



Best Practices for Rail Transport of Fuel Ethanol

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Best Practices for Rail Transport of Fuel Ethanol

The most common mode of transportation for fuel ethanol leaving an ethanol production facility is via rail transport. It is estimated that near 70% of all ethanol produced today will travel via rail during the path to the marketplace. Commonly referred to as the “virtual pipeline,” rail transport of fuel ethanol has proven to be extremely efficient and more than adequate for moving product to the marketplace. The “virtual pipeline” may contain upwards of 2.5 million gallons of fuel ethanol in single unit train transport, roughly equivalent to the typical load of petroleum introduced to the pipeline. As the industry continues to grow and expand, the “virtual pipeline” will surely grow and become even more efficient, thus assuring the continued leadership of fuel ethanol transport via rail.

Rail transport can play a significant role in the everyday operations of an ethanol production facility. For example, a 100 million gallon plant situated on a rail line can easily expect to receive and ship an average of 36 railcars per day. That entails receiving raw materials and process aides while at the same time shipping fuel ethanol and other co-products to customers. From a production cost perspective, rail transport can represent the third highest internal cost for a biorefinery, following only raw material procurement and direct energy costs.



The number of ethanol shipments by rail has paralleled the overall growth seen in the industry. This increase in shipments is also reflective of many new shipping origins.

Year	Overall Hazmat Ranking in Rail Shipments	Number of Shipments (Loads)
2004	Rank – 5	65,372
2005	Rank – 5	72,677
2006	Rank – 2	116,224
2007	Rank – 1	158,460
2008	Rank – 1	219,033
Ethanol Industry Projection		
2009	Rank – 1	est. 249,150 *

**10.5 BGY est. 70% Rail with 29,500 gal/ car*

There are many regulatory and general safety aspects associated with ethanol transport via rail. Department of Transportation (DOT) regulations specifically require that:

- No person may offer, accept, or transport a hazardous material in commerce unless that material is properly classed, described, packaged, marked, labeled, and placarded and is in proper condition for transportation according to DOT and International regulations.
- No person may transport a hazardous material in commerce unless the hazardous material is handled and transported according to DOT regulations.

This document presents general guidelines for the ethanol industry in an effort to promote improved regulatory compliance and to communicate many of the industry best practices for the continued safe transport of ethanol via rail. The information, though believed to be accurate at the time of publication, should not be considered as legal advice or as a substitute for developing specific company operating guidelines or reviewing the pertinent regulations individually.

Ethanol as a Hazardous Material

In order for fuel ethanol to be fit for its ultimate end use as an ignitable fuel for spark ignition engines, it must also be a flammable material. The DOT defines the chemical and physical characteristics of flammable liquids in 49 CFR 173.120.

Typical fuel ethanol (*Example: Ethanol meeting ASTM D 4806 Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for use as an Automotive Spark-Ignition Engine Fuel*) per DOT regulations is a Class 3 Flammable Liquid. A DOT flammable liquid has a flash point of not more than 60.5°C (141°F) or any material in a liquid phase with a flash point at or above 37.8°C (100°F). (49CFR173.120) Further, fuel ethanol meets the requirements of Packing Group II, flash point less than 23°C (73°F) and initial boiling point greater than 35°C (95°F). (49CFR173.121)

Fuel Ethanol Typical Properties		
Flashing Point	-5°F	ASTM D 56 (Tag Closed Cup)
Boiling Point	~172°F	n/a

For comparative purposes, the Occupational Safety and Health Administration (OSHA) regulations also classify flammable liquids and further differentiate products by Class. Typical fuel ethanol is considered a Class IB flammable product as defined by OSHA. Flammable liquids defined by OSHA possess a flash point below 100°F. Class IB designation includes liquids having flashpoints below 73 °F (22.8 °C) and having a boiling point at or above 100 °F (37.8 °C). (29CFR1910.106)

Standard Operating Procedures

Every shipping location should develop Standard Operating Procedures specific to the tasks needed for loading and unloading railcars. The procedures should provide sufficient detail for the operations required in order to complete the work in a safe and

efficient manner while meeting all regulatory and facility specific requirements. Standard operating procedures should support the company and site specific policies for conducting the company's business. The OSHA Process Safety Management regulatory requirements overlap DOT regulatory requirements for the ethanol tankcar load out area activities. (29CFR1910.119)

Resources are available to the ethanol industry and should play a key role in developing site specific policies and standard operating procedures. These resources include:

- U.S. Department of Transportation Hazardous Material Instructions for Rail, http://boe.aar.com/boe/download/US_HMI_Final%202008.pdf
- Association of American Railroads Pamphlet 34: Recommended Methods for the Safe Loading and Unloading of Non-Pressure (General Service) and Pressure Tank Cars: <http://boe.aar.com/>
- RFA Plant and Employee Safety Committee Recommendations for Ethanol Placarding: <http://www.ethanolrfa.org/industry/resources/safety/>
- Federal Railway Administration (FRA) recommends the use of this Ethanol Tank Car Loading Checklist: <http://www.ethanolrfa.org/industry/resources/safety/>

Rail Loading Best Practices

The following best practices are based on ethanol tank loading experience and comments from FRA inspector's observations in the field. The following practices have been developed and are being recommended to the ethanol industry in an effort to improve the safe handling and transport of fuel ethanol.



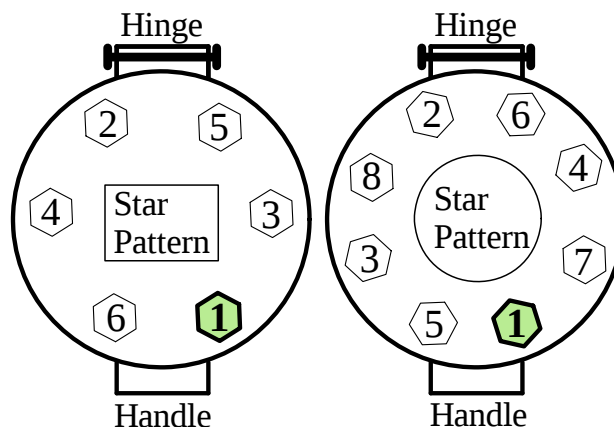
1. Selection of Tankcars
 - Tankcars chosen for ethanol transport must be suitable for use. The standard car for ethanol rail transport is the DOT 111A type of railcar.
 - These railcars typically have a 286,000 lb. total weight restriction with a nominal liquid capacity of 30,000 gallons.
 - These railcars are ½" thick carbon steel construction that are unjacketed/unlined and are limited to non pressure service.
 - The service life of this type of railcar is expected to be 30- 40 years.
2. Selection and Inspection of Gaskets, O-Rings
 - Gaskets must be suitable for use with fuel grade ethanol. The materials of construction of the gasket must be compatible with the product being shipped, fuel ethanol may contain up to 5% denaturant, most likely a nominal 2% denaturant (hydrocarbon product.)
 - Gaskets should be inspected upon each load and unload operation. Any noticeable deterioration of the gasket should prompt replacement. A

preventative maintenance program could be established for the regular change-out of tankcar gaskets.

- Testing should be done to determine which type of gasket material provides the best seal between the manway cover lid and the bottom outlet valve cap. It is important to use a durable and compatible gasket.
- The universal lip-type gaskets should only be used on manway nozzles where the gasket will not be pinched by a grooved manway lid or by a spring-aided manway hinge.
- O Rings must be suitable for use with fuel grade ethanol. The materials of construction of the O-Rings must be compatible with the product being shipped. Fuel ethanol may contain up to 5% denaturant, most likely a nominal 2% denaturant (hydrocarbon product). O-Rings selection and inspection may occur infrequently; therefore selection when the opportunity arises is important. If any evidence is present indicating O-Ring failure, corrective action should be taken immediately.

3. Standard Operating Procedures (SOP)

- SOP should be established for the tank car loading process.
- SOP should also include sufficient detail for tightening manway lids that provide a uniform compression on the gasket/nozzle interface.
- The procedures must recommend the tightening of the manway securing bolts using the star pattern the first time around at 50% of the final recommended torque. Impact the bolts with a spark proof tool to relieve any tension on the bolt and then retighten, using the star pattern again, to 100% of the final recommend torque.



- Use a lubricant on the bolt threads and nut bearing surface to reduce the friction between the nut and bolt. This promotes a more uniform torque reading.
- A listing of proper tools should be included. Using a torque wrench or impact wrench with an extension onto a spark-proof socket will provide adequate leverage for the tightening operation. The SOP should define the

proper tools for the operation and appropriate torque values for securing the manway bolts.

- A ½” drive (up to 250 ft/lbs torque) impact wrench with 80- 90 psi provides ample torque for securing the nuts on the bolted manway connection. A ¾” drive most likely provides too much torque (greater than 500 ft/ lbs) and could cause damage to the manway lid, threads of the bolts, and physical damage to the nuts.
- Never use a pipe wrench or cheater bar on hinged manway bolts.
- Always check all of the fittings on the tankcar, even the fittings for corrosion and damage, and fittings that may not have been used. Any defect found should be appropriately addressed.

4. Pre and Post Load Inspection Checklist

- A pre and post load inspection checklist should be completed for every load activity. The checklist should be completed in the field as the tankcar is physically being inspected. An example of the FRA recommended checklist for ethanol transport is included at the end of this document.

5. Bottom Outlet Cap

- During inspection of the tank car, no matter under load or empty, verification of the bottom outlet valve position must be made.
- While loading a tank car equipped with a bottom outlet valve, the following should be considered:
 - Bottom outlet valve must be verified for proper operation. Once proper operation has been verified, the valve should be closed and secured as appropriate.
 - Bottom outlet cap and/ or outlet plug should be removed during the entire time the car is being loaded. Continuous monitoring of the bottom valve area ensures the valve does not leak.
 - Ensure that any auxiliary valve(s), if tank is so equipped, is open during the entire loading process.
 - Ensure that post load, there is no more than a “dropping” of the liquid contents of the car from the bottom outlet cap.
- While unloading a tank car equipped with a bottom outlet valve, the following should be considered:
 - Confirm the bottom outlet valve is closed before loosening the bottom outlet cap or plug. If it cannot be confirmed that the bottom outlet valve is closed, the tank car should be unloaded through the fittings on top of the car.
 - Ensure that during the unloading process, if leakage shows upon starting the removal of the bottom outlet cap or plug, the cap or plug should not be entirely unscrewed. Sufficient threads should be left engaged to permit controlled escape of any accumulation of liquid.
- Any leakage from the bottom valve area must prompt an investigation prior to release from the facility.

6. Top-operated Bottom Outlet Valves
 - o Tankcars with a top-operated bottom outlet valve should not be selected for ethanol rail service.
7. Vacuum Relief Devices
 - o Vacuum Relief Devices should be inspected prior to every loaded shipment. With the tankcar owner's approval, these valves have been removed and plugged off due to concerns with product leakage.
8. Grounding and Bonding
 - o All ethanol shipping vessels and containers must be electrically grounded and loaded on bonded and insulated tracks to prevent the possibility of sparks from static electricity or stray electrical currents.
9. Shipping Papers
 - o A periodic review of the shipping papers associated with the transport of ethanol should be conducted for thoroughness and accuracy. The required information for shipping papers for rail transport are condensed in the DOT Hazardous Materials Instructions for Rail.
10. Outage, Headspace
 - o A procedure should be developed to determine the proper outage for the tank car contents.

Allow a lag time to verify any new procedures, (new gasket materials, new torque wrench settings, etc.) to ensure proper securement and safety procedures are adequate. The lag time should be long enough for the tankcar to be subjected to a range of ambient temperature conditions for example daytime and night time temperatures. Tanks cars may need to sit idle for 24 hours, then have the manway and bottom outlet closures re-checked to ensure continued securement. Double checking the manway securement bolts with a torque wrench will verify that bolts were not loosened due to stretching. It is always good measure to re-check the vacuum relief valve for no leakage.



Additional Information

Fuel ethanol customers and certain facility security plans for the transport of a hazardous material may require the use of tamper evident or tamper resistant seals.

All transport mode personnel should be issued a Material Safety Data Sheet (MSDS) on fuel ethanol. Transport companies should also be advised of all safety and firefighting guidelines.

At times, tankcars need to be washed or cleaned for maintenance or inspection. It is imperative to incorporate these cars into ethanol service as quickly as possible post wash in order to prevent the “rust bloom” from occurring. A rust bloom is the formation of iron oxide on the unlined carbon steel surface and can cause both fine and larger flakes of rust to migrate into the product.

All tankcar repairs must be completed by a DOT Certified or Registered Tank Car facility.

Placarding Recommendations

The RFA Plant and Employee Safety Committee previously provided this safety information to raise awareness of ethanol related transport and provide the industry guidance for proper shipping names and placarding for various ethanol blended fuels. Consistent labeling and marking of ethanol while in transit will help to improve the first response community’s ability to recognize ethanol shipments.



Ethanol Concentration	Preferred Proper Shipping Name
E1 to E10	Gasohol, UN 1203 <i>or</i> Gasoline, UN 1203
E11 to E94	Ethanol and Gasoline mixture, UN 3475
E95 to E99	Denatured Alcohol, NA 1987 <i>or</i> Alcohols n.o.s., UN 1987
E100	Ethanol, UN 1170 <i>or</i> Ethyl Alcohol, UN 1170

Additionally, placards should be regularly inspected and replaced as necessary. Placards should not be dirty, faded, or in poor physical condition.

DOT Training Requirements

The key to all operations and plant activities being completed in a safe, effective and efficient manner is the effectiveness of the training program for the personnel. Additionally, there may be elements of the training program required by a regulatory authority. The training requirements specific to DOT compliance are listed in 49CFR172.704. Important aspects of this training include:

- Hazardous material training including job specific training
- OSHA (29CFR1910.120 or 29CFR1910.1200), EPA (40CFR311.1), and any other training as required
- New employee and operator refresher training
- Record keeping

The record keeping requirements as specified by DOT are very detailed. The record created from the training session should have sufficient detail as to meet these requirements. Training records are an expected aspect of any regulatory audit.

DOT Registration Requirement

The DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) has an annual registration requirement for persons “who offer or transport hazardous materials in commerce.” The registration process includes a nominal annual fee, prior year registration (if applicable), identification of hazardous waste generation, and site security plan requirements as per 49CFR172.704. Registration calendar year starts July 1 and multiple year registration is allowed.

The annual fee associated with this registration provides necessary funding to train first responders in emergency response planning associated with the transport of hazardous materials. This funding also supports the publication of the Emergency Response Guidebook, a critical tool for emergency personnel to identify and respond to placarded shipments involved in an accident.

Details of the registration include:

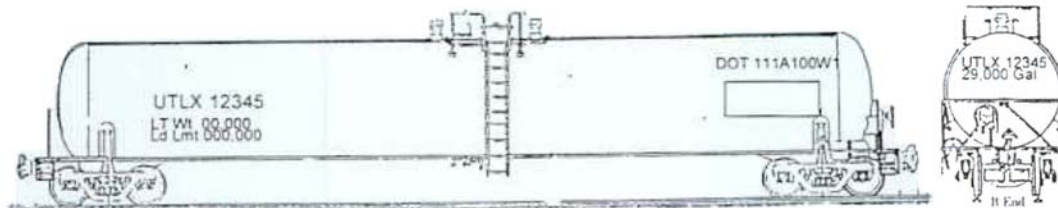
- The registration requirements and program information can be found in the Code of Federal Regulations, Chapter 49, Section 107.601- 109.620. The web link where the regulations may be found:
http://www.access.gpo.gov/nara/cfr/waisidx_06/49cfr107_06.html
- Registration form may be downloaded from the internet at:
<http://hazmat.dot.gov/regs/register/register.htm>
- Email requests to REGISTER@dot.gov
- Contact via telephone (617) 494-2545 or (202) 366-4109

Ethanol plants, ethanol transporters, and ethanol storage facilities are covered by this registration requirement. Modes of transport that are included in this registration are highway, rail, water and air.

ETHANOL TANK CAR LOADING CHECKLIST

Tank Car No.		Date	
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STENCIL INFORMATION



Specification		Gallon Capacity	
Lt. Weight		Ld Limit	
Safety Valve Due		Tank Test Due	

PRE-INSPECTION

Car Preparation:

- Apply derail or line switch away from track being loaded upon
- Set blue caution sign that displays "STOP" in 4" letters on open end of track
- Chock one wheel in both direction of car being loaded
- Apply handbrake on car being loaded

Car Inspection:

- Tank or jacket free from dents, punctures, or any sign of leakage
- All stenciling on car legible
- Handrails, running boards, platforms, ladder rungs or steps not bent or loose
- Four placard holders in place
- Break rod riding on wheel axle
- Springs missing
- Wheel bearing bolts (3) in place
- Cracks in bolster frame
- Leakage of oil from wheel bearing
- "DOT - E" stencil displayed on car. If yes, give number _____
- Defect card display on car
- Bottom outlet cap and plug chained to car
- (After removing bottom outlet cap) Bottom outlet valve opens and closes freely
- Bottom outlet valve is closed and not leaking
- (After opening manway cover) Interior of tank free of debris or foreign material
- (Under protective housing cover) Valve plugs attached to car, operate freely
- If equipped, vacuum relief valve not damaged

[illegible]

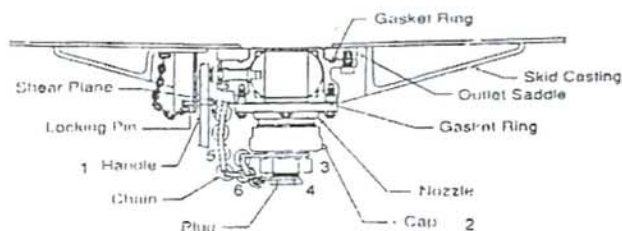
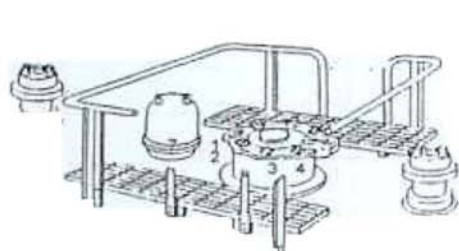
Comments:

OUTAGE REQUIRED

Loading Temp.		Specific Gravity	
Inches of Outage		Gallons Outage	

Source: Federal Railroad Administration (FRA)

FINAL INSPECTION



Top of Tank Car	Yes	No
[1] - Manway cover gasket is in good shape – not cracked, broken, chunks missing	-	
[2] - Manway lid and nozzle free from gouges, cracks, or chips		
[3] - Manway cover bolts tightened to specified torque using star pattern		
[4] - Impact manway cover bolts to relieve tension, re-tighten to specified torque		
[5] - Liquid valve plug and vapor valve plug are wrench tight and chained to car		
[6] - Vacuum relief valve functions properly		
[7] - Protective housing cover latched with securing pin		
[8] - If equipped, top-operated bottom outlet valve closed and packing nut tightened		
[9] - Security seals applied to manway cover and protective housing cover pin		

Bottom of Tank Car	Yes	No
[1] - Bottom outlet valve is closed and does not leak		
[2] - Bottom outlet valve handle is secured with a sealing pin		
[3] - Bottom outlet gasket is in good shape – not cracked, broken, free from debris, etc.		
[4] - Bottom outlet cap tightened with a wrench having a handle at least 36" long		
[5] - Bottom outlet plug tightened with a suitable wrench		
[6] - Bottom outlet cap chained to car with a 5/8" chain		
[7] - Bottom outlet plug chained to car with a 1/4" chain		

PLACARDS

	Yes	No
Placards are displayed on both ends and both sides of the tank car		
Placards are not torn or faded		
UN Number	1987	1993

SEAL NUMBERS

Manway Cover		
Protective Housing Cover Pin		
Bottom Outlet Cap		

☐ OK to Ship ☐ Corrective Action Required Prior to Shipping

Loader's Signature _____

Inspector's Signature _____

Source: Federal Railroad Administration (FRA)