel injury and exposure from the waste, as well as, increase efficiencies at the NTS receiving facility.

Discussion:

Several recurring themes were detected in issues associated with the receipt of intermodal containers that were used to transport radioactive waste to the NTS. These issues, if not resolved, have demonstrated the potential for significantly increasing disposal costs for those sites shipping radioactive waste for disposal at the NTS, as well as, increasing safety concerns for personnel offloading waste in the intermodal containers at the NTS waste management site.

Analysis:

Intermodal containers can take up to five times as long to process as standard packaged waste if waste becomes lodged during offloading. Intermodal containers require additional personnel to offload compared to standard packaged waste because they are emptied in a contamination area. In addition, inclement weather can significantly delay offloading operations as intermodals and support equipment cannot be cleared from the contamination area if the ground is wet or muddy. The minimum time needed to receive and prepare an intermodal container for return is three days per container. Additionally, moving disposal operations to larger craters reduced the offloading time because the equipment did not have to travel in and out of disposal craters, and thus, more intermodals could be staged in the area of disposal operations at one time.

In the future, processing intermodal containers at the NTS may raise the cost of disposing of waste at the NTS for all generating sites across the complex. As volume per shipment decreases and number of personnel required for each

process increases, the cost to the complex will continue to increase.
Fixed contamination levels on intermodal containers have exceeded U.S. Department of Energy release limits and were not detected at the generator's site because containers were not loaded in clean areas. Fixed contamination was detected on the rollers beneath the containers once it arrived at the NTS and required extra time and personnel to decontaminate prior to their return to the generator's site. Loading intermodals in clean areas and conducting thorough surveys at the generator's site that take into account areas on the intermodal container that may be contaminated, could reduce the potential for contamination and decrease the need for decontamination to be performed at the NTS.

Top-hinged containers pose a crush-point/pinch-point hazard to personnel who perform exit surveys. Top-hinged containers can comprise as much as ten percent of the containers shipped by specific generator. NTS requests side-hinged only intermodal containers to eliminate the hazard posed by top-hinged containers.

During offloading, intermodal containers were damaged by waste lodged in the container. Roll-off trucks used to transport intermodal containers were not appropriately sized for offloading the intermodal containers. Insufficient lift capacity increased the potential for damaging the container and vehicle based on the inability of the roll-off truck to handle load shifts. Failure to reduce the waste size to less than a nominal three feet in any one direction combined with compactor loading of the intermodal containers resulted in waste lodging during offloading which damaged containers. In addition, loads shifted during transport and resulted in waste resting against the container door. When retention devices were loosened, the waste fell out and endangered personnel. Waste loaded by a compactor was more likely to pile up against the door due to initial random settling during transport. Waste loaded by hand resulted in a more stable initial configuration that reduced potential load shifting. Failure to wrap and secure the inner liner in the packaging exposed inner components and increased the potential for spreading airborne contamination and release of radioactive material to the environment. In addition, without securing the inner liner, the waste could easily fall out of the container when the door was opened endangering NTS personnel offloading the waste.

The unusual configuration of the waste received resulted in higher than expected void space. Void space cannot be filled with other waste. At a minimum, void space increases waste disposal areas by three times the volume of waste received. Minimizing void space reduced the amount of dirt required to cover the containers. Moving disposal operations to larger craters allowed greater flexibility in the alignment of equipment and offloading configuration, and minimized the void space between containers.

Recommended Actions:

Utilize standard waste packages, when practical, to ship waste. Utilize only side-hinged intermodal containers. Secure the inner lining of the intermodal containers. Reduce waste size to less than three feet in any one direction to reduce the potential for damage from lodged waste objects. Load waste using the best available methods to ensure loads have a more stable initial configuration and do not shift during transport. Ensure roll-off trucks have sufficient capacity for the waste being transported to reduce damage to the container and the truck from shifted loads. Securely fasten intermodal containers to reduce the risk of injury to personnel who offload the waste.

Originator:

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Validator:

None provided

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Name Of Authorized Derivative Classifier:

Art Francis

Name Of Reviewing Official:

Art Francis

Priority Descriptor:

Blue / Information

Keywords:

None provided

References:

N/A

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DOE Function / Work Categories:

Packaging & Transportation

ISM Category:

Feedback and Improvement

Hazard:

Personal Injury / Exposure - Radiation / Contamination

Title: Full Metal-topped Intermodal Container transferred from Disabled Truck

Identifier: G-2002-OR-BJCETTP-1101

Date: 2002-11-21

Lesson Learned Statement:

The use of the intermodal IP-1 containers by the subcontractor proved beneficial when the hauling truck became disabled.

Discussion:

A heavy duty truck (chassis of a type commonly used as a dump truck, concrete mixing delivery truck, and as a transporter of roll-on/ roll-off containers) had axle and wheel separation. While transporting a 25 cubic yard capacity metal intermodal container containing approximately 37,060 pounds of radioactive material, the heavy duty truck with three rear axles experienced a bearing failure. The axle bearing did not squeal, smoke, exhibit vibration, abnormal wheel movement or otherwise provide any advance warning of the impending failure. Upon the sudden and catastrophic failure of the outboard right rear bearing, the right axle separated from the differential. This axle and connected dual wheel assembly left the intermodal truck and crossed both lanes of a two lane highway and came to rest in a wooded area. The loss of the axle and wheel assembly made the truck difficult to control and braking caused the rear of the truck to fishtail. Maintenance practices and driver inspections were being performed in a manner that would have identified bearing failure warning signs had they been obvious.

Analysis:

The use of the metal-topped intermodal containers that met the general design requirements for an Industrial Packaging Type 1 (IP-1) was beneficial in that the Class 7 cargo was easily transferred from the disabled truck and the shipment completed. U.S. Department of Transportation requirements for the placarded hazardous material provide the shipper with a variety of container options for bulk cargo. Tarp-covered, sift proof dump trucks were an alternative container that had been considered for this material. However, metal-topped intermodal containers were selected due to the operational flexibility afforded to the project in storage of loaded cargo and staging awaiting transportation. Had dump trucks been employed, the transfer of the loaded cargo next to a public road would have been very difficult. The intermodal container enabled the prompt transfer and disposal of the waste contents as planned without the loss of radioactive material to the environment.

Recommended Actions:

Projects transporting bulk waste for disposal should consider the use of intermodal containers for their cargo. These containers offer operational flexibility and provided beneficial capability to readily transfer bulk cargo from disabled carriers.

Originator:

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Validator:

John Lea, Bechtel Jacobs Company, LLC

Contact:

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Name Of Authorized Derivative Classifier:

Samuel C. Howard

Name Of Reviewing Official:

Dirk D. Holt

Priority Descriptor:

Green / Good Work Practice

Keywords:

metal-topped intermodal; IP-1 containers

References:

Occurrence Report: ORO-BJC-K25GENLAN-2002-0017

Information in this report is accurate to the best of our knowledge. As means of measuring the effectiveness of this report please use the "Comment" link at the bottom of this page to notify the Lessons Learned Web Site Administrator of any action taken as a result of this report or of any technical inaccuracies you find. Your feedback is important and appreciated.

DOE Function / Work Categories:

Packaging & Transportation
Waste Management

ISM Category:

Feedback and Improvement

Appendix IV – Customer Intermodal Container Management Program

D. Routine Inspection and Maintenance: The routine inspection and maintenance tasks must be performed by the end user on a regular basis while containers are on lease:

1. Tailgate chains should be regularly checked for link damage.
2. Inspect the tailgate gasket every time it is exposed (by opening the container) to verify gasket integrity and sealing capability. Gaskets should be replaced if:
   a.) they exhibit little or no compressibility or have tears, or
   b.) have cuts greater than ½ inch deep on the surface. The gasket may need to be greased to provide maximum sealing capability. (Cleaning the gasket after dumping or prior to reloading will prolong the life of the gasket.)
3. Container hard-top lids should be checked for gasket integrity, damage to rollers and to ensure all straps are secure and in tact.
4. Containers with tarp tops should be checked for rips and tears, and to ensure all straps are secure and in tact. The tarp must be intact; holes in tarps are an unacceptable condition. Please use proper patch materials to repair. NOTE: "Duct" tape is not an acceptable repair material.
5. Containers used to transport hazardous materials or hazardous waste must be free of holes in the body of the container. If rust, puncture or other type of hole is discovered proper weld repairs must be performed. Matching paint must be applied to the repaired area(s).
6. All caster (roller) pins must be present and in good repair. Retaining pins must also be present and in good repair.

E. Pre-Acceptance Checklist. When using an MHF-LS intermodal container the following guidelines should be integrated into site or project procedures:

1. A container inspection form should be completed each time the box is received or released for transport. The object is to create a paper trail to document the condition of the container when given to the next transporter. This has been designed to protect all parties and determine where damage has occurred.
2. Container should be inspected for dents, tears or rips, paint scrapes or any other type of damage or missing parts. This inspection must be completed using the original inspection form that was provided with the container or was sent under separate cover. The condition should be noted using the code listed on the bottom of the form. Be specific if damage is discovered.

3. If the condition of the container is not acceptable the inspector should document the problem and notify MHF-LS immediately.
4. If you have questions concerning this form or you identify damages or missing parts please call 724-772-9800 extension 5538. (Steve Lipecky, Equipment Manager)

1.0 General

The following guidelines have been developed to load bulk debris into MHF-LS intermodal containers.

2.0 Purpose

The purpose of this document is to provide written guidelines for loading debris type waste streams into MHF-LS intermodal containers. By following these guidelines, the user of the containers will greatly reduce possible damage during loading, unloading, and transit. Following the guidelines will reduce the user's liability for damages to intermodal containers, and insure safer, compliant transportation of bulk debris waste streams.

Note:
These are guidelines recommended by MHF-LS. Waste Acceptance Criteria (WAC), Waste Profiles, or Site Procedure requirements may take precedence over these guidelines. Consult and compare these documents before loading containers.

3.0 Container Operation and Procedures

3.1 Refer to the latest revision of the Customer Intermodal Container Management Program (CICMP). To acquire a copy, contact Steve Lipecky at 724-772-9800 extension 5538.

4.0 Debris Types

4.1 Concrete debris

Note: Before loading any concrete pieces larger then 1 foot, consideration should be given to preparing the container with 3-6 inches of soil, old pallets, or ½ inch plywood to protect the floor of the container from damage, such as floor penetration during loading.

4.1.1 Concrete may be loaded in the intermodal containers in one of two forms.

4.1.1.1 Reduce the concrete to rubble with a maximum dimension of approximately 1 foot.

4.1.1.2 Large blocks or slabs (greater then 1 foot) should be loaded into the intermodal under the following criteria.

Underside damage to a container, due to improper preparation, concrete was allowed to penetrate floor during loading.

- It must fit into the intermodal container without wedging into any area of the container,
- must not exceed the gross weight limit of the container,
- maintain a clearance of at least 18 inches between the top of the concrete and the bottom of the top header brace (located near the door end of the container).
- If the block or slab must be lowered in the box in so that it will not become wedged in the container, cribbing may be necessary to prevent movement during transportation and allow the waste to exit under the header and through the rear door with sufficient clearance to prevent damage.
- Rebar should be cut flush to the concrete as much as possible.

4.2 Steel Plate

Note: Before loading any steel plate heavier then 200 pounds, consideration should be given to preparing the container with 3-6 inches of soil, old pallets, or ½ inch plywood to protect the floor of the container from damage, such as penetration during loading.

Steel Plate loaded too high in container.

4.2.1 Steel plate should not exceed 4 feet in width or 16 feet in length. Steel plate should not be bent over or folded while placing it into the container. Steel plate should be loaded not to extent 18 inches from the header brace located near the door end of the container. Steel plate should never interfere with the lid of the container. Steel plate should never be forced or pushed into the container in a manner that would inhibit the plate from sliding out of the container when dumped. Cribbing maybe necessary to avoid binding of steel plate during unloading or to keep the plate stable from movement during normal transportation.

4.2.2 When loading shorter pieces of steel, be aware that load shifts can cause waste to “steeple” in the middle of the container, angling upward to pierce the aluminum lid. Size, load, or brace materials to avoid this effect.

4.3 Piping/Tube Steel

4.3.1 Piping/Tube Steel should be loaded similar to steel plate. Steel plate should not be bent over or folded while placing it into the container. Piping/Tube Steel should be loaded not to extent 18 inches from the header brace located near the door end of the container. Piping/Tube Steel should never interfere with the lid of the container. Piping/Tube Steel should never be forced or pushed into the container in a manner that would inhibit the Piping/Tube Steel from sliding out of the container when dumped. Cribbing maybe necessary to avoid binding of Piping/Tube Steel during unloading or to keep the plate stable from movement during normal transportation.

4.3.2 When loading shorter pieces of piping or tube steel, be aware that load shifts can cause debris to "steeple" in the middle of the container, the debris angling upward to pierce the aluminum lid. Load or brace materials to avoid this effect.

4.4 Misc./Metals/Building Debris/Structural Steel/Conduit

Note: Before loading any Misc./Metals/Building debris/Structural Steel/Conduit heavier then 200 pounds , consideration should be given to preparing the container with 3-6 inches of soil, old pallets, or ½ inch plywood to protect the floor of the container from damage, particularly floor penetration during loading.

4.4.1 Misc./Metals/Building debris/Structural Steel/Conduit should be loaded similar to Piping/Tube Steel. Misc./Metals/Building debris/Structural Steel/Conduit should not be bent over or folded while placing it into the container. Misc./Metals/Building debris/Structural Steel/Conduit should be loaded not to extent 18 inches from the header brace located near the door end of the container. Misc./Metals/Building debris/Structural Steel/Conduit should never interfere with the lid of the container. Misc./Metals/Building debris/Structural Steel/Conduit should never be forced or pushed into the container in a manner that would inhibit the Misc./Metals/Building debris/Structural Steel/Conduit from sliding out of the container when dumped. Cribbing maybe necessary to avoid binding of Misc./Metals/Building debris/Structural Steel/Conduit during unloading or to keep the plate stable from movement during normal transportation.

Too high in container, interfering with top of header

4.5 Missile Protection

Long, heavy debris, such as I-Beams, can form missiles during normal acceleration/deceleration in transit. Loading this type of debris should consider the potential for this type of debris to penetrate the ends of the containers during transit. Steps to mitigate the potential for this type of damage include loading the long heavy debris along with soil or other motion-damping material. Alternatively, lumber bulkheads can be constructed at the front and rear of the container to limit debris movement and absorb shock.

4.6 Other Loading Considerations

4.6.1 The front of most intermodal containers includes a "dog box" above and around the cable hook used to handle the boxes with a roll-off truck. The dog box is lighter gauge metal than the floor of the container, and loading activities should include measures to avoid dropping debris directly onto the dog box area.

Roll-off trucks shift unstable loads to rear. (Note: the trapezoidal "dog box")

4.6.2 If the debris is not secured inside the container, the use of a hoist trucks (roll-off trucks) will cause the material to mass itself against the door due to the inverting loading process onto the truck. This will cause a severe unbalanced load inside the container. It is important the load stay secured and evenly loaded inside the containers during all transportation and handling activities.

5.0 Further information

5.1 For further questions on intermodal containers before loading debris types waste streams contact:

Mark Delfratte
MHF-LS Operations at 724-772-9800 extension 5535.

Appendix V – Photographs of Debris Loading Examples

Case 1:

Gondola loaded with concrete debris containing excessive and improperly prepared rebar. The shipper attempted to condition the waste with a backhoe, pressing the rebar into the waste and 'padding' with other debris. This approach to load softening was successful in many cases.

However:

The Super Load Wrapper™ was breeched in a few cases. The solution in this case is to use stouter intermodal containers for the rebar-laden debris.

Case 2:

Damage cause from large steel plates, shipped unsecured in an intermodal. This damage to the bulkhead probably resulted from the railcar being "humped", creating a sudden deceleration of the railcar and intermodal. The solution was to secure future loads by strapping to the intermodal, and to add plywood load softeners to the bulkheads.

In addition, the radiological hazard from this load was temporarily addressed with the following weld repair:

Case 3:

This intermodal container was loaded with debris that was too large to effectively exit the container through the dump door. Individual pieces may have been small enough to fit, but the pieces shifted and "log-jammed" to prevent container emptying. Some of these overloaded containers were buried with their contents, owing to safety concerns about removing the debris manually (see the DOE ORPS report 2004-NV-NTSBN-006).

Typical oversize debris (too large for the container)

Good Practice:

In this effective practice, Lift Liner™ containing smaller debris pad and brace wrapped blocks securely against the gondola wall to prevent shifting of the load during transit. The gondola is lined with a Super Load Wrapper™.