



THE CHLORINE INSTITUTE

Pamphlet 88

*Recommended Practices
for Handling Sodium
Hydroxide Solution and
Potassium Hydroxide
Solution (Caustic) Cargo
Tanks*

Edition 3



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1. INTRODUCTION

1.1 SCOPE

This pamphlet provides guidelines, recommended practices and other useful information for the safe shipping, handling and/or receiving of sodium hydroxide solution and potassium hydroxide solution in cargo tank motor vehicles. It represents a compendium of Institute membership experience as of the date of publication.

1.2 CHORINE INSTITUTE STEWARDSHIP PROGRAM

The Chlorine Institute, Inc. exists to support the chlor-alkali industry and serve the public by fostering continuous improvements to safety and the protection of human health and the environment connected with the production, distribution and use of chlorine, sodium and potassium hydroxides, and sodium hypochlorite: and the distribution and use of hydrogen chloride. This support extends to giving continued attention to the security of chlorine handling operations.

Chlorine Institute members are committed to adopting CI's safety and stewardship initiatives, including pamphlets, checklists, and incident sharing, that will assist members in achieving measurable improvement. For more information on the Institute's stewardship program, visit CI's website at www.chlorineinstitute.org.

1.3 DEFINITIONS

In this pamphlet the following meanings apply unless otherwise noted:

ASME	American Society of Mechanical Engineers
air padding	The addition of clean, dry, oil free compressed air in order to increase system pressure in the cargo tank for unloading.
cargo tank	Any tank permanently attached to or forming a part of any motor vehicle or any bulk liquid or compressed gas packaging not permanently attached to any motor vehicle which by reason of its size, construction or attachment to a motor vehicle, is loaded or unloaded without being removed from the motor vehicle.
cargo tank motor vehicle	"A motor vehicle with one or more cargo tanks permanently attached to or forming an integral part of the motor vehicle" (49 CFR 171.18)
caustic	generic term for either caustic soda or caustic potash
caustic potash	solutions of varying concentration of potassium hydroxide (KOH)
caustic soda	solutions of varying concentration of sodium hydroxide (NaOH)
CFR	Code of Federal Regulations (U.S.)

CSA	Canadian Standards Association
DOT	U.S. Department of Transportation
DVIR	Driver Vehicle Inspection Report
EPA	U.S. Environmental Protection Agency
Institute	The Chlorine Institute, Inc.
marking	a descriptive name, identification number, instruction, caution, weight, specification or UN mark that is required to be applied to the cargo tank. A marking can be applied with a stencil.
MAWP	maximum allowable working pressure
motor vehicle	“includes a vehicle, machine, tractor, trailer, or semi-trailer, or any combination thereof, propelled or drawn by mechanical power and used upon the highways in the transportation of passengers or property...” [Ref. DOT 171.8]
MSDS	Material Safety Data Sheet
NTTC	National Tank Truck Carriers, Inc.
OSHA	U.S. Occupational Safety and Health Administration, Department of Labor
psig	pounds per square inch gauge
PPE	personal protective equipment
RQ	Reportable Quantity as defined in 49 CFR 171.8
pressure relief device	Self-reclosing valve or non-reclosing vent with rupture disc, designed to prevent the rise of internal pressure in excess of a specified value due to exposure to abnormal conditions.
TC	Transport Canada
TDG	Transportation of Dangerous Goods Regulations of Canada
transfer site	any facility where product is loaded and/or unloaded
WHMIS	Workplace Hazardous Material Information System (Canada)

1.4 SAFETY PROGRAMS

Every site handling caustic should have an on-going safety program. Periodic training sessions and safety inspections must be conducted in accord with DOT and OSHA regulations and equivalent Canadian requirements. Special attention should be paid to the appropriateness of emergency procedures and to equipment to be used in an emergency. Additional information on safety programs is available from the Institute and from caustic suppliers.

1.5 DISCLAIMER

The information in this pamphlet is drawn from sources believed to be reliable. The Institute and its members, jointly and severally, make no guarantee, and assume no liability, in connection with any of this information. Moreover, it should not be assumed that every acceptable procedure is included, or that special circumstances may not warrant modified or additional procedure. The user should be aware that changing technology or regulations may require a change in the recommendations herein. Appropriate steps should be taken to insure that the information is current when used. These recommendations should not be confused with federal, state, provincial, municipal or insurance requirements, or with national safety codes.

1.6 APPROVAL

The Institute's Transportation Issue Team approved Edition 3 of this pamphlet on March 20, 2010.

1.7 REVISIONS

Suggestions for revisions should be directed to the Secretary of the Institute.

1.7.1 Significant Revisions in Current Edition

Significant updates in this revision as approved include:

- Updates to formatting and terminology throughout;
- Deleted specifics of reporting information that is specified in the regulations;
- Removed information regarding less than full loads in Section 5;
- Added to facility design considerations in Section 6.2;
- Modified carrier qualifications in Section 7.1;
- Updated pre-unload inspection checklist in Section 10;
- Updated hose and fittings maintenance in Section 11;
- Added Section 12, Reducing Non-accidental Releases.

1.8 REPRODUCTION

The contents for this pamphlet are not to be copied for publication, in whole or in part, without prior Institute permission.

2. **GENERAL INFORMATION**

2.1 MARKING AND PLACARDING OF CARGO TANKS

Marking

The product identification number (UN 1824 for caustic soda and UN 1814 for caustic potash) must be marked on each side and each end of the cargo tank (49 CFR 172.302, 172.328 and 172.332). The product identification number may be included on the placard.

Each cargo tank must be durably and legibly marked, in English, with the date (month and year) and the type of test or inspection performed. The date must be readily identifiable with the applicable test or inspection. The marking must be in letters and numbers at least 1 ¼ inches (32-mm) high, on the tank shell near the specification plate or anywhere on the front head. The type of test or inspection may be abbreviated as follows:

V = External Visual Inspection and Test

I = Internal Visual Inspection

P = Pressure Retest

K = Leakage Test

L = Lining (if present)

UP = Upper Coupling

For example, the marking **6-01 P, V** would indicate that in June 2001 the tank received and passed the prescribed pressure retest and the external visual inspection and test (49 CFR 180.415).

Placarding

For any quantity of caustic in a cargo tank, a corrosive placard is required on each side and each end of the tank. Placards alert persons to the potential dangers associated with hazardous materials contained within the cargo tank. Placards also guide emergency personnel who respond to incidents involving hazardous materials (49 CFR 172.558).

2.2 PRODUCT DATA - SODIUM HYDROXIDE AND POTASSIUM HYDROXIDE SOLUTIONS (CAUSTIC)

Sodium hydroxide solution and potassium hydroxide solution are the proper shipping names for these products. However, this pamphlet uses the generic product names caustic soda and caustic potash, or caustic to mean both.

Personnel handling caustic cargo tank motor vehicles should be thoroughly familiar with the chemical and physical properties as well as the health hazards and first aid procedures appropriate for these products. It is highly recommended users of this pamphlet be familiar with Appendix A. Up-to-date Material Safety Data Sheets (MSDS) are available from caustic suppliers.

2.3 CAUSTIC IN TRANSPORTATION

Caustic soda and caustic potash are classified for transportation as Class 8 (corrosive materials). In Canada caustic soda and caustic potash carry a secondary classification of 9.2, *Hazardous to the Environment*. They are shipped as solutions in various containers including cargo tank motor vehicles. However, due to relatively high freezing points (see Appendix B) the materials may solidify during transportation. Caustic soda is generally shipped as 50% concentration, while caustic potash is shipped at a concentration of 45% to 50%. All persons handling cargo tank motor vehicles must be familiar with all applicable regulations and safety procedures for the particular product and its concentration. Higher concentrations of caustic are generally shipped at elevated temperatures that require special handling.

2.4 REACTIVITY AND COMPATIBILITY DATA

Under normal use and conditions, caustic is generally regarded as stable. However, caustic will rapidly attack and destroy such materials as leather, wool, pure metals or alloys of aluminum, zinc and tin. In addition, the reaction with these metals may generate flammable hydrogen gas. The reaction of caustic with aluminum is particularly vigorous and contact should be avoided. Shipping caustic in unlined tanks above 120°F (49°C) will result in significantly higher levels of iron pickup. Shipping above 140°F (60°C) is not recommended. Both caustic soda and caustic potash are strongly alkaline and may react violently with acidic materials such as hydrochloric or sulfuric acids. Under certain conditions the addition of water will cause a violent reaction. These reactions will generate heat and could cause splattering of the liquid, (see also Section 2.5). Neither caustic soda nor caustic potash form hazardous decomposition products nor contribute to hazardous polymerization.

2.5 OTHER HANDLING AND STORAGE CONSIDERATIONS

Caustic is a strong alkali solution. Considerable heat is generated when diluted with water. Proper handling procedures must be followed to prevent vigorous boiling, spattering or violent eruption of the diluted solution. ALWAYS ADD CAUSTIC TO WATER and provide agitation. Caustic will also react vigorously with many organic chemicals and due caution is required.

2.6 EFFECTS OF WATER AND CAUSTIC ON CARBON STEEL CARGO TANKS

Varying concentrations of caustic solutions combined with frequent steam heating and subsequent cooling, frequent tank washing with hot condensate water, and the presence of heated water vapor can cause damage to exposed carbon steel. The condition of the cargo tank vapor space needs to be monitored for possible damage from these conditions.

2.7 PERSONAL PROTECTION INFORMATION

Handling caustic requires adequate personal protective equipment to protect the user against product hazards. This topic is addressed in the Occupational Safety and Health Standard in 29 CFR 1910.262(13.4), and 29 CFR 1910.132 through 29 CFR 1910.134 (13.4). Users of this pamphlet should be familiar with these regulations and incorporate their requirements into the training of those involved in product transfer. Proper protective measures (which may include hard hat, chemical splash goggles, full face shields, chemical protective suit, gloves and boots) should be worn when handling caustic (See CI Pamphlet 65). Safety showers and eye wash facilities should be located in the immediate work area. However, detailed requirements for personal protective equipment should be established on a site specific basis. Additional information about protective equipment for handling caustic can be found in CI Pamphlet 65, *Personal Protective Equipment for Chlor-Alkali Chemicals* (CI Reference 13.1).

2.8 SPILL PREVENTION PROGRAM

All transfer facilities should have a documented spill prevention and containment program for all hazardous materials. Consideration must be given to the containment of caustic spills and leaks to comply with applicable federal, state and local regulations. Each transfer facility should determine the emergency response equipment needed for their facility and the training needed to deploy the equipment.

Part of the planning for actions necessary to respond to a spill includes obtaining advice from the supplier concerning the use of a weak acid to neutralize spilled caustic.

2.9 RELATED PUBLICATIONS

Additional information about handling caustic and personal protective equipment can be found in CI Pamphlet 94, *Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic): Storage Equipment and Piping Systems* (CI Reference 13.1), CI Pamphlet 80 *Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Barges* (CI Reference 13.1) and CI Pamphlet 65 *Personal Protective Equipment for Chlor-Alkali Chemicals* (CI Reference 13.1). For chemical and physical properties, handling and protective equipment information, reference is made to Appendix A.

3. **EMERGENCY RESPONSE**

3.1 EMERGENCY PLANNING

Emergency contingency plans should be current and in place for all areas of caustic handling and transportation. These plans should identify hazards and include systems for accident prevention and mechanisms for minimizing loss and damage resulting from accidents. Copies of the plan should be on file as required by regulation. Registration with CHEMTREC is necessary if CHEMTREC is part of the emergency plan. Reference is made to Section 4.2 of this pamphlet.

3.1.1 Plants and Transfer Sites

All personnel responsible for transfer operations should be completely familiar with their facility's emergency plan for handling spills and leaks of product. Refer to OSHA regulations 29 CFR 1910.120 (q) for emergency response training requirements. Each site should have proper emergency response equipment available.

3.1.2 Transportation

The DOT and TC have specific training requirements applicable to handling of hazardous materials. Shippers must familiarize themselves with these requirements and the OSHA/WHMIS requirements for off-site responder training.

Caustic Leak in Transit

At first indication of a leak in transit the cargo tank must be isolated. The vehicle should be pulled off the road and the cargo tank moved to a safe location. The driver should ascertain the problem from a safe distance and take appropriate actions. If help is required, the emergency plan should be activated. Written procedures or instructions from the emergency response guidebook should be followed. Telephone numbers for the caustic supplier and CHEMTREC or CANUTEC should be included in the emergency plan. Where possible the driver should stay on the scene to assist emergency response personnel in assessing the severity of the incident for determination of the need for response action.

Fire in Transit

In the event of fire, the vehicle should be removed from the fire zone immediately, if it can be done without undue risk. If it cannot be moved the driver should advise the emergency response personnel that the container should be kept cool by applying water to the cargo tank, however the product itself will not burn.

Collision

In the event of a minor collision not affecting the safety of the caustic cargo tank, normal procedures for reporting any traffic accident should be followed. In the event of a collision that damages the caustic cargo tank, or the running gear, the driver should confer with the shipper regarding plans to address the damage, even if no leak has developed. If a caustic leak develops or there is a potential for a leak, the emergency plan should be activated.

Reports

In the U.S. when transporting caustic in cargo tanks, all carriers including private carriers in local, interstate or international commerce must comply with 49 CFR 171.15, "Immediate notification of certain hazardous material incidents" and 49 CFR 171.16 "Detailed hazardous materials incidents reports." For requirements in Canada see TDG Part 8, Sections 8.1, 8.2 and 8.3. (CI Reference 13.5)

3.1.3 PPE Recommendations for Emergency Response

The following information comes from CI Pamphlet 65, *Personal Protective Equipment for Chlorine and Sodium Hydroxide*. This pamphlet is maintained by the Institute's Health, Environment, Safety, and Security Issue Team to provide recommendations on personal protective equipment that should be used in situations including emergency response. Readers should ensure the most current information is used when making decisions related to PPE selection and use. Recommendations by the Institute on PPE are intended to provide guidance which may be altered after a review of site specific hazards.

The recommendations are based in part on the assumption that responders to a severe release involving spraying caustic may encounter a concentration at or above that designated by the National Institute for Occupational Safety and Health as immediately dangerous to life or health (IDLH) (10 mg/m^3). These recommendations also assume the emergency responders will encounter no other hazardous chemicals requiring more stringent requirements.

Personal protective equipment for emergency responders to caustic releases should include gloves, a chemical protective suit, chemical protection for the head and neck, face shield and chemical splash goggles, respiratory protection and footwear or footwear cover. These items should be chemically resistant against 10-50% sodium hydroxide at 120°F (49°C) or the applicable temperature. In severe cases with spraying caustic in a major leak a positive pressure, full face self-contained breathing apparatus is recommended. In less severe cases, such as a leaking valve, where there is no appreciable spraying and/or splashing product and responders will not be exposed to concentrations in excess of 2 mg/m^3 of caustic release in any 15 minute period, no respiratory protection is needed.

3.2 CHEMTREC AND CANUTEC

For transportation-related incidents in the U.S., one should utilize CHEMTREC, the Chemical Transportation Emergency Center in Arlington, VA, as the dispatch agency. CHEMTREC operates around the clock - 24 hours a day, seven days a week to receive calls from any point in the United States and Canada at 800-424-9300 (703-527-3887 for all other calls). CHEMTREC provides immediate advice for those at the scene of emergencies, and then promptly contacts the appropriate shipper and others as required. Registration with CHEMTREC is provided through American Chemistry Council. In Canada, CANUTEC, the Canadian Transport Emergency Centre in Ottawa, should be used as the dispatch agency. Their telephone number is 613-996-6666 (Call collect). CANUTEC is administered by Transport Canada and operates in a manner that is similar to CHEMTREC.

3.3 REPORTING A RELEASE

Sodium hydroxide and potassium hydroxide are identified as hazardous substances in Table 302.4 – *List of Hazardous Substances and Reportable Quantities* of 40 CFR 302.4. CERCLA requires immediate notification of a release equal to or in excess of the reportable quantity. The reportable quantity of sodium and potassium hydroxide is currently 1,000 pounds (454 kg).

Should a reportable release occur in the U.S., the law requires the National Response Center (1-800-424-8802) or (202) 267-2675 to be immediately notified. In Canada local appropriate provincial response authorities must be immediately advised if a release exceeds five kilograms or five liters. State, provincial and local laws may require reporting to the appropriate state and/or local environmental agencies.

It may be necessary to directly notify the Coast Guard regarding releases that may affect the use of a waterway. In most cases, the initial report will be by telephone for expediency with a follow up written report.

If any agency notified has emergency response capabilities and/or responsibilities, they should also be informed of any assistance needed. A written follow-up emergency notice may be required as soon as practicable after a release. This document should:

- a. Set forth and update the verbal information given previously;
- b. Discuss actions taken to respond to and contain the release;
- c. Discuss any known or anticipated acute or chronic health risks associated with the release; and
- d. Where appropriate, give advice regarding medical attention for exposed individuals.

It is suggested that the final report list the cause and corrective actions, with a timetable if appropriate. If mailed, it is recommended the report be sent by certified mail, return receipt requested.

Federal Reporting Requirements

In addition to reporting to the National Response Center, certain facilities are required to make annual reports of emissions and releases of hazardous substances. See 40 CFR 370. In the case of an incident occurring in transportation that meets the reporting requirements of 49 CFR 171.16 a detailed report (DOT 5800.1) form must be filed.

State Reporting Requirements

Immediate State notification is usually required as follows. Reporting time limits vary.

- State environmental department or environmentally responsible agency (This may be more than one agency.)
- State police

Local Reporting Requirements

In addition to reporting immediately to the Local Emergency Planning Committee (LEPC), immediate notification may be required as follows. Reporting time limits vary.

- Town or City leadership groups
- Local police or sheriff
- Local fire department(s)
- Local health department

4. REGULATORY REQUIREMENTS

The DOT and TC regulate the transportation of hazardous materials. Caustic is a hazardous material. It is imperative that personnel involved in any aspect of handling, packaging and/or transportation of caustic are regularly trained and remain knowledgeable of hazardous material regulatory requirements. Publications should be readily available for reference. See Section 13 for ordering information.

4.1 DOT REGULATIONS

Title 49 CFR details the requirements for hazardous materials transportation in the U.S. Pertinent sections in the DOT Regulations, Title 49 CFR, are identified below, which cover many of the requirements relating to caustic cargo tanks.

171.15	Immediate notice of certain hazardous material incidents
171.16	Detailed hazardous materials incidents reports
172.101	Hazardous Materials Table
172.200-172.204	Shipping papers
172.300-338	Marking
172.325	Elevated temperature materials (marking)
172.328	Cargo tanks (marking)
172.500-560	Placarding requirements
172.558	Corrosive placard
172.600-172.606	Emergency response information
172.700-172.704	Training

173.29	Empty packages
173.33	Hazardous materials in cargo tank motor vehicles
173.242	Bulk packaging for certain medium hazard liquids and solids, including solids with dual hazards
177.800	Purpose and scope of this part and responsibility for compliance and training
177.816	Driver training
177.817	Shipping papers
177.823	Movement of motor vehicles in emergency situations
177.834	General requirements (loading and unloading)
178.320	General requirements applicable to all DOT specification cargo tank motor vehicles
178.345-178.348	General design and construction requirements applicable to Specification DOT 406, DOT 407, and DOT 412 cargo tank motor vehicles
180.401-180.417	Qualification and maintenance of cargo tanks
Part 383	Commercial driver's license standards; requirements and penalties
Part 387	Minimum levels of financial responsibility for motor carriers
Part 389	Rulemaking procedures - Federal motor carrier safety regulations
Part 390	Federal motor carrier safety regulations; General
Part 391	Qualifications of drivers
Part 392	Driving of motor vehicles
Part 393	Parts and accessories necessary for safe operation
Part 395	Hours of service of drivers
Part 396	Inspection, repair, and maintenance
Part 397	Transportation of hazardous materials; driving and parking rules
Part 399	Employee safety and health standards

4.2 EPA REGULATIONS

Personnel involved in the transfer operations for caustic soda and caustic potash should be aware of regulatory requirements for spills and/or other emissions. 40 CFR should be reviewed for specific federal requirements.

4.3 OSHA REGULATIONS

The OSHA's occupational safety and health standards are found in Title 29 CFR Part 1910. Title 29 CFR 1910.176 regulates material handling and storage, 29 CFR 1910.120 regulates the emergency response to hazardous substance releases and 29 CFR 1910 Subpart I regulates personnel protective equipment.

4.4 CANADA REGULATIONS

The Canadian regulations for the Transportation of Dangerous Goods (TDG) parallel DOT requirements in most respects. The Canadian regulations can be found in the Canadian Transportation of Dangerous Goods Act and Regulations. These regulations include, by reference, various standards and specifications found in Canadian Standards Association (CSA) publications and in Canadian General Standards Board (CGSB) publications. There are also provincial regulations specific to each province (CI Reference 13.5).

4.5 MEXICO REGULATIONS

The Normas Oficiales de Mexico (Official Mexican Standards), often referred to as Normas or NOMs, support the Mexican Hazardous Materials Land Transportation Regulation. The Mexican Secretariat for Communications and Transport is responsible for publishing and applying the NOMs. The Mexican NOMs are fairly consistent with those of the United Nations Recommendations on the Transport of Dangerous Goods (UN Recommendations) and TC and DOT regulations. For more information see www.phmsa.dot.gov/hazmatsee.

4.6 LOCAL REQUIREMENTS

In addition to federal requirements, state, provisional or local requirements might affect these operations. The reader is cautioned to check applicable codes.

5. **CARGO TANK DESCRIPTION**

5.1 CARGO TANK SPECIFICATIONS

The specifications for the cargo tanks that may be used to carry caustic are found in 49 CFR 173.242. The current design specifications for caustic cargo tanks are DOT 407 and DOT 412 which are found in 49 CFR 178.320 and 178.345 through 178.348 inclusive. DOT cargo tanks built to earlier design specifications MC 304, MC 307, MC 311 and MC 312 may still be used. The Canadian specifications for cargo tanks are found in CSA B620 and B621 (CI Reference 13.5).

The "wetted area" parts of the tank which may come in contact with the lading must be compatible with the lading. These parts include:

- a. tank shell (including heads);
- b. interior lining (if applicable, most caustic trailers are unlined);
- c. gasket material;
- d. valves and covers; and
- e. seats and seals.

All handling equipment at the transfer site must also be compatible with caustic. Certificates of Compliance and ASME data reports, if applicable, for cargo tanks must be maintained and available at the carrier's principal or designated headquarters.

5.2 CARGO TANK SIZES

Caustic soda is transported in cargo tanks containing quantities ranging from 3,000 to 6,000 gallons (19 to 38 liquid tons). With the high density of concentrated caustic solutions, resulting in 12 to 13 lbs/gal (U.S.) compared to water's 8.328 lbs/gal (U.S.), the load level becomes significant.

Transporting liquid caustic solutions is complicated by caustic's physical and chemical characteristics (see Appendix A). Special consideration is needed because of high density, corrosivity, high freezing point and crystallization characteristics.

5.3 CARGO TANK INSULATION

Although not specifically required by the regulations, many caustic cargo tanks are insulated. Most common insulation systems are urethane foam or fiberglass with a metal jacket. Insulated cargo tanks are commonly used for shipments where ambient temperatures could reduce the caustic temperature below the freezing point.

5.4 CARGO TANK FITTINGS

A typical caustic cargo tank has provisions for either top or bottom product transfer. The primary control valves and air supply valves are described in the following paragraphs. The representation in Figure 5.4.1 is typical for the 5,000 gallon cargo tank.

5.4.1 Pressure and Vacuum Relief

Each caustic cargo tank must be equipped to relieve pressure and vacuum conditions. The pressure and vacuum relief system must be designed to operate and have sufficient capacity to prevent cargo tank rupture or collapse due to pressure changes resulting from loading, unloading, or heating or cooling of the lading. All cargo tanks built in accordance with DOT specification 407 and 412 must be equipped with self-closing devices. Reference is made to 49 CFR 178.345-10.

5.4.2 Top Fitting Arrangements

The top fittings typically consist of a manway opening, top unloading valves, air pad valves, clean out fittings and a pressure/vacuum relief system.

Manway Opening - A typical manway is a 20 inch opening with a hinged and bolted cover. Covers are designed with sufficient strength and hold-down clamps to safely contain the cargo tank contents in an overturn. The covers must be secured and fully bolted down before transporting any product.

Product Unloading Valve - The unloading valve is mounted directly to the tank above a dip tube that extends to a sump in the bottom of the tank. The design can be diaphragm, ball, gate or one of others commonly used in chemical service.

Air Inlet Valve - An air inlet valve is mounted directly to the tank. It is usually one inch in size of a ball design although other designs and sizes are in use.

Clean Out Fittings - These fittings are typically located near the front of the tank, and are used for tank cleaning. They typically have flanged or threaded openings.

Spill Dam - Spill dams are located around the manway and top valves to provide containment of spilled product. The dam may also be part of the roll-over protection feature of the cargo tank.

5.4.3 Bottom Fitting Arrangements

There are several types of bottom fitting arrangements for caustic cargo tanks.

Bottom Operated Internal Valve Arrangement

The internal style bottom outlet valve has an external operating mechanism. These valves are opened against closing spring pressure by cable-operated levers, air pressure operated actuators or hydraulic pistons operated by a central manual hydraulic pump. A "trip" or release of the cable, air supply or the hydraulic pressure will cause the internal valve(s) to snap shut inside the cargo tank. The emergency control is normally located at the left front of the nose (roadside front corner) of the cargo tank, and will be a cable lever, air supply control valve, hydraulic tubing break-away terminal or hydraulic valve. Bottom outlet valves are either located inside the trailer or have protection to prevent the shearing of the valve during an accident.

External Valve Arrangements

A secondary valve is mounted externally to the tank. The valve can be ball, butterfly, gate or plug type design. External valves, mounted on each outlet in line with the internal safety valve, allow control of product flow. The handle for each valve must be readily accessible for operation. A typical arrangement is shown in Figure 5.4.2.

5.5 PUMPS

Self-draining centrifugal or positive displacement pumps may be carried as part of the equipment on the cargo tank or used during loading and unloading. These pumps must be constructed of materials compatible with caustic soda. Pumps should be cleaned of all residue after use.

5.6 STEAM COILS

Many cargo tanks are equipped with either interior or exterior heating coils. The pressure rating and maximum temperature rating for the heating system, if present, is stated on the cargo tank data plate. The data plate is mounted on the cargo tank frame near the front roadside corner of the vehicle.

5.7 INTERIOR COATINGS AND LININGS

The lining material must be compatible with the product. The membership has had good experience with modified epoxy. Some are using epoxy phenolic type linings in caustic soda service. Certain epoxy phenolics have been successfully used in caustic potash service. It is recommended the user consult with the various coating and lining manufacturers for specific recommendations based upon the user's operations, product and temperature limitations.

TYPICAL CAUSTIC TANK TRAILER
INSULATED / JACKETED
(General Arrangement)

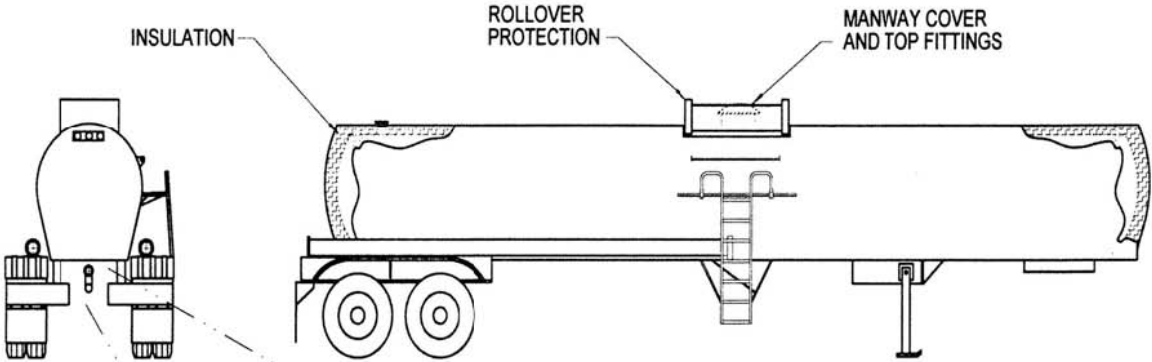
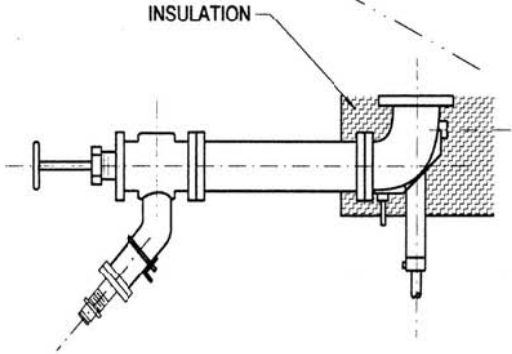


Fig. 5.4.1



SIDE VIEW of
TYPICAL BOTTOM OUTLET
(REAR or MIDWAY)

Fig. 5.4.2

6. DESIGNS FOR LOADING AND UNLOADING FACILITIES

6.1 GENERAL EQUIPMENT CONSIDERATIONS

General design information about caustic storage equipment and piping can be found in CI Pamphlet 94, *Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic): Storage Equipment and Piping Systems* (CI Reference 13.1).

6.2 DESIGN CONSIDERATIONS

The following should be considered when designing a caustic loading or unloading facility:

- A platform or ramp to provide access to the top of the cargo tank
- Safety showers located at ground level and on the loading/unloading platform
- Adequate lighting for safe night time operation
- Spill containment for the loading/unloading rack, transfer equipment and storage tanks
- Loading arms equipped with a device to prevent movement once loading has started
- Transfer hoses and piping that are compatible with caustic
- Temperature controls to prevent over-heating the caustic trailer (if equipped with heating coils)
- Gauging devices or high level shut off devices
- Flow metering to prevent over filling
- Automated shut off control valves
- Steam supply, hoses and connections for heating the cargo tank (if so equipped)
- Water supply, hose and connections for washing the top of the cargo tank
- Pressure control equipment for pressure unloading
- Fume recovery system for closed dome loading
- Truck access (clearance, maneuverability and means to communicate with driver to properly spot truck at rack for loading)

- Fall protection
- Ergonomic issues for accessing and working on top of truck
- Sampling process

7. OPERATORS OF CAUSTIC CARGO TANK MOTOR VEHICLES

The U.S. DOT has established stringent qualification requirements for drivers and carriers engaged in the transport of hazardous materials such as caustic soda. The intent of this section is to provide a basic understanding of these requirements. More detailed information on these requirements can be found in 49 CFR Parts 382 through 399 and Part 40. These regulations tend to place the responsibility for compliance on the carrier.

7.1 CARRIER QUALIFICATIONS

As an alternative to utilizing the shipper's own drivers, "for hire"/contract carriers may be selected to haul caustic. It is recommended that such carriers be pre-approved to meet a shipper's qualification standard and only those carriers should be utilized thereafter. Examples of carrier qualification requirements are:

- Proof of the minimum insurance required
- Copies of operating authority
- Pass a facility equipment/questionnaire or a driver training inspection/questionnaire
- Copy of DOT safety rating
- Hazardous Material Safety Permit
- Latest motor carrier safety survey
- In Canada, a CIAC carrier evaluation criteria system is in effect

7.2 DRIVER TRAINING

49 CFR 172 Subpart H outlines specific fundamental training topics for workers engaged in the handling and transport of hazardous materials. Among these topics are General Awareness/Familiarization Training, Function Specific Training and Safety Training.

Some of the topics that are to be covered include:

- Pre-trip safety inspection.
- Use of vehicle controls and equipment.

- Procedures for safe operation of vehicle.
- Requirements pertaining to attendance.
- Loading and unloading of materials.
- Operation of emergency control features of the cargo tank.
- The properties and hazards of the material transported.
- Retest and inspection requirements for cargo tanks.

The following is a listing of the regulatory areas covering topics for mandatory training requirements contained in Title 49 CFR:

Part 172.700	Purpose and scope
Part 172.704	Training requirements
Part 177.800	Purpose and scope and responsibility for compliance and training
Part 177.816	Driver training
Part 383.23	Commercial driver's license
Part 387.9	Financial responsibility, minimum levels (Motor Carriers)
Part 390	Federal Motor Carrier Safety Regulations: General
Part 391.11	Qualifications of drivers
Part 392	Driving of motor vehicles
Part 393	Parts and accessories necessary for safe operation
Part 395	Hours of service of drivers
Part 396	Inspection repair and maintenance
Part 397	Transportation of hazardous materials: driving and parking rules
Part 399	Employee safety and health standards

7.3 DOT HAZARDOUS MATERIALS REGISTRATION PROGRAM

Under DOT regulations found in 49 CFR 107.601 - 107.616, a person who offers or transports certain quantities or types of hazardous materials must register annually with DOT. This includes caustic carried in cargo tanks with capacities of 3,500 gallons or more. To register, the DOT Form F 5800.2 must be completed and sent to the U.S. Department of Transportation Hazardous Materials Registration. The registration requires an annual fee. The DOT will issue a registration number after payment.

8. **RECEIVING AND SPOTTING CAUSTIC CARGO TANKS**

When a cargo tank motor vehicle arrives at a facility the proper identification of the carrier and the product to be transferred should be verified before the cargo tank is directed to the transfer site. If a tank is empty and clean there should be a cleaning certificate. If the tank is empty but not cleaned, then a document certifying the last product loaded should be available.

The carrier furnishing the cargo tank is responsible for safe delivery to and positioning of the cargo tank at the transfer destination. The unit should be on firm ground or supports, and out of the paths of other vehicles. When the truck is spotted at the transfer rack, the driver should shut off the engine (unless it is required for the transfer), set the brakes and chock the wheels.

Precautions should be taken to prevent unauthorized movement of the cargo tank. A recommended practice is obtaining keys from the driver or placing a "loading in progress" sign on the tractor windshield. It is recommended the driver not be permitted to remain in the cab during transfer operations.

If the tractor is to be withdrawn, the trailer support should be placed on a firm surface capable of supporting the unit. An extra nose support under the 5th wheel plate should also be used.

Drivers should wear specified safety equipment for the site when they exit the truck and should be instructed on emergency evacuation procedures.

9. **CAUSTIC CARGO TANK LOADING**

9.1 GENERAL

When loading a caustic cargo tank, the safety aspects of the operations should be uppermost in the minds of loading personnel. The loader must verify that proper spotting and receiving have been completed before beginning transfer operations. Proper personal protective equipment should be worn during the transfer operations (See CI Pamphlet 65). Safety showers and eye wash facilities should be located in the immediate work area.

DOT (49 CFR 177.834(i)) and TC (CSA Standard B622) (CI Reference 13.5) regulations require a cargo tank to be attended by a qualified person at all times during loading. The person attending the loading must be alert and be within 25 feet of the cargo tank. A qualified person is one that has been made aware of the hazards of caustic and the procedures to be followed in an emergency, is authorized to move the cargo tank and has the means to do so.

An inspection checklist should be used for all aspects of the loading operation. It should include all recommendations contained in this pamphlet plus any company procedures or special requirements specific to each facility. The checklist documents that the proper loading and securement procedures have been completed and, if necessary, proper corrective actions have been taken.

9.2 PRE-LOAD INSPECTION CHECKLIST

The purpose of the pre-load inspection is to identify problems before loading. The pre-load portion of the checklist should at a minimum include:

- Determination that the proper cargo tank has been supplied.
- Check of the cargo tank for DOT/TC specification plate to determine the compatibility of the material of construction or lining for use in caustic soda service. A cargo tank that does not have a DOT/TC specification plate should not be loaded.
- Confirmation that the test dates on the specification plate are current and that the material to be loaded will not exceed the temperature, weight and density limit.
- A check that there is written certification or documentation stating whether the trailer has been cleaned or identifying the last contained product.
- A check to ensure that only compatible materials are loaded into compartmented tank trucks.
- An inspection of the running gear, safety appliances, marking, and placarding.
- Verification that all tank fittings are closed tightly to prevent any leakage.
- Verification that the unloading valves are closed tightly to prevent an accidental discharge.
- Visual inspection of the top and bottom fittings, manway cover including gaskets and bolts, and the tank interior for lining condition, cleanliness and heel. Mechanical problems that would prevent proper sealing should be corrected prior to commencing the transfer operation.
- Verification that the cargo tank has been depressurized prior to opening the manway to the interior of the tank. Prior to inspecting the interior of the tank, the tank needs to be depressurized to allow for the manway to be safely opened.

Because of the risk of contamination or reactivity of cargo tank contents, if a liquid heel is discovered during the pre-load inspection, appropriate plant procedures must be followed.

9.3 PRODUCT TRANSFER

After the pre-load inspection is complete and the cargo tank is found acceptable, product transfer can begin. Before making connections, four corrosive placards (UN 1824 for caustic soda and UN 1814 for caustic potash) should be applied to the cargo tank.

It is recommended the following be included in procedures for loading a caustic cargo tank:

- a) Determine the amount of product to be loaded.
- b) Ensure all outlet valves are closed.
- c) Ensure the loading line is secured to prevent movement. Product surge through the piping could cause the loading line to "jump" and cause a product release.
- d) When loading is done on a scale, flexible-filling lines must be used to insure accurate weighing.
- e) When ready to transfer, open product valve, engage transfer pump and begin product flow.
- f) During the transfer process, periodically inspect the tank outlet valve to ensure there is no leakage. If leakage is detected, immediately stop the transfer, and determine cause of leak. Ensure defect has been corrected prior to continuing with transfer.
- g) Fill the tank to the proper level following established plant procedures ensuring the cargo tank's weight capacity is not exceeded. This is defined as the load limit, and consists of both the design capacity of the tank, and the gross vehicle weights (GVW) of the power unit. Exceeding this limit may result in an unsafe condition. In addition, state or provincial axle and gross load limits must not be exceeded.
- h) Secure all the valves, valve plugs, valve caps and the manway cover using a properly sized wrench. All fittings must be tool tight.

9.4 POST-LOAD INSPECTION CHECKLIST

The post-load inspection checklist should, at a minimum, include the following:

- Verification of the proper securement of all components and fittings.
- Verification that the cargo tank motor vehicle is not overweight.
- Application of seals, product information tags or other information required by regulation and the facility.
- Washing off of any product residue from the cargo tank following established plant procedures.

- Confirmation the cargo tank is properly marked and placarded.
- Confirmation the manway covers are securely fastened, and all other openings, securely closed and tightened before transit.
- Completion of the cargo tank inspection check list report and a release of the tank for shipment.
- A visual inspection of the cargo tank for leakage or mechanical problems.
- A check that proper shipping papers have been prepared and are given to the driver.
- A check that the driver has the appropriate guidebook (or appropriate page) in the cab if the hazard communication notation on the shipping paper is the emergency response guide number.
- If used, ensure the proper MSDS accompanies the shipping papers.
- Inspect transfer hoses (See Section 11.3).

10. CAUSTIC CARGO TANK UNLOADING

10.1 GENERAL

When unloading a caustic cargo tank, the safety aspects of the operations should be uppermost in the minds of unloading personnel. The unloader must verify that proper spotting and receiving have been completed before beginning transfer operations. Proper personal protective equipment (which may include hard hat, chemical splash goggles, full face shields, chemical protective suit, gloves and boots) should be worn during the transfer operations (See CI Pamphlet 65). Safety showers and eye wash facilities should be located in the immediate work area.

An inspection checklist should be used for all aspects of the unloading operation. It should include all recommendations contained in this pamphlet plus any company procedures or special requirements specific to each facility. The checklist documents that proper unloading and securement procedures have been completed and, if necessary, proper corrective actions have been taken.

10.2 PRE-UNLOAD INSPECTION CHECKLIST

The purpose of the pre-unload inspection is to identify problems before unloading begins. The pre-unload inspection checklist should at a minimum include:

- Verification that shipping papers and other required documentation have been delivered to a responsible authority at the user destination. A signed delivery receipt should be obtained before the motor carrier leaves the area.

- Verification that the tank is loaded with caustic by careful inspection of the bill of lading, the vehicle number, commodity marking and placards and/or sampling. Extreme care should be taken to ensure cargo tank contents are properly identified.
- Inspection of the running gear, safety appliances, marking (including stenciling), placarding and other pertinent items to identify all defects in the cargo tank motor vehicle before unloading caustic.
- A check of the tank fittings to verify there is no leakage.
- A check of the temperature of the caustic and, following the supplier's recommendations, heating the cargo tank as necessary prior to product transfer.
- A check of all unloading connections.
- A check that unloading equipment such as transfer hoses, fittings, pumps, lines, valves air system are compatible with caustic.
- Inspection of transfer hoses (see Section 11.3).
- Verification that grounding cables have been connected to the trailer if required by plant procedures.
- Establishment by the unloader of the location of the nearest safety showers and eyewash.
- Verification that the receiving tank has sufficient capacity to receive the caustic to be transferred including capacity needed for evacuation of transfer piping and hoses by air.
- Ensure the receiving operator is aware of the location and proper operation of the tanker's emergency shut off valve.
- Inspect the receiving tank to assure:
 - That the caustic will be unloaded into the correct receiving tank
 - The tank is compatible with the product being delivered
 - The tank is properly labeled and stenciled
 - The receiving piping is labeled and properly supported
 - The hook-up fittings are compatible with the product being delivered

- The hook-up fittings should be inspected for cracks, distortion, and worn or missing clamping ears
- The hook-up gaskets should be inspected for cracks or dry rot
- Check tank fittings to verify there are no signs of leakage

Depending on individual facility and carrier procedures specific elements of the pre-unload inspection could be the responsibility of the driver, facility personnel or both individuals.

10.3 PRODUCT TRANSFER

After the pre-unload inspection is satisfactorily completed, product transfer can begin. Pumps, pressure padding, or in some cases by gravity can be used to unload caustic cargo tanks. Unloading can take place through either a bottom fitting or a top fitting. If an unfamiliar unloading arrangement is encountered, the carrier should be contacted immediately.

Monitoring the Unloading

DOT (49 CFR 177.834(i)) and TC (CSA Std. B622) regulations require a cargo tank to be attended by a qualified person at all times during unloading. The person attending the unloading must be alert and be within 25 feet of the cargo tank. A qualified person is one that has been made aware of the hazards of caustic and the procedures to be followed in an emergency, is authorized to move the cargo tank and has the means to do so.

Bottom Unloading By Pump or Gravity

Product transfer through the bottom outlet can be accomplished by pumping or by gravity. It is recommended the following be included in procedures for the bottom unloading by pump or gravity:

- Keep the manway cover open or maintain a continuous positive pressure to avoid pulling a vacuum on the tank.
- Ensure the plant's unloading connection is securely attached to the cargo tank's bottom outlet before any product valves are opened.
- Ensure all unloading systems are leak free throughout the product transfer process.
- Disconnect unloading lines after steaming, blowing or gravity clearing. With the relatively high freezing points of certain liquid caustic solutions, it is vital to completely clear product from pumps and lines after use to prevent freezing/crystallizing of the caustic that might remain in the system.
- Ensure that pressure is relieved on unloading connections/lines when transfer is complete. Take appropriate precautions when breaking connection to prevent back pressure, or residual splashing.

Top or Bottom Unloading By Air Pad

When top or bottom unloading by air padding, a positive pressure is applied through the valve on the cargo tank to force the product out of the tank. Extra precautions should be observed with this method of product transfer to minimize the effect of a leak from a pressurized cargo tank.

It is recommended the following be included in procedures for unloading using an air pad:

- The dust cap should be removed from the trailer outlet valve and the unloading hose connected after inspection of the hose and fittings. Unloading connections must be securely attached before any product valves are opened.
- All unloading systems must be leak free throughout the product transfer process.
- The manway cover must be secured before applying pressure.
- The unloading pressure must not exceed the safe working pressure of the cargo tank. Air pressure can be adjusted to regulate the flow of caustic through the unloading line. Approximately 15 to 20 psig should be sufficient depending on location of storage tank.
- A drop in air pressure or the sound of rushing air generally indicates the tank is empty. The air supply should be turned off and the air line and the cargo tank depressurized.
- Unloading lines should be disconnected after steaming, blowing or gravity clearing. With the relatively high freezing points of certain liquid caustic solutions, it is vital to completely clear product from pumps and lines after use to prevent freezing/crystallizing of the caustic that might remain in the system.
- All valves should be closed and all caps replaced.

10.4 STEAMING CAUSTIC CARGO TANKS

Caustic may be shipped in insulated cargo tanks and usually arrives ready to unload. Delays in shipments or very cold weather may require the caustic to be steam heated before unloading. Heating the cargo tank with low pressure steam (less than 15 psig) through the external coils will thaw frozen caustic sufficiently to allow the caustic to be unloaded.

The steam source at the unloading station should be regulated from line pressure (usually 100 to 125 psig) down to a supply pressure of 15 psig to prevent hot steam from damaging the lining or the cargo tank. A steam line (hose or piping, or both) is attached to one of the two nipples on the cargo tank, a steam trap is connected to the other opening on the cargo tank's steam coils, and the trap discharge is connected to the condensate return system. The use of a properly sized and operating steam trap will give the fastest melting time for frozen caustic.

After product flow is established, the steam supply to the cargo tank should be turned off to prevent damage. All steam hoses and piping should be removed before the cargo tank is moved. Steam coils on the cargo tank should be drained and blow dried with air to prevent coil damage due to freezing.

10.5 POST-UNLOAD INSPECTION CHECKLIST

The post-unload inspection checklist should, at a minimum, include the following:

- Verification of the proper securement of all components and fittings.
- Application of seals, product information tags or other information required by regulation and the facility.
- Confirmation that the cargo tank is properly marked and placarded.
- Wash off of any product residue from the cargo tank exterior following established plant procedures.
- Complete the inspection checklist and release the cargo tank for shipment.
- Verify that any fitting used to depressurize prior to shipment is closed.

Good operating practice should include notations on the delivery receipts such as storage tank gallons delivered with content readings before and after, identification of containers filled, containers filled and net weight of each, analysis sheet (if required), quantity in pounds or gallons delivered to the storage tank, before and after readings, and weight tickets (if available).

11. **MAINTENANCE REQUIREMENTS**

As with all hazardous material transport containers, caustic cargo tanks must be maintained in a safe operating condition. It is essential all scheduled tests and inspections be carried out with great diligence and care.

11.1 DAILY INSPECTION AND MAINTENANCE

Prior to operation the assigned driver must be satisfied that critical devices and accessories of the vehicle are in good working order. Title 49 CFR 392.7 outlines these critical devices and accessories. The driver is required to review the previous driver's Driver Vehicle Inspection Report (DVIR) for any problems, safety deficiencies and corrections. A DVIR is required to be completed at the end of the driver's tour of duty.

Inspections must be conducted on the vehicle at the completion of the day's work and any necessary deficiencies corrected before the unit resumes service on the public highways. Records must be kept and be available for reference during future scheduled maintenance events to assure that a uniform and cohesive flow of information is available to future inspectors. DOT requirements for inspection, repair and maintenance can be found in 49 CFR Part 396.

11.2 PERIODIC MAINTENANCE

Careful and thorough vehicle maintenance should be performed on a fixed schedule as dictated by operating conditions and environment. For example, colder climates may cause maintenance problems such as corrosion due to road salting and spring and tire failure due to potholes caused by frozen roadways.

Internal valve leak testing is a required procedure at many loading facilities, and roadside inspections may include checking for leakage through the closed internal valves. The valve seats should be replaced as needed to maintain full sealing capability. If reliable sealing becomes a problem, a higher grade of seat material should be used. There are suitable elastomeric seats available that have high chemical resistance and good physical resilience. It is the shipper and carrier's responsibility to ensure compatibility of the gasket and seat material with the product.

11.3 HOSE AND FITTING MAINTENANCE

Hose assemblies used to transfer caustic should be constructed of appropriate materials, assembled by the manufacturer or distributor and hydrostatically tested prior to first use. Hose assemblies should be carefully examined prior to each subsequent use to assure none of the following conditions exist: leakage, frayed or worn braid, ballooned or bunched braid, hose elongation or corrosion. It is recommended that an acceptable procedure for maintenance, testing and inspection of hoses be set by each facility/carrier based on experience and equipment use.

A review of DOT 5800.1 incident reports shows that one of the most common failures of equipment **and cause of subsequent releases of material** is the hose. At a minimum transfer hoses should be inspected pre-load and post-load for the following:

- Hoses should be inspected for cracks, cuts and abrasions. The hoses should also be inspected for "flat spots" and should not be elongated.
- Hose couplings should be inspected for cracks, distortions or other damage that may prevent sealing. Clamping ears should not be broken or worn.
- Hose gaskets should be in good shape with no signs of cracks or dry rotting.
- Hose clamps should be examined for cracks, worn spots and should be tight.
- Hoses should be clean or dedicated to the product being delivered.

11.4 TESTS AND INSPECTIONS

Title 49 CFR Part 180 contains the requirements for maintenance, use, inspection, repair, retest and requalification of cargo tanks. Report and record retention requirements can be found in 49 CFR 180.417. Testing requirements in Canada are very similar to those in the U.S. Reference is made to CSA B620 (CI Reference 13.5).

Any required weld repairs, as described in 49 CFR 180.413, may only be accomplished by a repair shop awarded a National Board "R" Stamp.

The following is a summary of tests and inspections for caustic cargo tanks:

External Visual Inspection (V)	Every one (1) year
Internal Visual Inspection (I)	Every one (1) year for insulated cargo tanks or if lading is corrosive to tank, otherwise every five (5) years.
Lining Test (L)	Every one (1) year if lading is corrosive to tank
Leakage Test (K)	Every one (1) year
Pressure Test (P)	Every one (1) year for cargo tanks that are insulated and lined, otherwise every five (5) years. Exception: Pressure testing is not required for uninsulated lined cargo tanks, with a design pressure or MAWP of 15 psig or less, which receive an external visual inspection and a lining inspection at least once each year.
Thickness Test (T)	Every two (2) years for unlined cargo tanks if lading is corrosive to the tank.
Upper Coupler	Inspected without removal, every one (1) year (49 CFR 180.407(d)(2) (viii)). Removed for inspection every two (2) years when the lading is corrosive to the tank (49 CFR 180.407(d)(2) (ix)). For all other tanks, removed for inspection at the pressure test interval (49 CFR 180.407(g)(1)(iii))

The tank should be subjected to hydrostatic pressure during the pressure test. See 49 CFR 180.407 for the specific requirements for the above listed tests and inspections.

Upon satisfactory completion of the test/inspection events, the tester must place a legend denoting the month/year of the test followed with the letter signifying the type of test performed (e.g. **6/01 P** for a pressure test performed during June 2001). This legend must be permanently affixed near the tank's specification plate or anywhere on the front head in characters no less than 1 ¼ inches in height. A legend is not required denoting the removal of the upper coupler device, but records of this event must be available for review (49 CFR 180.415).

Caustic cargo tanks must be equipped with a legible specification plate denoting the MC or DOT specification type, the date of manufacture, the maximum allowable working pressure, cargo capacity, and other pertinent information.

Records demonstrating completion of tests and inspections must be maintained at the tank's terminal or at a permitted regional, central or terminal office according to DOT rules in Part 180.417. Records must be immediately available for review and must be completed and signed by the authorized inspector or tester. Only facilities expressly registered with the DOT and possessing a registration number may grant inspector or tester authorization using criteria established by the DOT. For minimum qualifications for inspectors and testers see 49 CFR 180.409.

12. REDUCING NON-ACCIDENTAL RELEASES

12.1 GENERAL

Any unintended release of hazardous materials that occurs during transportation is required to be reported by carriers and shippers on DOT 5800.1 report forms and recorded in a DOT database.

12.2 REVIEW OF DOT 5800.1 DATA

The Chlorine Institute Transportation Issue Team sponsored an evaluation of caustic cargo tank DOT 5800.1 incident data. These incidents can be categorized by transportation phase as shown in Figure 12.1. Further evaluation showed the source of the leak by transportation phase as shown in Figure 12.2. The loading and unloading checklists and many of the other recommendations provided in this pamphlet were developed to address the common causes of releases during all phases of transportation.

Figure 12.1
Leaks by Transportation Phase
5800 Reports for Caustic/Potash Cargo Tanks
Jan. 2005 – Sept. 2009

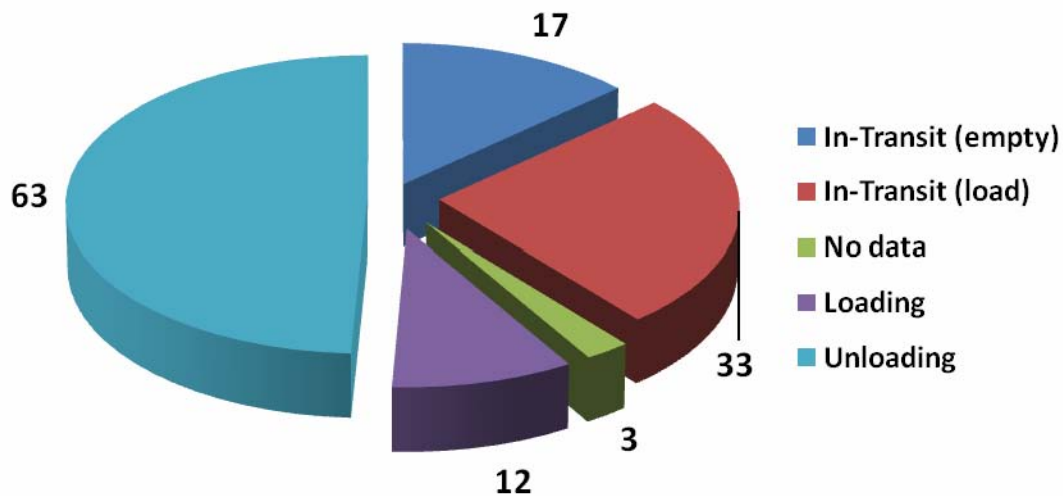
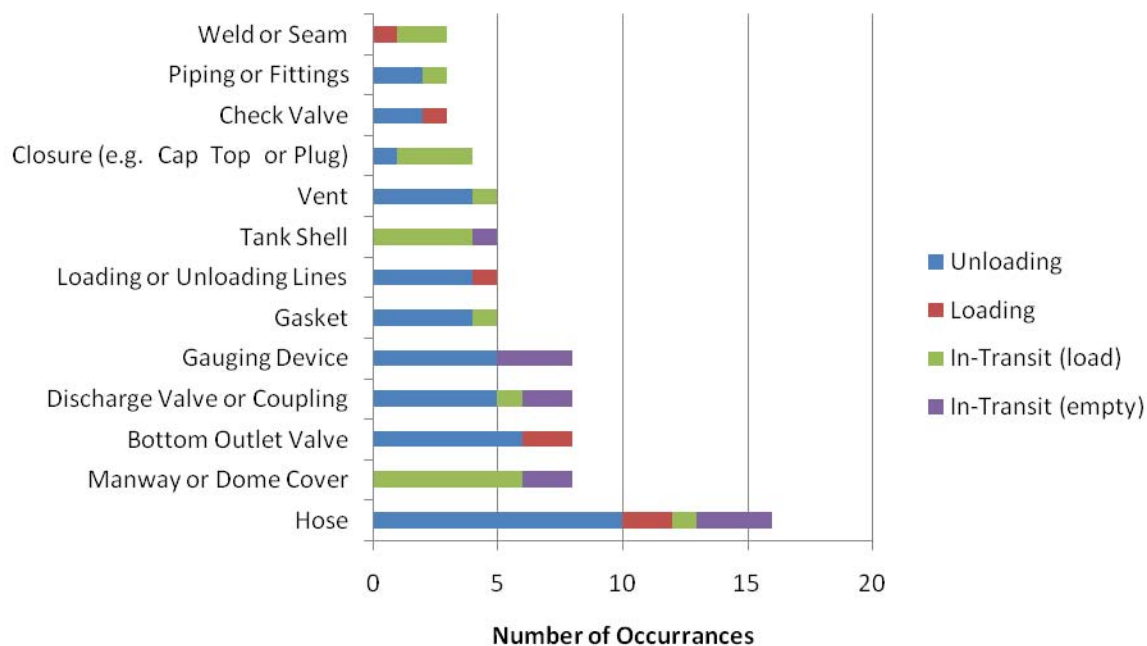


Figure 12.2
Leak Source by Transportation Phase
5800 Reports for Caustic/Potash Cargo Tanks
Jan. 2005 – Sept. 2009



12.3 BEST PRACTICES TO REDUCE TRANSPORTATION INCIDENTS

The following are some industry best practices that member companies have been employing to reduce incidents. These best practices include:

- Performing annual (or other periodic) pressure testing of hoses to insure integrity
- The use of a formal procedure (e.g. checklist) that requires both the driver and facility personnel to mutually verify elements included in Section 10.2
- Using lip gaskets instead of ring gaskets for manway covers
- Ensuring sufficient outage when loading a cargo tank car
- Auditing carriers for adequate training, maintenance and inspection practices

13. REFERENCES

13.1 INSTITUTE PUBLICATIONS

<u>Pamphlet & DVD #</u>	<u>Title</u>
65	<i>Personal Protective Equipment for Chlor-Alkali Chemicals</i> , ed. 5; Pamphlet 65; The Chlorine Institute: Washington, DC, 2008 .
80	<i>Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Barges</i> , ed. 3; Pamphlet 80; The Chlorine Institute: Washington, DC, 2001 .
87	<i>Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Tank Cars</i> , ed. 3; Pamphlet 87; The Chlorine Institute: Washington, DC, 2005 .
94	<i>Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic): Storage Equipment and Piping Systems</i> , ed. 3; Pamphlet 94; The Chlorine Institute: Washington, DC, 2007 .
	The Chlorine Institute, Inc. Website: www.chlorineinstitute.org

13.2 DOT REGULATIONS

Code of Federal Regulations. Title 49. Parts 100-185. Office of the Federal Register National Archives and Records Administration. U.S. Government Printing Office: Washington, DC, (revised annually).

North American Emergency Response Guidebook. Office of Hazardous Material Transportation (DHM-51). Research and Special Programs Administration. U.S. Department of Transportation: Washington, DC, **2000**.

13.3 EPA REGULATIONS

Code of Federal Regulations. Title 40. Part 150. Office of the Federal Register National Archives and Records Administration. U.S. Government Printing Office: Washington, DC, (revised annually).

13.4 OSHA REGULATIONS

Code of Federal Regulations. Title 29. Part 1910. Office of the Federal Register National Archives and Records Administration. U.S. Government Printing Office: Washington, DC, (revised annually).

13.5 CANADA REGULATIONS

Guide to Canadian Transportation of Dangerous Goods Act and Regulations, mini version; ICC International Compliance Center Ltd: Mississauga, Ontario, **1999**.

Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods; CSA B620-03; Canadian Standards Association: Mississauga, Ontario, **2003**.

Selection and Use of Highway Tanks, Portable Tanks, Cargo Compartments and Containers for the Transportation of Dangerous Goods Class 3, 4, 5, 6.1, 8 and 9; CSA B621-03; Canadian Standards Association: Mississauga, Ontario, **2003**.

Selection and Use of Highway Tanks, Multi-unit Tank Car Tanks, and Portable Tanks for the Transportation of Dangerous Goods Class 2; CSA B622-03; Canadian Standards Association: Mississauga, Ontario, **2003**.

13.6 AMERICAN CHEMISTRY COUNCIL PUBLICATIONS

Responsible Care. Several brochures, pamphlets, videos and merchandise on the six Codes are available and are updated periodically. American Chemistry Council; Arlington, VA.

13.7 OTHER REFERENCES

Tank Trailer and Tank Container Nomenclature - TTMA Recommended Practice RP No. 36. Available from Truck Trailer Manufacturers Association, 1020 Princess St., Alexandria, VA 22314 (www.ttmanet.org)

For further assistance and information on items referenced, contact:

American Chemistry Council
1300 Wilson Boulevard
Arlington, VA 22209
703-741-5000
703-741-6000 (Fax)
www.americanchemistry.com

Canadian General Standards Board
Place du Portage III, 6B1
11 Laurier Street
Gatineau, Quebec K1A 1G6
819-956-0425
1-800-665-2472 (Canada only)
819-956-5740 (Fax)
www.pwgsc.gc.ca/cgsb

CSA International
178 Rexdale Boulevard
Toronto, Ontario M9W 1R3 (CANADA)
416-747-4000 (standard purchases)
416-747-4149 (Fax)
www.csa-international.org

ICC International Compliance Center Ltd.
205 Matheson Boulevard, East, Unit 7
Mississauga, Ontario CANADA L4Z 1X8
888-977-4834
866-821-0735 (Fax)
www.thecompliancecenter.com

National Tank Truck Carriers, Inc.
950 N. Glebe Road, Suite 520
Arlington, VA 22203-4183
703-838-1960
703-838-8860 (Fax)
www.tanktruck.org

Superintendent of Documents
Government Printing Office
732 N. Capitol Street, NW
Washington, DC 20401
202-512-2104 (sales)
www.access.gpo.gov

The Chlorine Institute, Inc.
1300 Wilson Boulevard Suite 525
Arlington, VA 22209
703-894-4140
703-894-4130 (Fax)
www.chlorineinstitute.org

Truck Trailer Manufacturers Association
1020 Princess St.
Alexandria, VA 22314-2247
703-549-3010
www.ttmanet.org

APPENDIX A

DATA SHEET A-1

NAME: Sodium Hydroxide Solution

CHEMICAL FORMULA: NaOH

TRADE NAME: Caustic Soda

SYNONYMS: Liquid Caustic, Lye Solution, Caustic, Lye, Soda Lye

PHYSICAL DATA OF 50% SOLUTION

Boiling Point: 293°F (145°C) 50% Solution

Vapor Pressure: N/A

Solution in water: 100%

Vapor Density: 2.49 @ 32°F (0°C)

Sp. Gravity: 1.52

Appearance: Colorless or slightly colored, clear or opaque:

Odor: Odorless

Molecular weight: 40.00

FIRE AND EXPLOSION HAZARD DATA:

Flash Point: None

Flammable Limits: LFL: N/A
UFL: N/A

Fire and Explosion Hazards:

In water solution caustic can react with amphoteric metals (such as aluminum) generating hydrogen which is flammable and/or explosive when ignited.

REACTIVITY DATA:

Stability:

Product absorbs water and carbon dioxide from the air.

INCOMPATIBILITY:

Hazardous Material Decomposition:

Dilution with water evolves large amount of heat. Product is strong caustic alkali. May react violently with acid and a number of organic compounds. Caustic reacts rapidly with aluminum, tin, and zinc. It will also react with bronze and brass.

HEALTH HAZARDS:

Eye:

May cause severe irritation with corneal injury and result in permanent impairment of vision, even blindness. Dusts may irritate eyes.

Skin Contact:

Short single exposure may cause severe skin burns.

Ingestion: May cause gastrointestinal irritation or ulceration and severe burns of the mouth and throat.

Inhalation: Dusts or mists may cause severe irritation to upper respiratory tract.

HANDLING AND STORAGE PRECAUTIONS:

Ventilation: Control airborne concentrations below the exposure guideline. Good general ventilation sufficient for most operations.

Respiratory Protection: In misty atmospheres, use an approved mist respirator. If respiratory irritation is experienced, use an approved air-purifying respirator.

Skin Protection: Use protective clothing impervious to this material. Selection of specific items such as gloves, boots, apron, hard hat with face-shield or full-body suit will depend on operation. Remove contaminated clothing immediately, wash skin area with soap and water, and launder clothing before reuse.

Eye Protection: Use chemical goggles. Full-face shield in addition to goggles may be desirable to protect face. Maintain eye wash fountain and safety shower at or near work area.

ADDITIONAL INFORMATION:

Special Precautions to be Taken in Handling and Storage:

Prevent eye and skin contact. Do not breathe dusts or mists.

Avoid storing next to strong acids. Caustic should be stored in clean, dry areas. Do not store in underground tanks. Product absorbs water and CO₂ from air. Keep containers closed and sealed.

Special Precautions for Diluting Caustic Soda Solution:

ALWAYS add caustic soda solution to water with constant agitation.
NEVER add water to the caustic soda solution.

The water should be lukewarm (80-100°F) (27-38°C). NEVER start with hot or cold water.

The addition of caustic soda to liquid will cause a rise in temperature. If caustic soda becomes concentrated in one area, or is added too rapidly, or is added to hot or cold liquid, a rapid temperature increase can result in DANGEROUS mists or boiling or spattering which may cause immediate VIOLENT ERUPTION.

APPENDIX A

DATA SHEET A-2

NAME: Potassium Hydroxide Solution

CHEMICAL FORMULA: KOH

TRADE NAME: Caustic Potash

SYNONYMS:

PHYSICAL DATA OF 50% SOLUTION

Boiling Point: 290°F (143°C)

Vapor Pressure: N/A

Solution in Water: 100%

Vapor Density: N/A

Sp. Gravity: 1.52@ (15.6°C)

Appearance: Clear liquid

Odor: Odorless

Molecular Weight: 56.1

FIRE AND EXPLOSION HAZARD DATA:

Flash Point: None

Flammable Limits: LFL: N/A
UFL: N/A

Fire and Explosion Hazards:

REACTIVITY DATA:

Stability: Under normal conditions, the material is stable.

INCOMPATIBILITY:

Hazardous Material

Decomposition: Avoid direct contact with water. This product may be added slowly to water or acids with dilution and agitation to avoid a violent exothermic reaction. Avoid contact with aluminum, tin, zinc, and alloys containing these metals. Avoid contact leather, organic halogen compounds, organic nitre compounds, acid and wool.

HEALTH HAZARDS:

Eye: Is destructive to eye tissues on contact. Will cause severe burns that result in damage to the eyes and even blindness.

Skin Contact: Is destructive to tissues contacted and produces severe burns. A latent period may exist between exposure and sense of irritation.

- Ingestion:** May cause severe burns and complete tissue perforation of mucous membranes of the mouth, throat, esophagus and stomach.
- Inhalation:** Mists or spray may cause damage to the upper-respiratory tract and even to the lung tissue proper which could produce chemical pneumonia, depending on severity of exposure.

HANDLING AND STORAGE PRECAUTIONS:

- Ventilation:** Use with adequate ventilation.
- Respiratory Protection:** When exposure to dust, mist or spray is possible, employ respiratory protection.
- Skin Protection:** Use protective clothing impervious to this material. Selection of specific items such as gloves, boots, apron, hard hat with face-shield or full-body suit will depend on operation. Remove contaminated clothing immediately, wash skin area with soap and water, and launder clothing before reuse.
- Eye Protection:** Use chemical goggles. Full-face shield in addition to goggles may be desirable to protect face. Maintain eye wash fountain and safety shower at or near work area.

ADDITIONAL INFORMATION:

Special Precautions to be Taken in Handling and Storage:

Prevent eye and skin contact. Do not breathe dusts or mists.

Avoid storing next to strong acids. Caustic should be stored in clean, dry areas. Do not store in underground tanks. Product absorbs water and CO₂ from air. Keep containers closed and sealed.

Special Precautions for Diluting Caustic Soda Solution:

ALWAYS add caustic potash solution to water with constant agitation.
NEVER add water to the caustic potash solution.

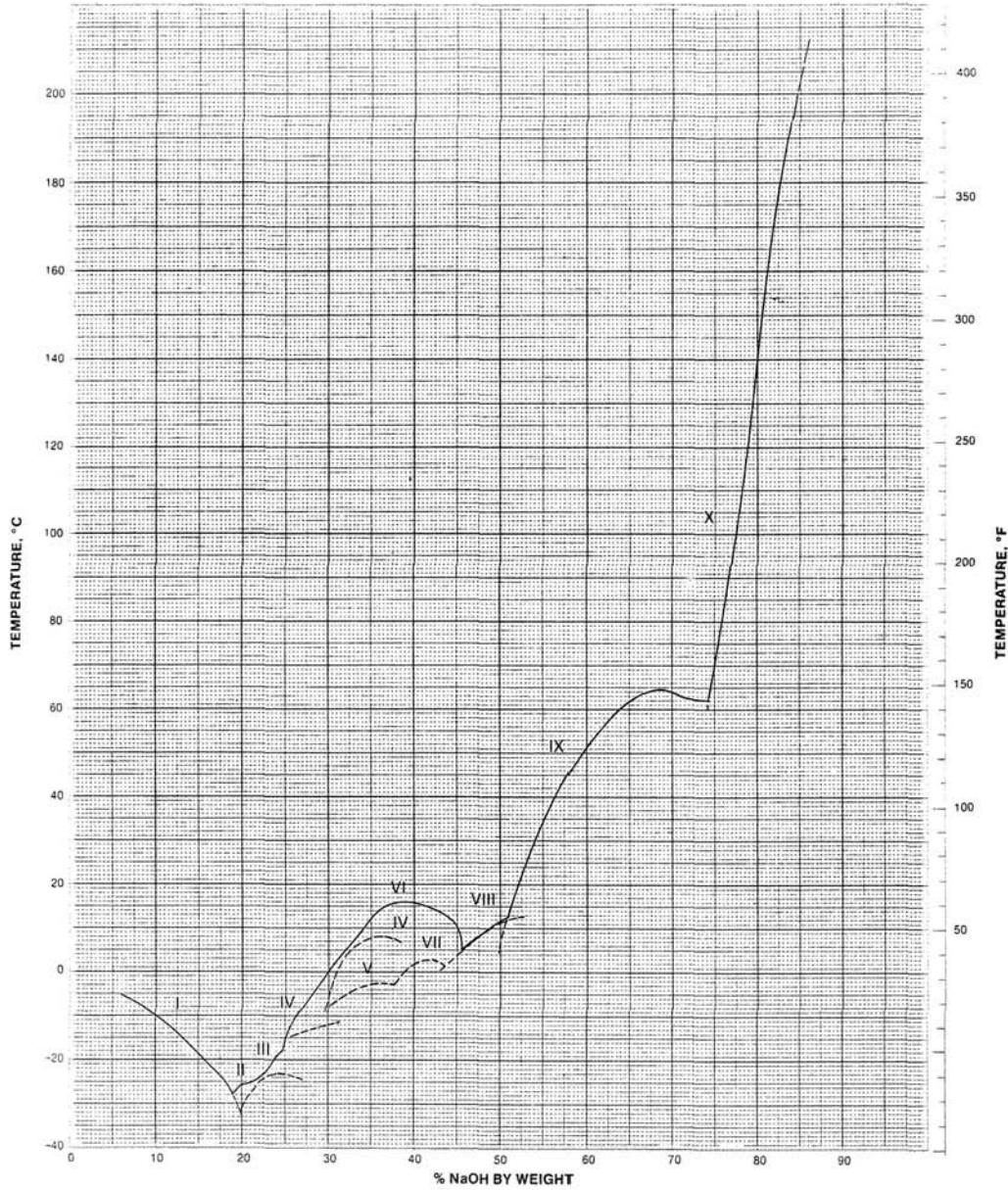
The water should be lukewarm (80-100°F) (27-38°C). NEVER start with hot or cold water.

The addition of caustic potash to liquid will cause a rise in temperature. If caustic potash becomes concentrated in one area, or is added to rapidly, or is added to hot or cold liquid, a rapid temperature increase can result in DANGEROUS mists or boiling or spattering which may cause immediate VIOLENT ERUPTION.

APPENDIX B

FREEZING POINT DATA

Chart No. 7 Freezing Point Curve for Aqueous Caustic Soda Solutions



Roman Numerals Represent Following:
 I H₂O (Ice)
 II NaOH · 7 H₂O
 III NaOH · 5 H₂O
 IV alpha NaOH · 4 H₂O
 V beta NaOH · 4 H₂O
 VI NaOH · 3.5 H₂O
 VII NaOH · 3 H₂O
 VIII NaOH · 2 H₂O
 IX NaOH · 1 H₂O
 X (May be NaOH · 0.5 H₂O)

More Important Transition Points are as Follows:
 I to II -19.12° F. -28.4° C. 18.96% NaOH
 II to III -11.56° F. -24.2° C. 22.11% NaOH
 IV to VI 41.72° F. 5.4° C. 32.25% NaOH
 VI to VIII 41.22° F. 5.12° C. 45.9% NaOH
 VIII to IX 53.96° F. 12.2° C. 50.9% NaOH
 IX to X 144.14° F. 62.3° C. 74.3% NaOH

REF.: LANDOLT & BORNSTEIN
4th EDITION, 467-88 (1912)

NOTE: Solid line represents normal freezing points of Chemically Pure Caustic Soda at which crystals are in equilibrium with mother liquor; dashed lines indicate metastable regions where, under special conditions, crystals will appear.

APPENDIX C**CHECKLIST**

This checklist is designed to emphasize major topics for someone who has already read and understood the pamphlet. Taking recommendations from this list without understanding related topics can lead to inappropriate conclusions.

Place a check mark (✓) in the appropriate box below:

Yes	No	N/A		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Is the reactivity and compatibility information from Section 2.3 incorporated in procedures and programs?	{2.3}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Are procedures in place to monitor the vapor space of cargo tank for corrosion?	{2.5}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3. Does the facility have a Spill Prevention Program in place?	{2.7}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	4. Do the emergency plans include notifying CHEMTREC? If so is the facility registered with the American Chemistry Council?	{3.1}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5. Do the facilities' training programs for handling hazardous materials and for off-site emergency response comply with requirements?	{3.1.2}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. Do emergency plans call for notifying the National Response Center of spills greater than or equal to 1000 pounds of caustic?	{3.3}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7. Were the cargo tank specifications outlined in Section 5 taken into consideration when specifying caustic cargo tanks?	{5}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8. Do the carriers and drivers meet the qualifications and training specified in Section 7?	{7}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9. Are proper receiving and spotting procedures in place?	{8}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10. Are loading and unloading checklists used?	{9, 10}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11. Are procedures in place to address thawing product if necessary?	{10.4}
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	12. Has a cargo tank maintenance program been established?	{11}

REMINDER: Checklist users should document exceptions to recommendations contained in this pamphlet.



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