



# TEAMSTERS Safety & Health FACTS

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## Hazards of Transportation and Transfer of Ethanol and Ethanol-Blended Fuels

This fact sheet presents general guidelines regarding the hazards of transporting ethanol and ethanol-blended fuels via rail and trucks to promote regulatory compliance and best practices for their safe transport. This information should not be considered as legal advice or as a substitute for developing specific operating guidelines or reviewing the pertinent regulations individually.

### Introduction

Ethanol<sup>1</sup>, also called ethyl alcohol, pure alcohol, grain alcohol, or drinking alcohol, is a volatile, flammable<sup>2</sup>, colorless liquid and has a strong characteristic odor. It is easily ignited by heat, sparks, or flames, and burns with a smokeless blue flame that is not always visible in normal light.

The vast majority of ethanol transported in the U.S is used as a bio-fuel additive for gasoline fuel. Fuel ethanol is blended in much of the nation's gasoline. E10<sup>3</sup>, sometimes called *gasohol*, is a fuel mixture of 10% anhydrous ethanol and 90% gasoline that can be used in most modern automobiles. "E-95 has now become the leading single hazardous material transported by rail, recently surpassing liquefied petroleum gases."<sup>4</sup>

Ethanol is also used widely in substances intended for human contact or consumption, including alcoholic drinks, lotions, soaps, hairsprays, industrial solvents, vinegar production, scents, flavorings, colorings, and medicines.

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<sup>1</sup> CAS 64-17-5.

<sup>2</sup> Flammable means that the material will burn or catch on fire easily at normal temperatures (below 37.8 degrees C or 100 deg F).

<sup>3</sup> The "E" number describes the percentage of ethanol in the mixture by volume.

<sup>4</sup><http://www.ethanolresponse.com/downloads/03%20Transportation%20and%20Transfer%20of%20Ethanol%20Blended%20Fuels.pdf>

## Health Hazards

### Acute Health Effects:

- Inhalation or contact with it may irritate or burn the skin and eyes, nose, mouth and throat;
- Fire may produce irritating, corrosive and/or toxic gases;
- Vapors may cause dizziness or suffocation.

### Chronic Health Effects:

- Ethyl alcohol may cause mutations (genetic changes)<sup>5</sup>;
- Repeated contact can dry the skin with cracking, peeling, and itching;
- Repeated high exposure may affect the liver and the nervous system.

### Personal Protective Equipment:

- Skin contact with ethanol should be avoided and solvent-resistant gloves and clothing should be used when handling ethanol. Nitrile is recommended by safety equipment manufacturers<sup>6</sup>;
- Wear indirect-vent, impact and splash-resistant goggles when handling liquids.
- Wear a face-shield along with goggles when working with corrosive, highly irritating or toxic substances;
- Contact lenses should not be worn when working with this substance;
- Recommended personal protective clothing includes positive pressure self-contained breathing apparatus (SCBA).<sup>7</sup>

## Safety Hazards

Ethanol and ethanol-fuel blends are flammable liquids. The DOT defines the chemical and physical characteristics of flammable liquids in 49 CFR 173.120. DOT designates typical fuel ethanol per as a Class 3 Flammable Liquid.<sup>8</sup>

The Occupational Safety and Health Administration (OSHA) considers typical fuel ethanol a Class IB flammable product. Class IB includes liquids having flashpoints below 73 deg. F. (22.8 deg. C.) and having a boiling point at or above 100 deg. F. (37.8 deg. C.).<sup>9</sup> Fuel grade ethanol is

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<sup>5</sup> NJ 2007 Right to Know Special Health Hazardous Substance List, Mutagens.

[http://www.nj.gov/health/eoh/rtkweb/documents/hsl\\_mutagens.pdf](http://www.nj.gov/health/eoh/rtkweb/documents/hsl_mutagens.pdf)

<sup>6</sup> NJ Right to Know Hazardous Substance Fact Sheet, Ethanol.

<http://nj.gov/health/eoh/rtkweb/documents/fs/0844.pdf>

<sup>7</sup>2008 Emergency Response Guidebook, PHMSA, DOT.

[http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/erg2008\\_eng.pdf](http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/erg2008_eng.pdf)

The 2008 Emergency Response Guidebook, PHMSA, DOT, provides guidance on 'potential hazards' (fire or explosion; health); 'public safety' (protective clothing; evacuation); 'emergency response' (fire; spill or leak; first aid).

<sup>8</sup> <http://cfr.vlex.com/vid/173-120-class-19942349>

<sup>9</sup>[http://www.osha.gov/pls/oshaweb/owadis.show\\_document?p\\_id=9752&p\\_table=STANDARDS](http://www.osha.gov/pls/oshaweb/owadis.show_document?p_id=9752&p_table=STANDARDS)

subject to all safety precautions applicable to loading gasoline or other Class I flammable liquids into a transport truck. The truck should be grounded and bonded when loading/unloading.<sup>10</sup>

An increased percentage of all fuel transportation-related incidents are likely to involve ethanol or ethanol-blended fuels, so it is essential that emergency responders be able to quickly and effectively identify their presence at the scene of an incident.

Fuel ethanol fires require specific equipment, materials, and training. Conventional gasoline fire-fighting methods and chemicals are not likely to be effective on high-ethanol content fuel fires. Ethanol blended fuels with greater than 10% ethanol require the use of a Polar Solvent or Alcohol Resistant (AR) type of Foam commonly known as an AR-AFFF. Traditional AFFF foams have limited to no ability to extinguish fire emergencies when the ethanol content is above 10% by volume. AR foams have shown superior performance across the entire range of ethanol blended fuels and would be the best use of fire response equipment. Dry Chemical fire extinguishing agents may also work on ethanol-blended fuels; however, the dry chemical manufacturer must be consulted for appropriateness.<sup>11</sup>

Fire departments, the rail industry, the trucking industry, and waterway officials such as the Coast Guard must work together before an emergency occurs to develop appropriate response strategies in an effort to protect human life and minimize damage to the environment and to property.

## Placarding

A variety of regulatory or consensus standards provide information about chemicals involved in spills/fire incidents:

- Material Safety Data Sheet (MSDS)
- UN numbers
- DOT placards
- NFPA 704 placard

Department of Transportation (DOT) regulations specifically require that “No person may offer, accept, handle 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 standards.”<sup>12</sup>

DOT has classified hazardous materials according to their primary danger and has assigned standardized symbols to identify the classes. Materials are grouped by their major hazardous characteristics; however, many materials will have other hazards as well. Ethanol and ethanol fuel blends are in the flammable liquids category. Placards for flammable liquids have a red background with a white flame and the word “Flammable” on them.

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<sup>10</sup> Federal Railway Administration (FRA) recommends the use of this Ethanol Tank Car Loading Checklist: <http://www.ethanolrfa.org/industry/resources/safety/>

<sup>11</sup> <http://www.thebulletin.org/web-edition/features/public-safety-and-transporting-ethanol>

<sup>12</sup> <http://cfr.vlex.com/vid/171-2-general-requirements-19941832>

Tankers carrying ethanol and ethanol-fuel blends will generally be placarded with a flammable placard or United Nations' (UN) 1203 flammable placard when transporting lower ethanol concentrations up to and including E-10 blended fuels. The E-95 ethanol-blended fuel will be placarded with a UN or North American (NA) 1987 flammable placard.<sup>13</sup> Transport trucks hauling E-85 should be placarded as UN 3475 (ethanol and gasoline mixture).<sup>14</sup>

The Hazardous Materials Table in 49 CFR 172.101 gives the proper shipping name or directs the user to the preferred proper shipping name.<sup>15</sup>

<b>Ethanol Concentration</b>	<b>Preferred Proper Shipping Name</b>
E-1 to E-10	Gasohol (UN 1203) <i>or</i> Gasoline (UN 1203)
E-11 to E-94	Ethanol & gasoline mixture (UN 3475)
E-95 to E-99	Denatured alcohol (NA 1987) <i>or</i> Alcohols n.o.s. (UN 1987)
E-100	Ethanol (UN 1170) <i>or</i> Ethyl alcohol (UN 1170)

One more marking system of interest to emergency responders is the National Fire Protection Association (NFPA) 704 diamond. The NFPA 704 diamond uses colors, numbers, & special symbols to indicate presence of hazardous materials. A higher number equals greater hazard.

NFPA diamond for E-100, E-98, E-95, E-85, & E-10 (gasoline) consists of:

- 1: Blue health square: slight to moderate irritation
- 0: Reactivity yellow square
- 3: Flammability red square: high flammability with ignition likely under most conditions
- No commonly accepted special character (white)

Proper shipping names and placarding for various ethanol-blended fuels while in transit will help to improve the first response community's ability to recognize ethanol shipments. Additionally, placards should be regularly inspected and replaced as necessary. Placards should not be dirty, faded, or in poor physical condition.

## **Transport**

<sup>13</sup><http://www.ethanolresponse.com/downloads/03%20Transportation%20and%20Transfer%20of%20Ethanol%20Blended%20Fuels.pdf>

<sup>14</sup> This mandatory placarding will direct "First Responders" to Guide 127 of the Emergency Response Guidebook (most recent publication 2008).

<sup>15</sup> <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=4fa3ec1c196278cefa5bb95fa1c04ae8&rgn=div8&view=text&node=49:2.1.1.3.7.2.25.1&idno=49>

There is a growing demand for ethanol, and other biofuels and biofuel blends.

The DOT has regulatory authority over the safe and reliable transportation of hazardous materials by all modes. DOT's Hazardous Materials Regulations govern the transportation of ethanol and other biofuels and blends by rail, air, motor carrier, and barge.

Train, truck, and barge are the options that ethanol producers and marketers have to get tens of millions of gallons of the renewable fuel, from its various points of origin mainly from the Midwest, i.e. the Corn Belt, to plants and oil terminals where it will be blended and consumed. Rail transportation dominates ethanol transportation by hauling an estimated 75 percent of the product.<sup>16</sup> "Statistically, when moving one ton of any commodity—liquid or dry bulk—rail transport is more economical than truck and barge is more economical than rail." Fuel-grade ethanol is now, by volume, the leading single hazardous material transported by rail. Seven- to eight-million gallon barges are also transporting large volumes of ethanol along all major navigable waterways.

The majority of the fuel ethanol (E-95) is transported from the production facilities to the storage depots by rail. Most of Midwest & other ethanol production facilities have access to rail sidings, but many bulk storage fuel depots do not have rail sidings. So, there is some transfer of fuel ethanol from rail tanks directly to road tankers, called *trans-loading*, for distribution to bulk storage facilities via highways. This is considered to be an interim process until permanent transfer facilities can be provided. Trans-loading has the greatest potential for transfer problems due to a lack of permanent fixtures or safety equipment. Emergency responders should be aware of this process occurring in their areas.

49 CFR part 172 lists and classifies those materials which the Department has designated as hazardous materials for purposes of transportation and prescribes the requirements for shipping papers, package marking, labeling, placarding, emergency response, training, and safety and applicable to the shipment and transportation of those hazardous materials.

49 CFR Part 174 addresses the requirements for carriage by rail, including operating, loading, and unloading requirements, along with detailed requirements for Class 3 (flammable liquid) materials.

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<sup>16</sup> <http://www.hdrinc.com/Assets/documents/Publications/RailLine/june2007/Ethanol.pdf>

## Training Requirements

Subpart H, Title 49, outlines the training requirements for all hazardous material (hazmat) workers, including drivers and rail operators.<sup>17</sup>

The training requirements specific to DOT compliance are listed in 49 CFR 172.704<sup>18</sup>. Important aspects of this training include:

- Hazardous material training including job specific training;
- OSHA (29 CFR 1910.120 or 29 CFR 1910.1200), EPA (40 CFR 311.1), and any other training as required;
- New employee and operator refresher training;
- Recordkeeping.

Additional ‘function-specific’ training requirements, for drivers, are found in part 177, section 177.816, and for rail operators in part 174.

Additional training requirements for the individual modes of transportation are prescribed in parts 174, 175, 176, and 177 of this subchapter.

## OSHA Standards

There are many safety and health regulatory requirements associated with ethanol transport via rail or trucks. Ethanol is regulated by the U.S. Department of Transportation (DOT), the Occupational Safety and Health Administration (OSHA) and cited by the National Institute for Occupational Safety and Health (NIOSH), the American Conference of Governmental Industrial Hygienists (ACGIH), and the National Fire Protection Agency (NFPA).

OSHA is responsible for safety and health of workers during the production and storage of ethanol. With regard to transportation of ethanol, OSHA standards are aimed at ensuring that the exposure of workers, on the ground, during loading and unloading, is minimized and emergency response plan for operations involving the release or threat of release of hazardous substances, such as ethanol are in place.

The following OSHA standards apply to hazards that workers might encounter during loading/unloading activities. For more information on each of these standards, please refer to the related IBT Safety and Health Department Fact Sheet,<sup>19</sup> on <http://www.teamster.org/content/review-safety-and-health-fact-sheet-archive>.

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<sup>17</sup> <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=3bae5a01bfa80e84daff10903e383781&rgn=div6&view=text&node=49:2.1.1.3.7.8&idno=49>

<sup>18</sup> <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=3bae5a01bfa80e84daff10903e383781&rgn=div8&view=text&node=49:2.1.1.3.7.8.25.4&idno=49>

<sup>19</sup> <http://www.teamster.org/content/review-safety-and-health-fact-sheet-archive>

### **Hazard Communication Standard (HAZCOM), 29 CFR 1910.1200:**

The HAZCOM standard requires that all potentially exposed employees be provided with information about the hazards of chemicals and relevant protective measures, access to MSDSs, and an effective training program;

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.

### **Hazardous Waste Operations and Emergency Response (HAZWOPER), 29 CFR 1910.120:**

The HAZWOPER standard addresses emergency response operations for releases, or substantial threats of releases, of hazardous substances regardless of the location of the hazard. An employer is required to develop and implement an emergency response plan to handle anticipated emergencies, unless the employer can demonstrate that the operation does not involve employee exposure or the reasonable possibility for employee exposure to safety or health hazards.

The standard requires worker training to be based on the duties and functions to be performed by each responder. A driver would likely be trained at the 'first responder awareness level.'

These are individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release. They would take no further action beyond notifying the authorities of the release.

'First responders at the operations level' are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release.<sup>20</sup>

### **Process Safety Management Standard (PSM), 29 CFR 1910.119:**

The PSM standard has requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals, which may result in toxic, fire or explosion hazards.

It also applies to "Flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration."<sup>21</sup>

The PSM standard requires that facilities having at least 10,000 pounds of flammable material, which is equivalent to less than 2,000 gallons of ethanol, have a PSM program.

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<sup>20</sup> [http://www.osha.gov/pls/oshaweb/owadis.show\\_document?p\\_table=standards&p\\_id=9765](http://www.osha.gov/pls/oshaweb/owadis.show_document?p_table=standards&p_id=9765)

<sup>21</sup> [http://www.osha.gov/pls/oshaweb/owadis.show\\_document?p\\_table=STANDARDS&p\\_id=9760](http://www.osha.gov/pls/oshaweb/owadis.show_document?p_table=STANDARDS&p_id=9760)

In rail facilities, the OSHA PSM requirements overlap with DOT regulatory requirements for the ethanol tankcar loadout area activities.<sup>22</sup>

### Workplace Exposure Limits

**OSHA:** The legal airborne permissible exposure limit (PEL) is 1000 parts per million (ppm) averaged over an 8-hour workshift.

**NIOSH:** The recommended airborne exposure limit (REL) is 1000 ppm averaged over a 10-hour workshift.<sup>23</sup>

**ACGIH:** The threshold limit value (TLV)-short-term exposure limit (STEL) is 1000 ppm, which is a 15-minute limit that should not be exceeded at any time during a workday, even if the 8-hour limit is not exceeded. The STEL of 1000 ppm, on the basis of its upper respiratory tract irritation, but does not assign a permissible exposure limit (8 hour).<sup>24</sup>

### Additional Resources

The following resources provide information on safe loading, unloading and transport of ethanol via rail:

- U.S. Department of Transportation Hazardous Material Instructions for Rail, [http://boe.aar.com/boe/download/US\\_HMI\\_Final%202008.pdf](http://boe.aar.com/boe/download/US_HMI_Final%202008.pdf)
- Emergency Response Guidebook (ERG), U.S. Department of Transportation <http://phmsa.dot.gov/hazmat/library/erg>
- OSHA/EPA Occupational Chemical Database <http://www.osha.gov/web/dep/chemicaldata/default.asp>
- 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/>
- NRT Quick Reference Guide: Fuel Grade Ethanol Spills (including E85), The US Department of Transportation's National Response Team (NRT)
- [http://www.nrt.org/production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/SA-1060ETOH-85-FinalRev00\\_2010\\_022610.pdf/\\$File/ETOH-85-Federal Railway Administration \(FRA\)](http://www.nrt.org/production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/SA-1060ETOH-85-FinalRev00_2010_022610.pdf/$File/ETOH-85-Federal%20Railway%20Administration%20(FRA)%20recommends%20the%20use%20of%20this%20Ethanol%20Tank%20Car%20Loading%20Checklist.pdf) recommends the use of this Ethanol Tank Car Loading Checklist: <http://www.ethanolrfa.org/industry/resources/safety/>
- Introduction to Ethanol Training Module <http://www.ethanolrfa.org/pages/industry-resources-safety>
- Quick Reference Guide: Fuel Grade Ethanol Spills (including E85) Ethanol Emergency Response Coalition <http://www.ethanolresponse.com/>

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<sup>22</sup> <http://www.chemkeys.com/blog/wp-content/uploads/2010/02/Best-Practices-for-Rail-Transport-of-Fuel-Ethanol.pdf>

<sup>23</sup> Pocket Guide to Chemical Hazards, NIOSH, <http://www.cdc.gov/niosh/npg/npgd0262.html>

<sup>24</sup> 2010 Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs), ACGIH.



- Best Practices for Rail Transport of Fuel Ethanol  
<http://www.chemkeys.com/blog/wp-content/uploads/2010/02/Best-Practices-for-Rail-Transport-of-Fuel-Ethanol.pdf>
- Resources, Ethanol Emergency Response Coalition  
<http://www.ethanolresponse.com/resources.html>
- Fuel Ethanol, Industry Guidelines, Specifications, and Procedures, Renewable Fuels Association (RFA)  
<http://www.ethanolrfa.org/page/-/objects/pdf/newRFA%20Fuel%20Ethanol%20960501.pdf?nocdn=1>  
[Final\\_Rev00\\_2010\\_halfpt%20increase\\_022610.pdf?OpenElement](http://www.ethanolrfa.org/page/-/objects/pdf/newRFA%20Fuel%20Ethanol%20960501.pdf?nocdn=1)