Field Transfers of Tank Cars

presented by

Allen D. Maty
Chief Inspector - Northern Region
Association of American Railroads
Kansas City, Missouri

and

Robert M. Stine
Regional Manager
Chemical Transportation Safety
Union Pacific Railroad
Kansas City, Missouri

Association of American Railroads
Bureau of Explosives
Hazardous Materials Seminar

Dallas, Texas
April 19-21, 1994

This document presents the key concepts presented in a workshop
"Field Transfers of Tank Cars" at the
Association of American Railroads - Bureau of Explosives
Hazardous Materials Seminar
in Dallas, Texas – April 19-21, 1994

Field Transfers of Tank Cars

Introduction

Although infrequent, situations occur where a railroad tank car that has been in transit cannot be safely, legally, or practically forwarded to a fixed unloading facility; and, a reduction, transfer, or removal of the lading is necessary or warranted.

This program will focus on field product removal from a tank car which may be necessitated by accident or non-accident conditions such as:

1. Mechanical defect discovered during normal operations;
2. Mechanical damage caused by a derailment or collision;
3. Derailment site conditions which prevent or preclude rerailing;
4. Damaged or leaking valves or fittings that cannot be repaired or otherwise secured;
5. Need to reduce the tank's internal pressure due to fire exposure, polymerization, mechanical damage, etc.; and/or
6. The tank being overloaded by weight or volume.

Subjects to be covered include:

- Overview
- Preferred Conditions
- Potential Risks
- Safety Precautions
- Transfer Methods
  - Gas (liquefied compressed gases/pressure cars)
  - Liquid (general service cars)
- General Procedures
- Flaring
- Venting
- Vent and burn

CMA 110053

This page intentionally left blank.

Product Removal Methods

Overview

Product removal methods are those techniques used for removing the contents from a damaged or overloaded tank car. The methods include:

- Transfer
- Flaring
- Venting.

Techniques for gaining access to the contents of a tank car when damage to the valves and fittings precludes normal access include:

- Hot tap
- "Cold" tap

Note: All of these product removal methods are considered outside the legitimate responsibility of the local emergency responder; however, oversight of the planning and implementation of these methods is within the realm of responsibility of local emergency response agencies. Remember, protecting yourself and the community are your primary responsibilities.

Deviations from these general procedures are acceptable as long as they are safe.

Transfers

A **transfer** is the movement of the contents of a damaged or overloaded tank car into receiving tank *(e.g., a tank car, cargo tank, intermodal tank, or fixed tank).*

In rail transportation, transfers may be used when:

- the tank car tank itself is sound; however, due to bolster or other mechanical damage, the car cannot be safely mounted on its trucks and rerailed,
- the site conditions prevent rerailing the damaged tank car *(e.g., the terrain does not permit use of cranes or other rerailing equipment),*
- the tank car tank is overloaded,
- the damage to leaking valves and fittings cannot be repaired, or
- the tank car tank has been damaged to the extent that it cannot be safely rerailed and moved to an appropriate unloading point.

Preferred Conditions

To the extent possible, the following conditions should exist, or be met, before performing a transfer *(these conditions are considered optimal, but may not be met in all cases due to local circumstances)*:

- suitable systems are in place for monitoring for exposures and for protecting persons and property in the event of an accidental release during the transfer.
- suitable transfer equipment is available,
- personnel experienced in transfer operations are available,
- a receiving tank(s) of the proper specification are available with sufficient capacity to receive the contents of the damaged tank car *(any residue in the receiving tank(s) must be compatible with the material to be transferred),*
- the liquid and vapor valves are accessible and operable, or the use of a hot or cold tap is possible,
- the tank car is in a position that will allow the transfer *(e.g., check valves have not seated, or, if they have, tools are available to unseat the valves),*
- a delayed rupture is not likely, and
- the tank is not exposed to fire,

Potential Risks

The following risks may be associated with a transfer:

- failure of the tank or transfer equipment could expose people, property, and the environment to the tank car's contents,

- failure of the damaged tank car tank due to pressure rise from use of compressor or compressed gas, and/or
- contamination of the damaged car's contents with residues in the transfer equipment or receiving tanks could result in an undesired reaction.

Safety Precautions

The following safety precautions must be taken when performing a transfer:

- secure the car(s) from movement - tighten the hand brakes and chock the wheels, if necessary,
- place blue flags, if required,
- limit site access to required personnel only,
- perform transfer using only qualified personnel,
- check to see that the transfer equipment is clean and appropriate for the material being transferred,
- clean and wrap all pipe threads with pipe joint tape before making connections,
- clean all hose connections before joining, replacing "O" rings if necessary,
- use an emergency shut-off system *("emergency shut-off" and "back check valves")* to either automatically or manually shut down the transfer in case of an unintentional release caused by a hose break or other malfunction. **Note:** The use of the emergency shut-off system eliminates the need for personnel on the tank during the transfer
- use personal protective equipment for toxic materials,
- monitor site with vapor monitoring equipment,
- in transferring flammable materials using an open system, ground and bond the car. **Note:** NFPA 77, ***Recommended Practice on Static Electricity,*** does not require protective measures *(e.g., grounding and bonding)* when loading and unloading tank cars through a closed system
- control ignition sources within 15 feet of operations:
  - do not permit smoking on site,
  - eliminate or shut off electrical equipment that is not intrinsically safe, and
  - shut off any internal combustion engines that are not intrinsically safe.

Transfer Methods

Typically, transfers in the field are distinguished by the basic equipment used to move the contents from a damaged or overloaded tank car. Gas or liquid transfers can be accomplished in the field using one of the following methods:

- using a vapor compressor,
- using a vapor compressor and a liquid pump,
- using compressed air or an inert gas
- using a liquid pump, and
- using vapor pressure *(with or without flaring)*.

Table 1
Transfer Method Selection Chart

Transfer Method	*Use of transfer method when an increase in internal pressure is* Acceptable	Unacceptable*
Vapor compressor	X	
Vapor compressor and liquid pump	X	
Compressed (inert) gas	X	
Liquid pump		X
Internal vapor pressure (with or without flaring)		X

* Unacceptable - heavily damaged tank car tanks

Gas Transfer Using a Vapor Compressor

This product removal method uses a vapor compressor to move the contents of a damaged or overloaded tank car into a receiving tank *(e.g., a tank car, cargo tank, or portable tank)*. The vapor compressor pulls the vapors from the receiving tank, compresses them, and forces them into the damaged tank car. The higher pressure in the damaged tank car pushes the liquefied gas into the receiving tank. The use of the vapor compressor will result in a pressure increase in the damaged tank car. This transfer method should be used only when an increase in pressure in the damaged tank car is acceptable.

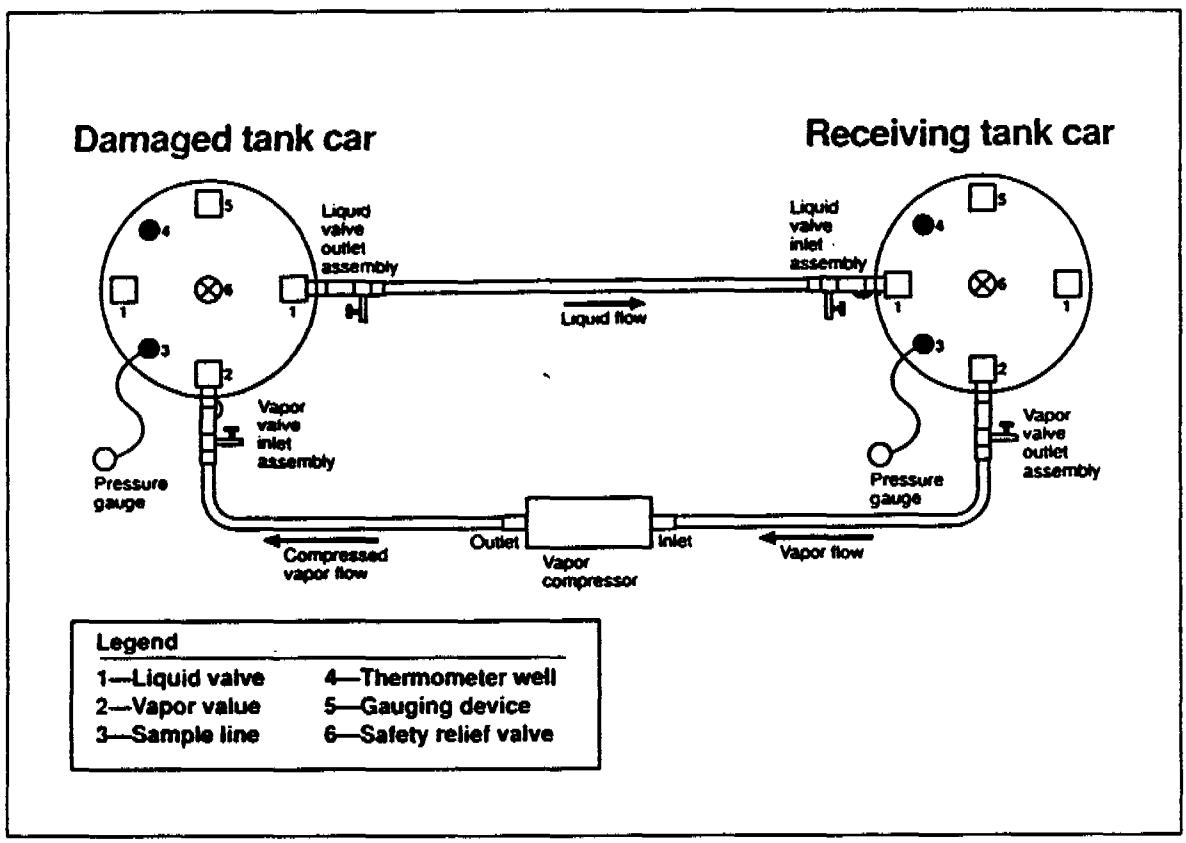

Figure 1: Diagram of a gas transfer using a vapor compressor

Gas Transfer Using a Vapor Compressor and a Liquid Pump

This product removal method uses a vapor compressor and a liquid pump to move the contents of a damaged or overloaded tank car into a receiving tank *(e.g., a tank car, cargo tank, or portable tank)*. The vapor compressor is used to accelerate the rate of transfer by withdrawing vapors from the receiving tank, compressing them, and forcing them into the damaged tank car. The higher pressure in the damaged tank car pushes the liquefied gas into the pump. The use of the vapor compressor will result in a pressure increase in the damaged tank car. This transfer method should be used only when an increase in pressure in the damaged tank car is acceptable. This method is justified when the receiving tank is a greater distance from the damaged or overloaded tank car.

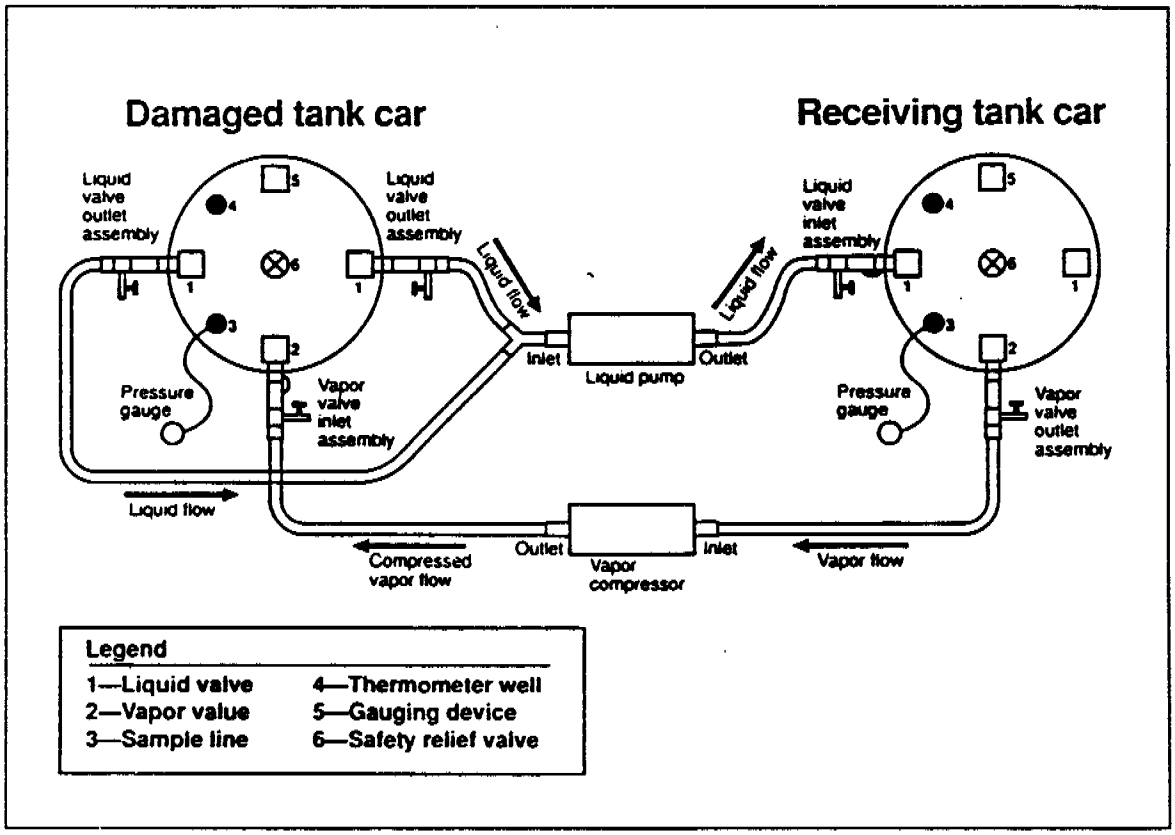

Figure 2: Diagram of a gas transfer using a vapor compressor and a liquid pump.

Gas Transfer Using A Compressed Gas (Inert Gas)

This product removal method uses a compressed gas *(e.g., nitrogen or carbon dioxide)* to move the contents of a damaged or over-loaded tank car into a receiving tank *(e.g., a tank car, cargo tank, or portable tank)*. The compressed gas creates a positive pressure differential in the damaged tank car that pushes the liquid into the receiving tank. Vapor from the receiving tank may have to be vented to atmosphere or scrubbed. The use of the compressed gas will result in a pressure increase in the damaged tank car.

Notes: This transfer method should be used only when an increase in pressure in the damaged tank car is acceptable.

Check with the shipper to determine the compatibility of the compressed gas to be used.

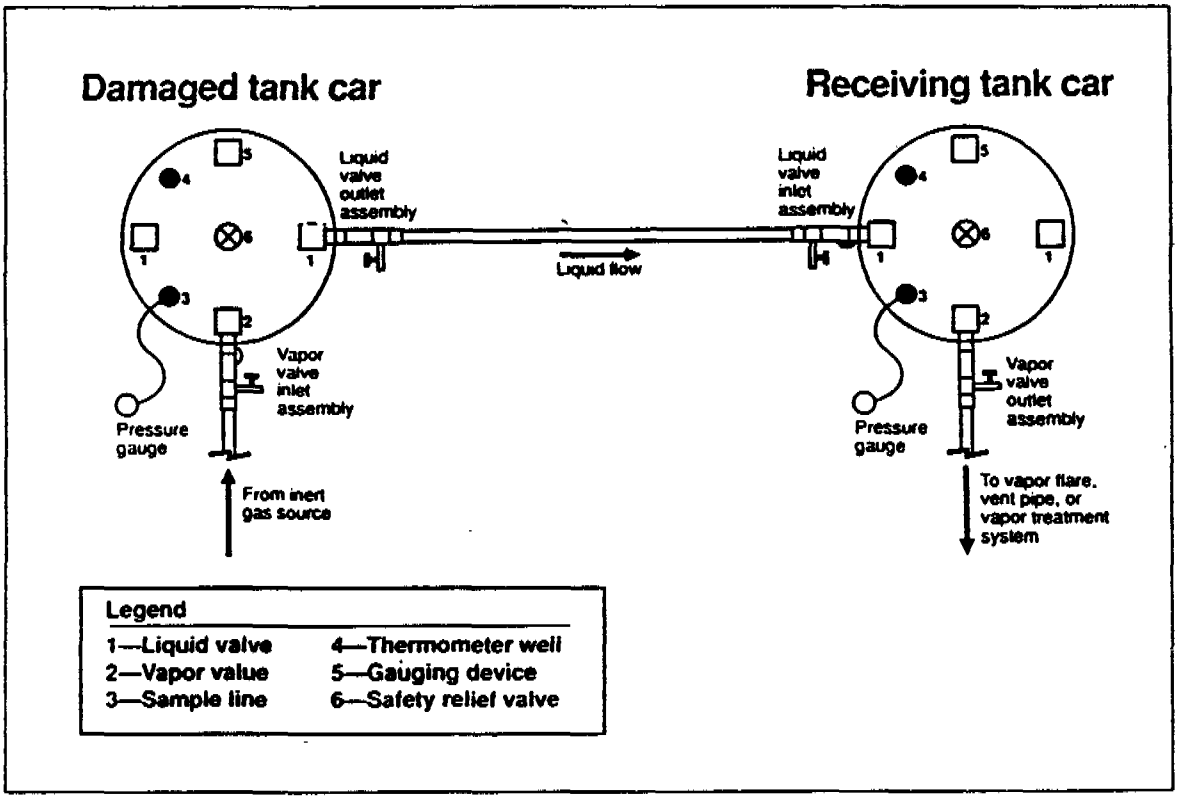

Figure 3: Diagram of a gas transfer using compressed gas

Gas Transfer Using a Liquid Pump

This product removal method uses a liquid pump to move the contents of a damaged or overloaded tank car into a receiving tank *(e.g., a tank car, cargo tank, or portable tank)*. The material in the damaged or overloaded tank car is then pumped into the receiving tank.

Note: The use of a liquid pump does not increase the pressure in the damaged tank car; however, if another means of creating positive pressure differential is used, a pressure increase may occur.

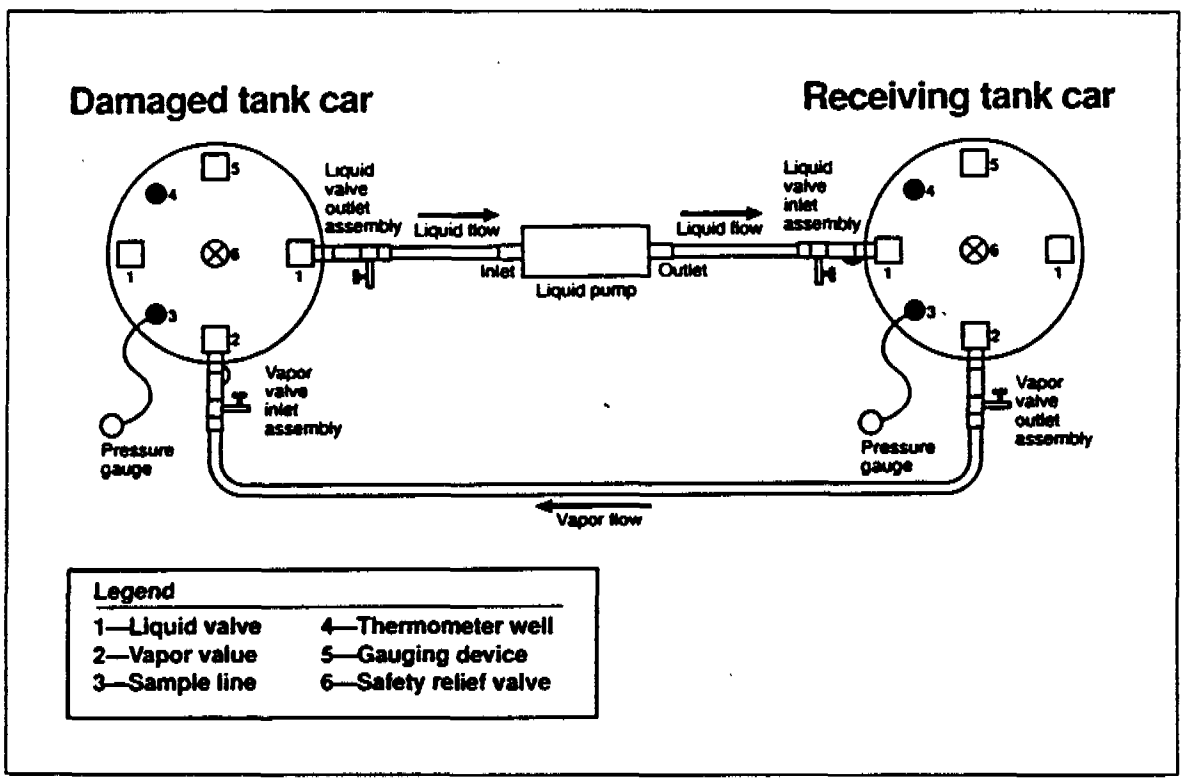

Figure 4: Diagram of a gas transfer using a liquid pump

Gas Transfer Using Product Vapor Pressure with or without Flaring

This product removal method uses the material's own vapor pressure to move the contents of a damaged or overloaded tank car into a receiving tank *(e.g., a tank car, cargo tank, or portable tank)*. In addition, a vapor flare maintains the necessary positive pressure differential between the damaged or overloaded tank car and the receiving tank by burning off vapors in the receiving tank at the outlet of a flare pipe *(see the section on Vapor Flaring)*. The pressure in the receiving tank is kept as low as possible.

Note: The use of a liquid pump does not increase the pressure in the damaged tank car.

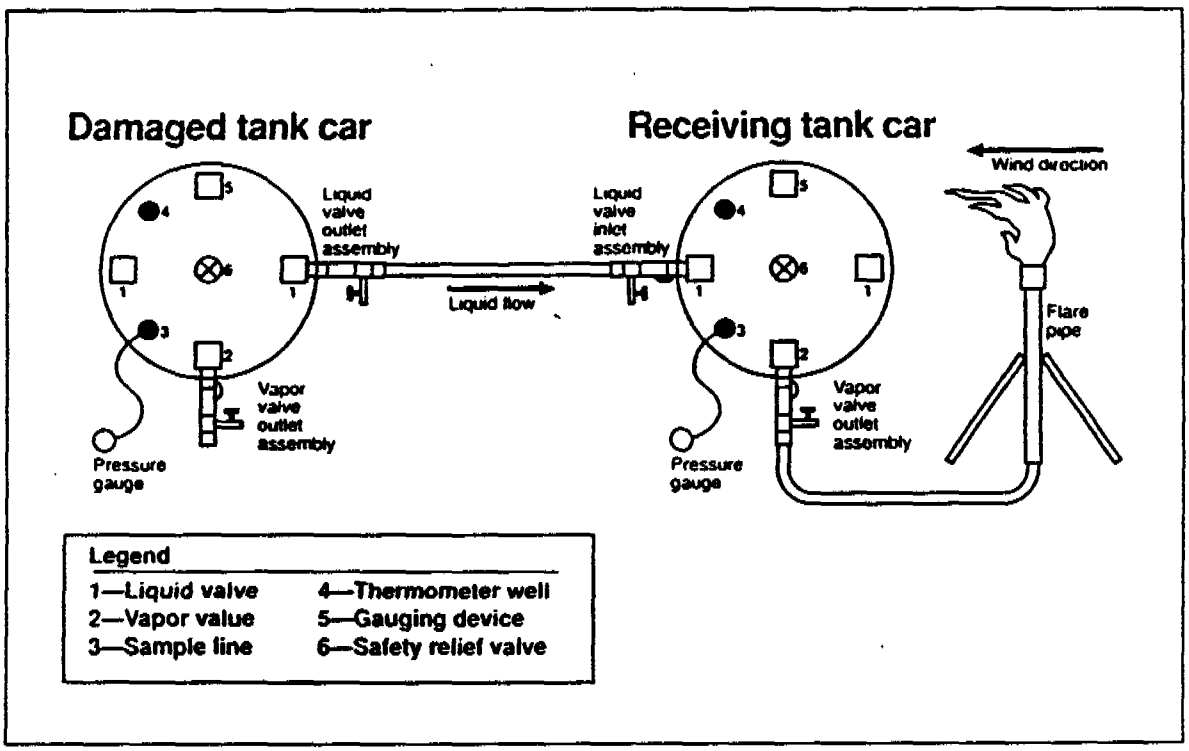

Figure 5: Diagram of gas transfer using product vapor pressure and flaring

Liquid Transfer Using a Liquid Pump

This product removal method uses a liquid pump to move the contents of a damaged or overloaded tank car into a receiving tank *(e.g., a tank car, cargo tank, or portable tank)*. The liquid pump may be supplemented by gravity, an inert gas, a vacuum *(e.g., vacuum truck)*, or any combination thereof.

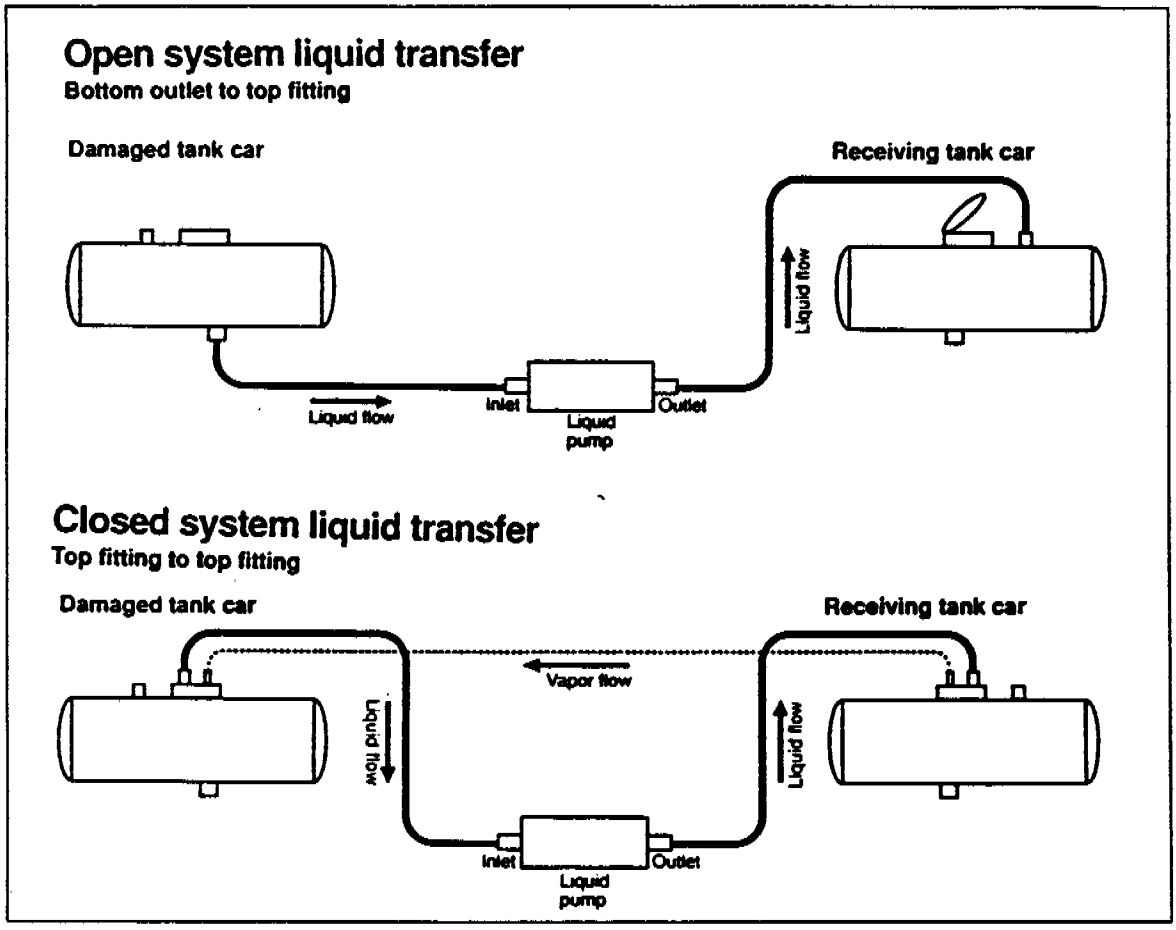

Figure 6: Diagram of liquid transfer using a pump

Liquid Transfer Using A Compressed Gas

This transfer method uses a compressed gas *(e.g., nitrogen or carbon dioxide)* to move the contents of a damaged tank car to a receiving tank *(e.g., a tank car, cargo tank, or intermodal tank)*. The compressed gas creates a pressure differential and pushes the liquid into the receiving tank. Vapor from the receiving tank may have to be scrubbed or vented. The use of the compressed gas will result in a pressure increase in the damaged tank car.

Note: This transfer method should be used only when an increase in pressure in the damaged tank car is acceptable.

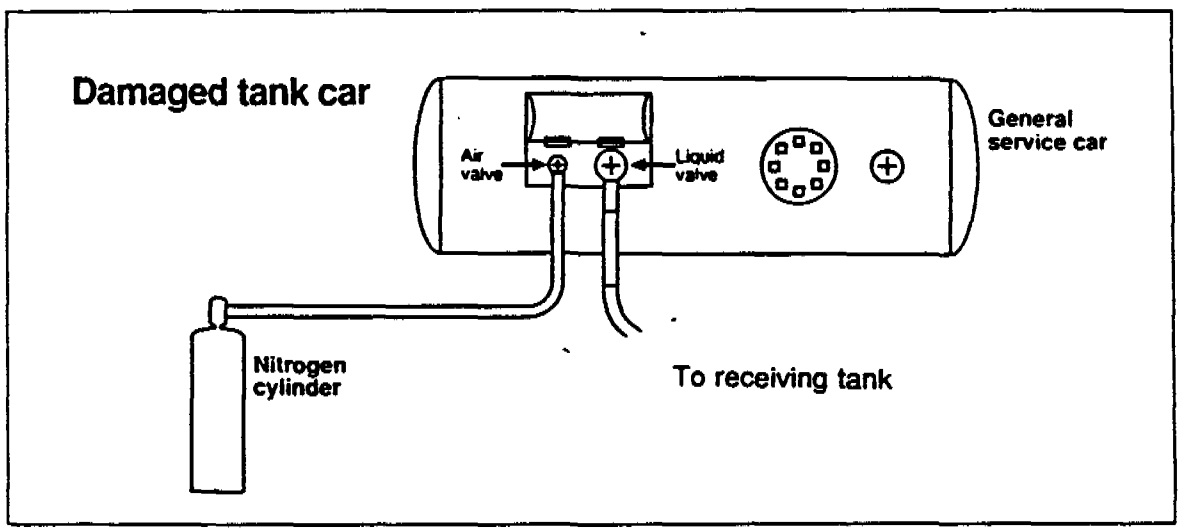

***Figure 7:** Diagram of liquid transfer using a compressed gas*

General Procedures

1. Plan the transfer operation.
   a. Obtain compatible receiving tank of sufficient capacity.
   b. Check the receiving tank for damage.
   c. Identify the transfer method to be used.
   d. Develop a list of required equipment for the selected transfer method.
   e. Prepare a plan for set-up, implementation, and shut-down of the transfer operation.
   f. Prepare a site safety plan.
   g. Obtain required transfer equipment.
2. Set up the transfer operation.
   a. Hold a safety briefing.
   b. Position receiving tank and transfer equipment.
   c. Connect fittings.
   d. Attach required hoses and/or piping.
   e. Set up and activate the emergency shut-off system, if used.
   f. Purge the liquid and vapor hoses and test for leaks.
3. Implement transfer operation.
   a. Adjust pressure differential, if necessary.
   b. Start flow of material from damaged tank car.
   c. Monitor operation.
4. Shut down the transfer operation.
   a. Stop the flow of material.
   b. Purge the hoses and/or piping.
   c. Disassemble and decontaminate the transfer equipment.
   d. Secure cars.
5. Determine disposition of cars and prepare them for transportation *(hazard communication and readiness for transportation).*

Flaring

Flaring is the controlled release and disposal of flammable materials by burning from the outlet of a flare pipe *(horizontal or vertical)*. It is used to reduce the pressure or dispose of the residual vapors in a damaged or overloaded tank car.

In rail transportation, flaring is used for three basic purposes:

- to reduce the pressure inside a tank car,
- to dispose of vapors remaining in a tank car during or after transfer of the liquid, and
- to burn-off liquid where transfer is impractical.

Flaring may also be used to expedite recovery operations. Or, it may be used as an interim method until a transfer can begin.

Preferred Conditions

Extreme care must be exercised in a flaring operation and only after consultation with the shipper, carrier, or other tank car specialist. The following conditions are desired when flaring:

- suitable systems are in place for protecting persons and property in the event of an accidental release during the transfer,
- suitable flaring equipment is available,
- personnel experienced in flaring are available,
- the liquid and vapor valves are accessible and operable, or the use of a hot or cold tap is possible,
- the tank car is in a position that will allow the flaring *(e.g., check valves have not seated or, if they have, tools are available to unseat the valves)*,
- the tank is not exposed to fire, and
- a delayed rupture is not likely.

Potential Risks

The following risks may be associated with flaring:

- failure of the tank or flaring equipment could expose people, property, and the environment to the contents of the damaged tank car,
- ignition of released vapors if flare is extinguished without shutting off flow of product,
- heat generated by the flare may cause an improperly shielded flare hose to fail, resulting in a product discharge and possible fire,
- heat generated by the flare may cause a fire–for liquids, this fire may be difficult to control, and
- products of combustion could be harmful to exposures.

Safety Precautions

The following safety precautions must be taken when performing vapor or liquid flaring:

- secure the car from movement–chock wheels and tighten hand brakes;
- place blue flags, if required;
- limit site access to required personnel only,
- perform flaring using only qualified personnel,
- use appropriate personal protective equipment;
- monitor site with vapor monitoring equipment;
- ground and bond the car,
- control ignition sources within 15 feet of operations:
    - do not permit smoking on site,
    - eliminate or shut off electrical equipment that is not intrinsically safe, and
    - shut off any internal combustion engines that are not intrinsically safe.
- use an emergency shut-off system *("Snappy Joe" and "back check valves")* to either automatically or manually shut down the transfer in case of an unintentional release caused by a hose break or other malfunction,
- suspend all other work during flaring operations, and
- protect tank and hoses from the heat generated by flaring.

Flaring Vapors

Vapor flaring is the burning of vapors of a liquefied compressed gas at the outlet of a vertical flare pipe as they exit the flare pipe.

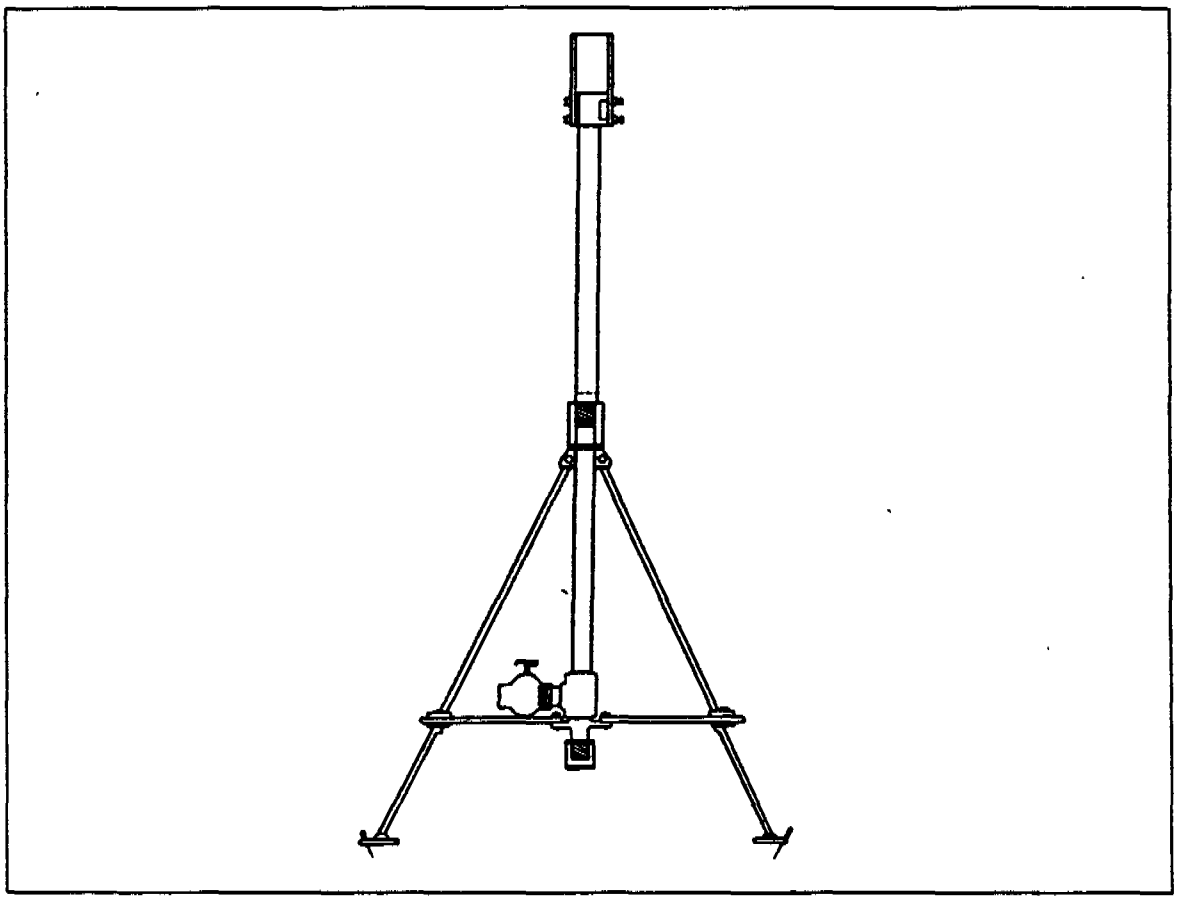

Figure 8: Diagram of flare stand

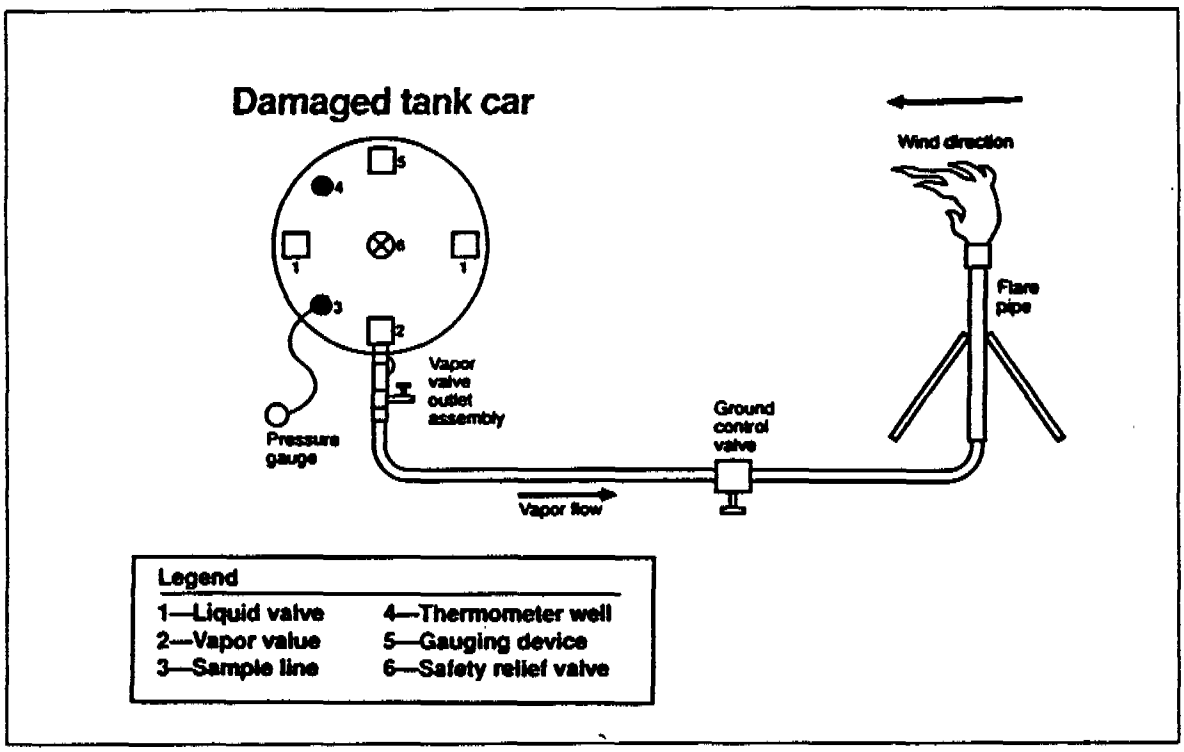

Figure 9: Diagram of vapor flaring operation

Flaring Liquids

Liquid flaring is the vaporizing of liquid product and burning of the vapors at the end of a horizontal flare pipe. A pit is used to contain any product that is not completely burned.

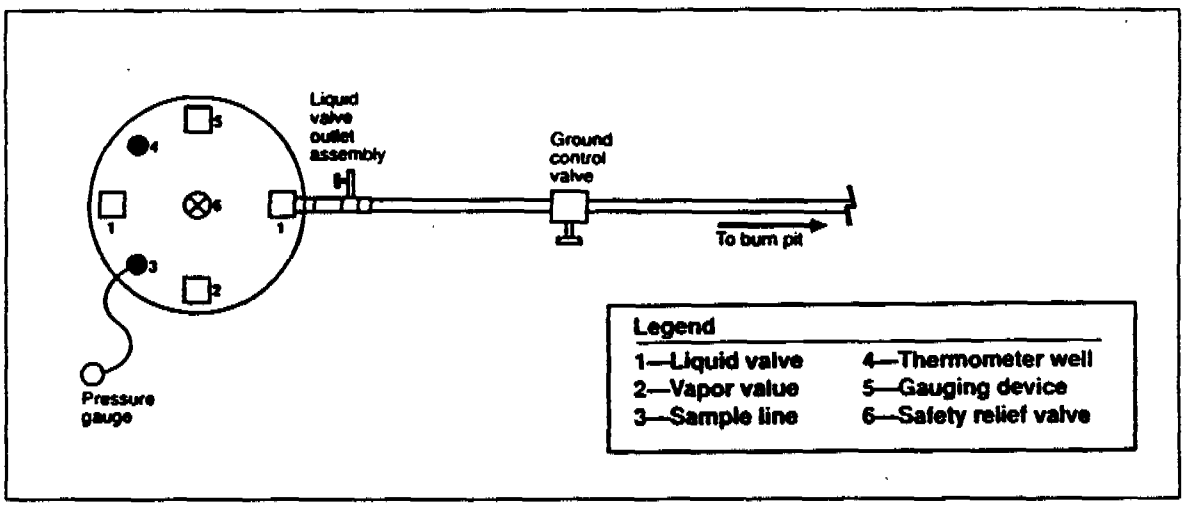

Figure 10: Diagram of liquid flaring operation set-up for a pressure tank car

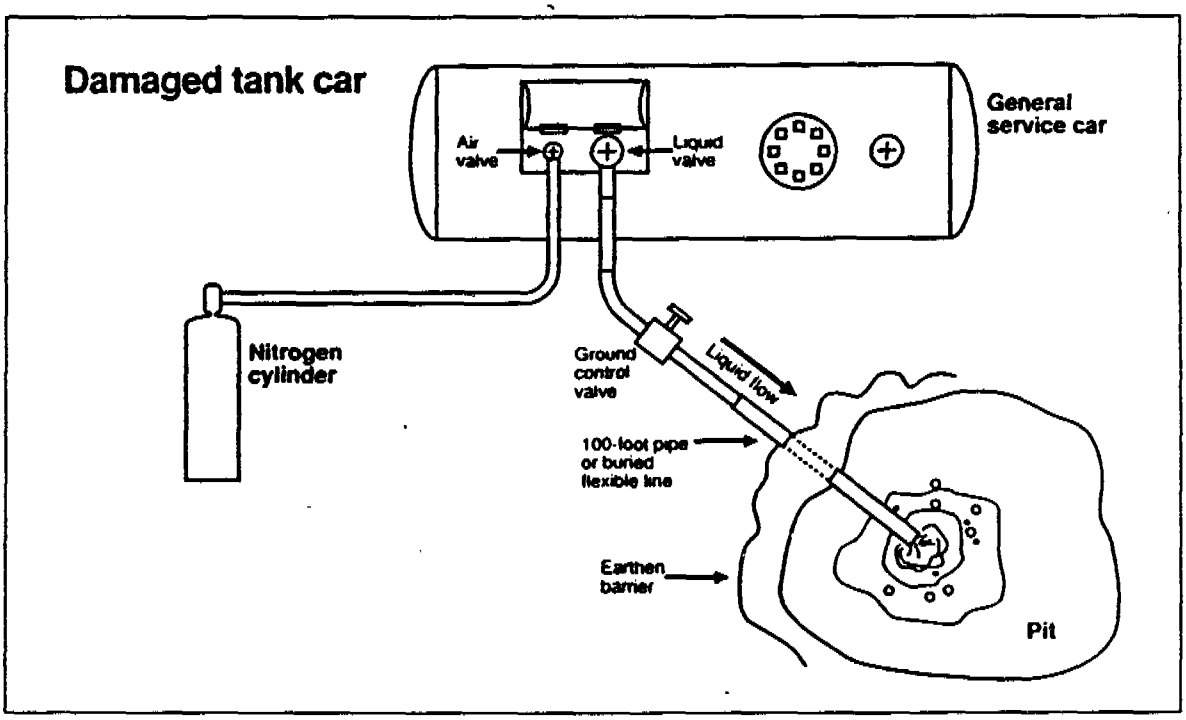

Figure 11: Diagram of liquid flaring operation set-up for a non-pressure tank car

General Procedures

1. Plan flaring operation.
   a. Identify the required equipment for the flaring operation.
   b. Prepare a plan for location, set-up, implementation, and shut down of the flaring operation.
   c. Arrange for appropriate fire protection.
2. Set up flaring operation.
   a. Obtain required equipment for flaring operation.
   b. Hold safety meeting.
   c. Set up equipment on top of tank car.
   d. Clear area of vegetation and other combustible materials.
   e. Dig pit for liquid flaring operation.
   f. Position flare stand *(150-200 feet upwind or crosswind for vapor and 200-300 feet upwind or crosswind for liquids).*
   g. Attach flaring lines *(hose and/or pipe).*
   h. Test for leaks.
   i. Set up ignitor.
   j. Protect flaring operation from radiant heat.
3. Implement flaring operation.
   a. Light ignitor line.
   b. Start flow of material from damaged tank car.
   c. Monitor flaring activities.
   d. Protect exposed flare piping as necessary.
4. Shut-down flaring operation.
   a. Stop flow of material.
   b. Dismantle and clean flaring equipment as necessary.

Venting

Overview

Venting is the process of reducing the pressure in a tank by releasing liquefied compressed gas vapors into the atmosphere. This release can be direct or, in case of toxic products, indirect through an appropriate treatment system. Typically, venting is used with nonflammable gases.

Extreme care must be exercised in a venting operation and only after consultation with the shipper, carrier, or other tank car specialist.

Preferred Conditions

The following conditions should exist, or be met, before performing venting. These conditions are considered optimal, but may not be practical in all cases:

- suitable systems are in place for protecting persons and property in the event of an accidental release during the venting,
- the tank car is in a position that will allow the venting *(e.g., check valves have not seated or, if they have, tools are available to unseat the valves),*
- personnel experienced in venting are available,
- rate of venting can be controlled to minimize potential exposure to local population, property, and the environment,
- appropriate treatment system for toxic vapors is available,
- the tank is not exposed to fire.

Potential Risks

The following risk may be associated with venting:

- improperly controlled rate of venting could expose people, property, and the environment to the contents of the damaged tank car.

Safety Precautions

The following safety precautions must be taken when venting:

- place blue flags, if required, and secure the car from movement--chock wheels and tighten hand brakes,
- limit site access to required personnel only,
- perform venting using only qualified personnel,
- use personal protective equipment, and
- monitor site with vapor monitoring equipment in order to adjust venting rate.

General Procedures

1. Plan venting operation.
   a. Identify the required equipment for venting.
   b. Prepare a plan for location, set-up, implementation, and shut-down of the venting operation.
   c. Arrange for appropriate fire protection.
2. Set up venting operation.
   a. Obtain required equipment for venting operation.
   b. Hold safety meeting.
   c. Set up equipment on top of tank car.
   d. Set up scrubber system for toxic vapors.
   e. Test for leaks.
3. Implement venting operation.
   a. Start flow of material from damaged tank car.
   b. Monitor airborne concentrations of product and adjust venting rate as required.
4. Shut down venting operation.
   a. Stop flow of material.
   b. Dismantle and clean venting equipment as necessary.

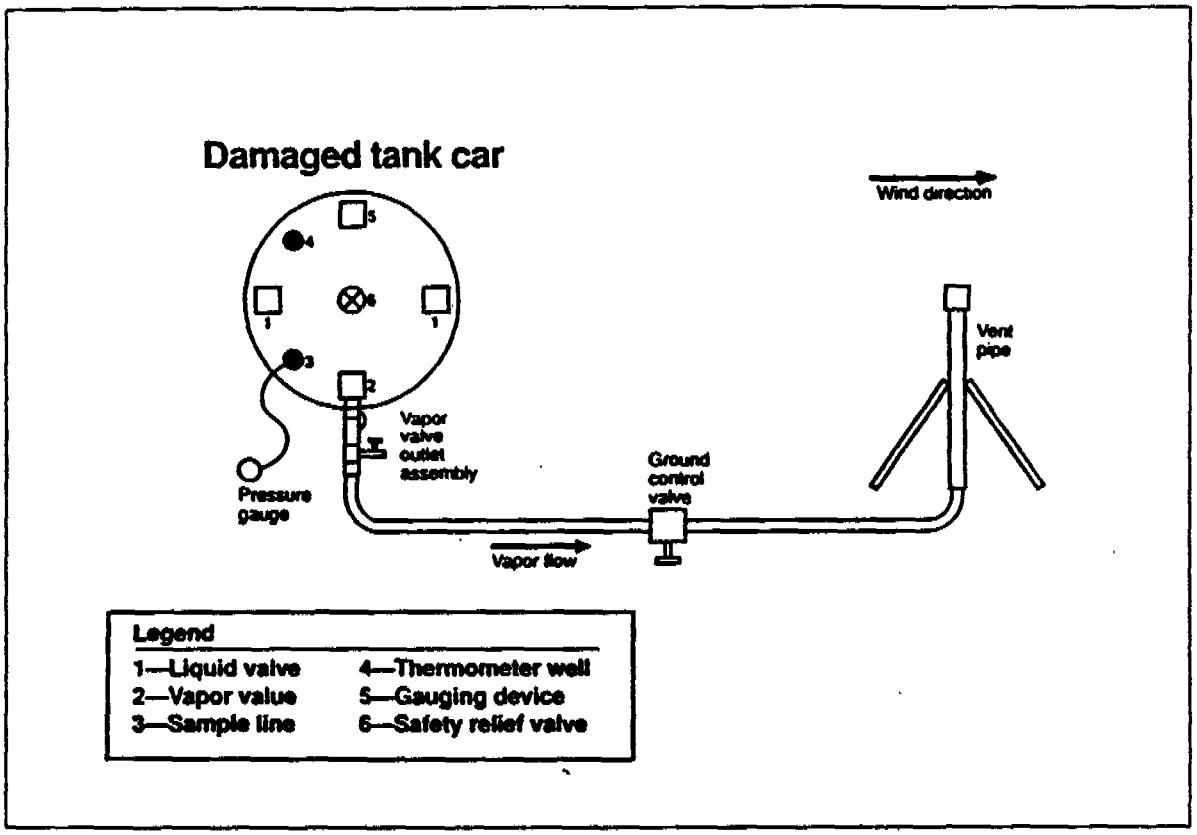

Figure 12: Diagram of venting operation

Vent and Burn

Vent and burn is a method of removing liquefied flammable compressed gases or flammable liquids from a tank car by creating controlled openings in the tank using explosives. Explosive charges are strategically placed on the tank; one at the highest point on the tank for venting vapor and the second at the lowest point on the tank for releasing liquid. The released contents are allowed to flow into a pit for evaporation or burn-off.

Vent and burn is the last resort and is to be performed only by experienced personnel.

The following circumstances may prompt the decision to perform a vent and burn operation.

- The tank car tank has been damaged to the extent that it cannot be safely rerailed and moved to an appropriate unloading point; and transfer, flaring, or venting are impractical, because the car cannot be safely repositioned to provide access to the required valves.
- The involved tank car was exposed to intense fire, which has been extinguished, but which may have either elevated the temperature of the product, resulting in a dangerous increase in vapor pressure, or weakened the tank itself.

Vent and burn is another control operation considered outside the legitimate responsibility of the local emergency responder. However, oversight of vent and burn operations is the responsibility of local emergency response agencies.

Preferred Conditions

The responder should ensure that the following conditions prevail before a vent and burn operation is performed. These conditions are considered optimal, but may not be practical in all cases:

- precautions have been taken to protect the local population,
- the product is a flammable compressed gas, flammable liquid, or combustible liquid,
- it has been determined that other cars, especially those containing hazardous materials, will not be adversely affected by the operation,
- the required explosives and equipment are available,
- personnel who are trained in vent and burn operations are available to perform the operation, and
- the environmental impact of the operation has been considered.

Inherent Risks

The following risks are associated with vent and burn operations:

- if the vent and burn operation fails, a violent rupture of the tank may occur; the product may be spread over a wide area on the ground or released into the atmosphere as unburned vapors, rather than transferred to a pit or flared from the car as intended, and
- failure of the vent and burn operation could expose people, property, and the environment to the contents of the damaged tank car.

Safety Precautions

The safety precautions to be taken during vent and burn operations include:

- evacuate on the basis of possible violent rupture, including fragments from the car, or toxic vapor cloud,
- expert selection and placement of charges is required,
- provide air monitoring to determine if the evacuation area needs to be expanded,
- only personnel required to set charges should be on site when the charges are set,
- have FAA impose air traffic restrictions over the site,
- have fire fighting capability on standby at edge of the evacuation zone; in forested or grassland areas, this may include aerial fire fighting forces, and
- ensure close coordination and liaison among all parties on the operation.

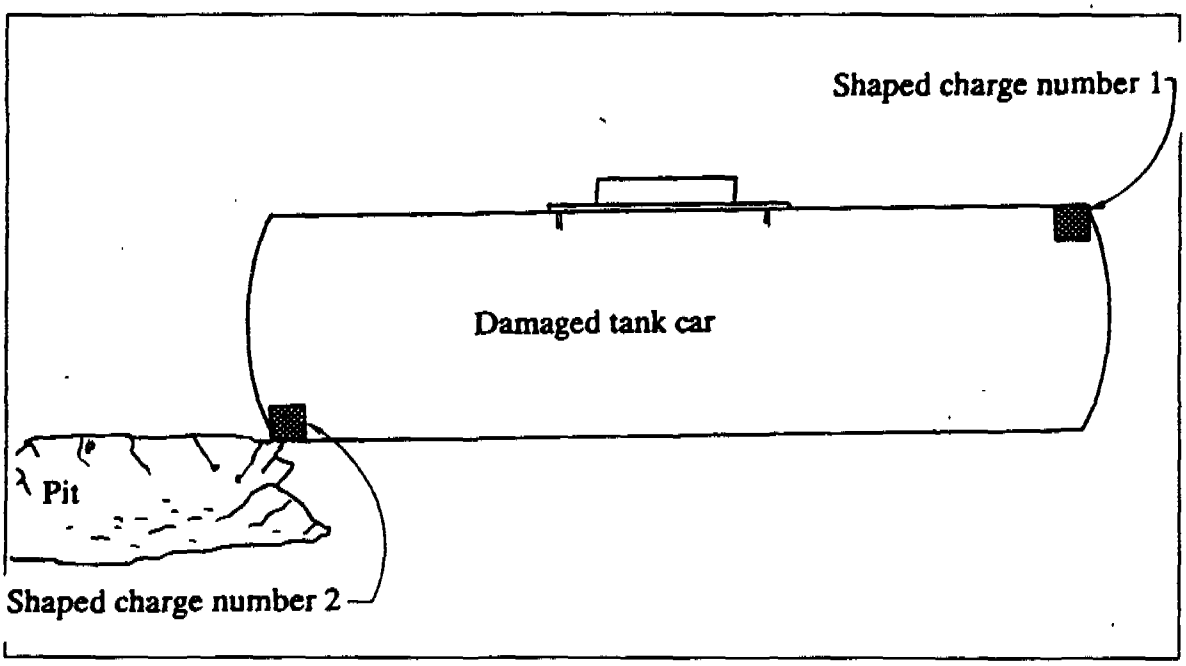

Figure 13: Diagram of placement of charges on a tank car in preparation for vent and burn.

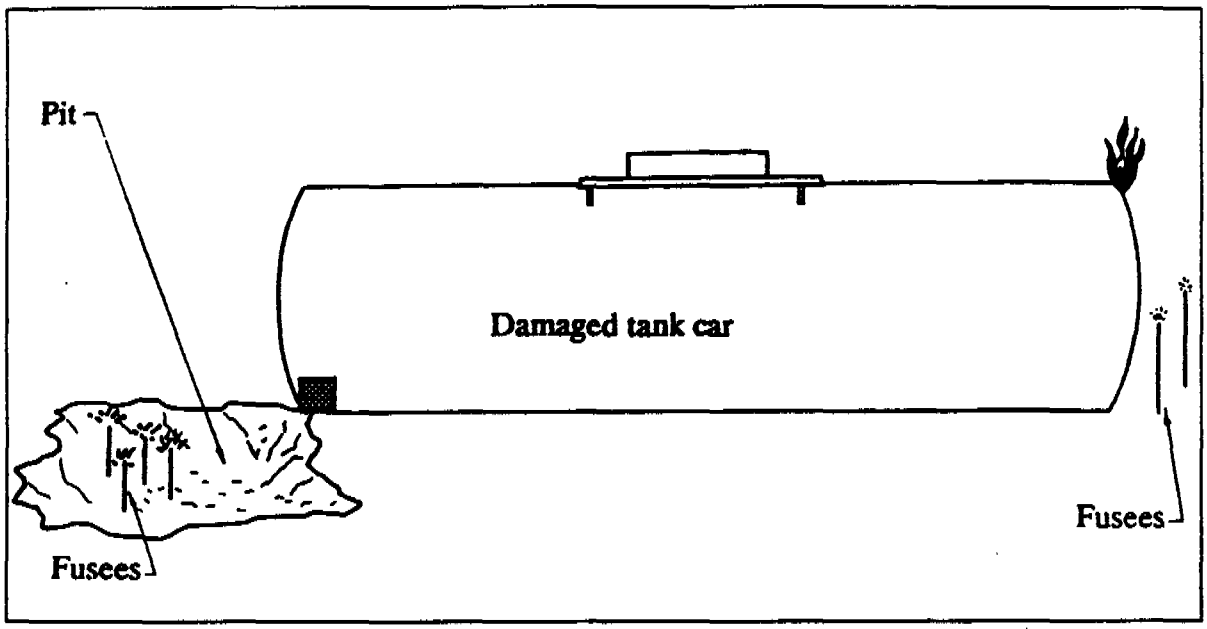

Figure 14: Diagram of firing first charge in vent and burn operation

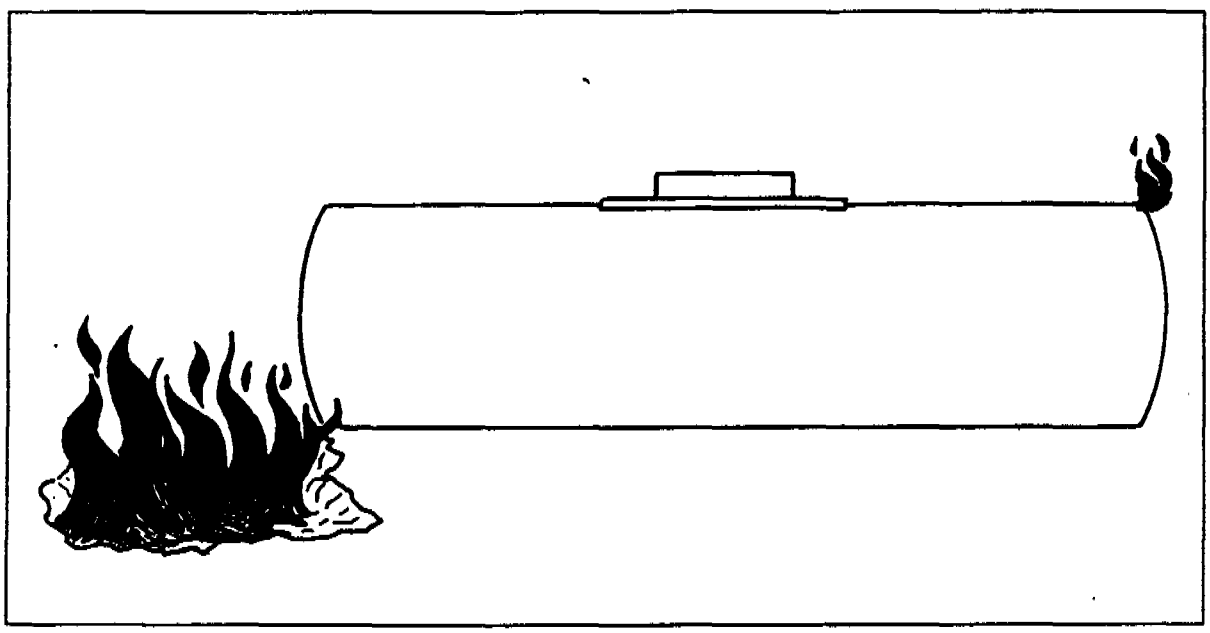

Figure 15: Diagram of firing second charge in vent and burn operation

CMA 110079

Hot and Cold Tapping

The **hot tap** is a technique or providing access to the contents of a tank car when damage to the valves and fittings precludes access to the contents. Once the hot tap is completed, transfer, flaring, or venting can take place.

Hot tapping involves the welding of a threaded nozzle into an undamaged section of the tank that is in contact with the liquid. A liquid valve is attached to the nozzle. A hole is then drilled through the tank with a special drilling machine. This hot tapping *(drilling)* machine is equipped with seals which prevent loss of product during the drilling operation. Liquid hoses or pipe can be attached to the valve outlet.

The **cold tap** is similar to hot tapping except that the attachment of the threaded nozzle to the tank is accomplished, without welding, by strapping the nozzle plate onto the tank.

Preferred Conditions

The following conditions should exist, or be met, before performing a hot tap. These conditions are considered optimal, but may not be practical in all cases:

- suitable systems are in place for protecting persons and property in the event of an accidental release during the transfer,
- the lading is ***not*** one of the following products:
  - cryogenic liquids
  - ethylene oxide
  - elemental sulphur
  - bromine
  - sulfuric acid
  - hydrochloric acid
  - ethylene
  - propylene oxide
  - chlorine
  - hydrocarbons in stainless steel tanks
  - nitric acid
- the lading in the car can be subjected to the heat from the welding operation without undergoing chemical reactions,
- the required equipment, including equipment for removing the tank jacket and insulation *(if present)*, is available,
- the tank has an appropriate, undamaged section in contact with the liquid for welding the nozzle,
- an ASME certified welder is available *(6G position)*,
- the tank is not exposed to fire, and
- the area is free of flammable vapors.

CMA 110080

Potential Risks

The following risks may be associated with hot tapping:

- failure of the tank, installed valve, or nozzle could expose people, property, and the environment to the contents of the damaged tank car,
- the heat that is applied to the tank during the welding procedure could initiate a chemical reaction inside the tank, leading to a tank rupture or explosion,
- if the hot tap is mistakenly performed in the vapor space of the tank, the tank steel may be overheated, weakening the tank and resulting in catastrophic failure,
- the hot tap will produce thermal stress in the tank steel; the magnitude of this stress will depend on the welding technique used,
- the time required to perform a hot tap is approximately 2 hours; after the hot tap has been completed, the response crew still needs to implement the selected unloading method *(transfer, flaring, or venting)*, thereby increasing overall amount of time that responders are in the vicinity of the tank, and/or
- metal shavings from the hot tap could become lodged in the control valve which is attached to the nozzle; the shavings could prevent the valve from closing completely, resulting in loss of product when the hot tap machine is removed.

Safety Precautions

The following safety precautions must be taken when hot tap operations are selected:

- ensure that nonessential personnel are removed from the area while welding and hot tap operations are being performed,
- perform hot tap using only qualified personnel,
- perform a proof pressure test with nitrogen before starting the drilling process,
- control ignition sources, and
- practice welds.

CMA 110081

General Procedures

1. Plan hot tap operation.
   a. Identify the required equipment for the hot tap.
   b. Prepare a plan for location, set-up, implementation, and shut-down of the hot tap.
   c. Arrange for appropriate fire protection.
2. Set up hot tap operation.
   a. Obtain required equipment for hot tap.
   b. Hold safety meeting.
   c. Make practice welds.
3. Implement hot tap operation.
   a. Weld nozzle to tank.
   b. Attach liquid valve to nozzle.
   c. Attach hot tap machine to liquid valve.
   d. Check for leaks.
   e. Drill tank.
   f. Withdraw hot tap machine.
   g. Proceed with transfer, flaring, or venting.

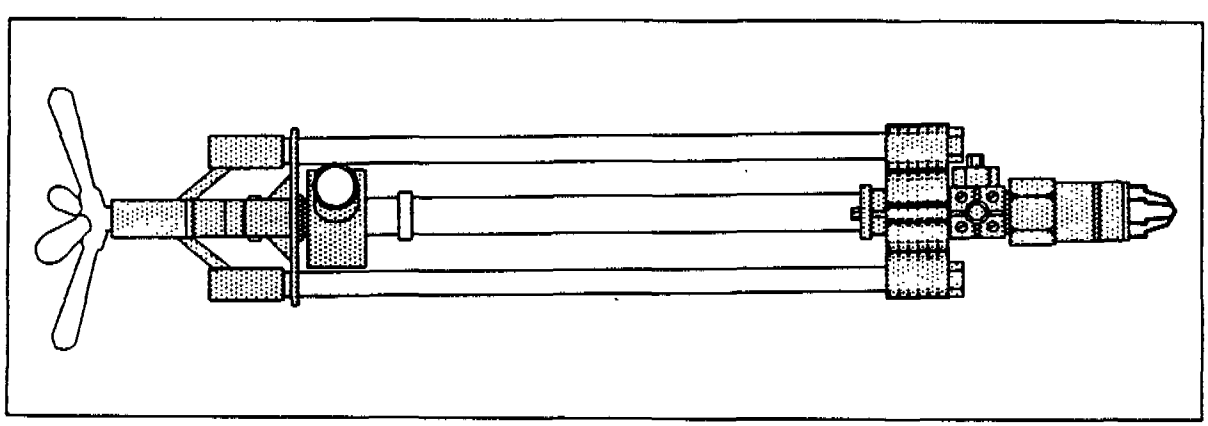

Figure 16: Diagram of hot tap equipment

CMA 110082

Reference Sources

Transportation Test Center, ***Field Product Removal Methods for Tank Cars***, Association of American Railroads for the Federal Railroad Administration, Office of Research and Development, 1993.

National Fire Protection Association, NFPA 30, ***Flammable and Combustible Liquids Code***, NFPA, Quincy, MA (see latest NFPA Codes and Standards Catalogue for current editions).

National Fire Protection Association, NFPA 58, ***Standard for the Storage and Handling of Liquefied Gases***, NFPA, Quincy, MA (see latest NFPA Codes and Standards Catalogue for current editions).

National Fire Protection Association, NFPA 77, ***Recommended Practice on Static Electricity***, NFPA, Quincy, MA (see latest NFPA Codes and Standards Catalogue for current editions).

CMA 110083

CMA 110084