BENZENE

ACHIEVING HES EXCELLENCE

Product and Technical Information

SUNOCO Chemicals

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This brochure is intended to be an educational tool. It may be useful in an effort to increase awareness of the hazards of benzene and its general handling considerations. It is intended to be used by persons with skill, knowledge and training in the safe handling of hazardous chemicals, and the user has sole responsibilty to determine the suitability of benzene for any particular use and in any manner.

This brochure is not intended to provide in-depth training on specific handling techniques or emergency response procedures. It cannot be assumed that all acceptable safety measures are contained herein or that other additional measures may not be required under particular or exceptional conditions or circumstances. Please refer to material safety data sheets, which are available from Sunoco, Inc., to obtain additional information regarding the handling, use, and storage of benzene.

This brochure references a number of statutes and regulations. However, it is not intended to identify all currently applicable statutes and regulations. The reader is advised to consult the various applicable federal, state, and local statutes and regulations, and, if appropriate, legal counsel.

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Introduction

Benzene* is produced by Sunoco at refineries located in Marcus Hook, PA, Westville, NJ, and Toledo, OH. The benzene is transported by marine vessel from the Marcus Hook and Westville refineries and loaded and shipped via tank cars from the Toledo refinery. Sunoco also maintains inventory at a third-party terminal in Philadelphia where benzene can be loaded into trucks and shipped.

Benzene is an organic chemical used to produce a wide variety of chemical intermediates. The primary intermediates include styrene, cumene, cyclohexane, and aniline.

* Chemical Abstracts Registry Number 71-43-2

Typical Physical Properties

Structural Formula 

Empirical Formula	C_6H_6
Physical State	Liquid
Flammable Limits in Air (% by volume)	Lower Limit 1.3% Upper Limit 7.5%
Flash Point	
Closed Cup	12.0˚F (-11.1˚C)
Auto-ignition Temperature	928.4˚F (498.0˚C)
Boiling Point	176.2˚F (80.1˚C)
Color	Colorless
Critical Pressure	710.4 psia 48.3 atm
Critical Temperature	552.2˚F (289.0˚C)
Density at 68˚F (20˚C)	7.365 lb/gal 0.879 g/mL
Heat of Vaporization at 70˚F (21˚C)	187.8 BTU/lb
Melting Point	41.9˚F (5.5˚C)
Molecular Weight	78.11 g/mol
Odor	Sweet
Reactivity	Relatively unreactive
Solubility	
Water at 77˚F (25˚C)	1.79 g/L 0.0149 lb/gal
Specific Gravity (20˚C/4˚C)	0.879
Specific Heat at 140˚F (60˚C)	0.42 BTU/ lb˚F 0.42 cal/g°C
Threshold (odor)	2.7 - 12 PPM
Vapor Density (Air = 1)	2.7
Vapor Pressure at 77˚F (25˚C)	1.9 psia 0.129 atm
Viscosity (liquid) at 70˚F (21˚C)	4.24×10^{-4} lb/ft·s 6.31×10^{-4} pa·s
Viscosity (vapor) at 70˚F (21˚C)	5.02×10^{-6} lb/ft·s 7.47×10^{-6} pa·s
Volatility	100 wt%

Specifications For Benzene

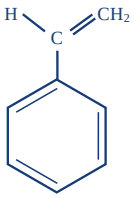
Property	Test Method	Sales Specifications
Composition	D4492	
Benzene, wt %		99.80 Min
Toluene, wt %		0.03 Max
Non-Aromatics, wt %		0.15 Max
1,4 Dioxane, wt PPM		10 Max
Solidification Point, °C	D852 or Equiv.	5.35 Min
Color, Pt-Co or APHA	D1209 or Equiv.	20 Max
Acid Wash Color	D848	1 Max
Appearance	Visual	Clear
Total Sulfur, Wt. PPM	D4045 or Equiv.	0.4 Max
Thiophene, mg/kg	Calculated	1 Max*
Water, Wt. PPM	D6304 or Equiv.	Report

* Sunoco does not test for Thiophene. Chemically, Thiophene cannot be >1 ppm if Total Sulfur is <0.4 ppm on a weight basis.

Meets ASTM D2359-02 - Standard Specification for Refined Benzene-535

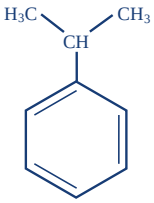
End Uses

Benzene is used as a basic feedstock for producing numerous derivatives. The major derivatives and uses are described briefly below.



Styrene

Styrene is the largest derivative of benzene. Styrene is produced by the alkylation of benzene with ethylene to form ethylbenzene, which is then dehydrogenated to make styrene. Styrene is used primarily as a monomer to produce plastics such as polystyrene, styrene-butadiene rubber (SBR), acrylonitrile-butadiene-styrene (ABS) resins, and styrene-butadiene latex.



Cumene

Cumene (isopropylbenzene) is produced by the alkylation of benzene with propylene. The main use of cumene is as a chemical intermediate for phenol and acetone production.

Phenol's major uses are for phenolic resins and bisphenol A production. Bisphenol A is used as a monomer to produce polycarbonate and epoxy resins.

A key acetone derivative is methyl methacrylate, a monomer used to manufacture acrylic resins.

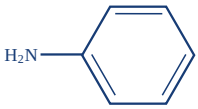
Cyclohexane

Cyclohexane is produced by the catalytic hydrogenation of benzene. The main use for cyclohexane is as a chemical intermediate for caprolactam and adipic acid production. A small amount of cyclohexane is used as paint remover and as a solvent for lacquers and resins.

Caprolactam and adipic acid are used to manufacture nylon 6 and nylon 6,6, which are polyamide polymers used for fibers, films, and engineering plastics.

End Uses (continued)

Aniline



Aniline is produced by reacting benzene with a mixture of sulfuric acid and nitric acid to form nitrobenzene, which is hydrogenated in the presence of a catalyst to give aniline. Aniline is used mostly to produce methylene diphenyl diisocyanate (MDI) and poly methylene diphenyl diisocyanate (PMDI), which are reacted with polyols to give polyurethanes for flexible foam production and adhesives. Other uses for aniline include rubber-processing chemicals, agricultural chemicals, specialty fibers, and dyes.

Other Uses

Benzene is also used as an industrial solvent and a chemical intermediate in many other processes. Other chemical products made from benzene include detergent alkylates, chlorobenzene, maleic anhydride, and surfactants.

Handling Information

DOT Regulatory Shipping Information

Benzene is classified by the U.S. Department of Transportation (DOT) as a Class 3 (flammable liquid) material. When shipping via all modes of transportation, shipments must be documented, packaged, labeled, marked, placarded, loaded, and unloaded in accordance with the applicable DOT Regulations.

Title 49, Code of Federal Regulations contains the regulations for shipping hazardous materials via air, highway, rail, and water, except bulk water shipments, which are regulated by Titles 33 and 46, Code of Federal Regulations.

Storage

Benzene freezes at 41.9°F (5.5°C). Vessels of ordinary carbon steel serve satisfactorily because benzene has no appreciable corrosive activity on mild steel at the temperatures usually encountered in transportation and storage. Constant circulation through external steam-heat exchangers is the preferred method to keep benzene in a liquid state while in storage. However, due to the low flash point of 12°F (-11.1°C) and a boiling point of 176.2°F (80.1°C), benzene should only be heated to a point that it remains in a liquid state. Typically this would be in the range of 60°F (15°C) - 80°F (27 °C), depending on the ambient temperature. Storage tanks should consist of floating roofs or the vapor space above the liquid should have a nitrogen or inert gas pad.

Storage in plastic containers is not recommended, as some plastics may leach benzene. In addition, benzene may cause some plastics to degrade. All lines that are isolated after any transfer should be blown clear with nitrogen or an acceptable inert gas. All transfer lines should be heat traced and insulated.

Sampling Benzene In Shipping Containers

Proper Personal Protective Equipment (PPE) should be worn when sampling benzene.

Samples of benzene may be taken through the manway opening of a shipping container by means of a bottle placed in a stainless steel holder and suspended by a light stainless steel chain. Before taking a sample for testing, the bottle should be rinsed with the benzene to be sampled, and quickly closed to minimize moisture pickup and other contamination. An ordinary three-gallon pail may be used to collect the sampling bottle, bottle holder and chain as they are withdrawn, dripping, from the tank.

Transfers from Shipping Containers and Storage Tanks

Benzene can be transferred by pumping, by forcing via pressure from an inert gas, or by gravity. The product has a flash point of 12°F (-11.1°C) and forms an explosive mixture with air within limits of 1.3% and 7.5% by volume. The product is slightly soluble in water. In most cases benzene is transferred in a closed loop system when unloading bulk containers. The bulk container is supplied with nitrogen to replace the benzene being transferred from the container. During the loading of bulk containers, a closed loop system is used and the vapors are either recovered in a vapor recovery unit or purged to an air pollution control device such as an incinerator or ground flare. Depending on the facility's Hazardous Air Pollutant (HAP) emissions or annual benzene loading volumes, it may be subject to loading control regulations under EPA's NESHAP (40 CFR Part 61) and MACT (40 CFR Part 63) programs. Centrifugal and turbine-type pumps are used in transfer operations. Pipelines

Handling Information (continued)

carrying benzene should be heat traced and insulated to keep the chemical in a liquid state to avoid plugging lines. The freezing point of benzene is 41.9° F (5.5° C). Steam tracing and electrical heat tracing are the most common means of heating; insulation is also recommended.

Shipments

Sunoco ships benzene in tank trucks and tank cars. The following guidelines apply to unloading tank cars and tank trucks. The safety guidelines also apply to barges. Barges or other vessels are required to be equipped with steam coils. Sunoco ships high-quality benzene in various capacity tank cars. All tank cars in Sunoco's fleet are equipped with external steam heater coils. In order to maintain a high-quality product, Sunoco's tank cars are equipped with loading configurations and valves that are made of stainless steel.

Type of Container	Net Weight (Approx. Lbs.)
Rail	
23,500 Gallon Carbon Steel Tank Cars	170,000
25,500 Gallon Carbon Steel Tank Cars	185,000
Truck	
6,500 Gallon Stainless Steel	45,500

Unloading Benzene Tank Cars

Proper personal protective equipment must be worn whenever personnel are on or under the benzene tank car during the unloading operation.

Benzene tank cars can be unloaded by the use of inert gas or by the use of a pump. Although some of the tank cars are equipped to be bottom-unloaded as well as top-unloaded, Sunoco strongly recommends that benzene be unloaded from the top. Failure of a bottom unloading line would allow the remaining benzene within the car to escape until one of the tank car valves is completely closed. In the case of top unloading, the closing of the pump or inert gas will stop the flow of benzene up through the siphon pipe.

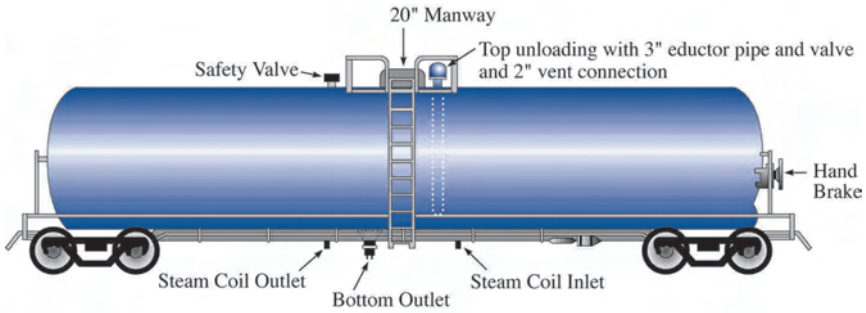
Car Thawing

When it is necessary to thaw benzene tank cars, they should be spotted on a level section of the unloading rack and isolated from moving cars. Brakes must be applied, chocks must be in place, the tank car must be grounded, and caution signs must be in place. The rail infrastructure located at the unloading area should be grounded and bonded. It is then safe to vent the car by means of the vent valve, as shown in the diagram on page 8. Before starting to thaw, a proper vent must be established to avoid any pressure build up inside the tank car. The manway cover can then be opened to permit inspection of the contents. Low pressure steam should be connected to the steam inlet(s) on the bottom of the tank car. (See illustration on page 8). Regulate the steam pressure to a maximum of 50 psig to avoid overheating. Heat the benzene in the tank car to 50-60° F. During the thawing process, the temperature of the car should be continuously monitored and recorded. The temperature of the benzene can be measured directly by inserting a thermocouple into the benzene or a thermowell.

Benzene Tank Car Unloading Guidelines – Top Unloading by Pumping

Strategically place all signs and placards before operations begin. Tank cars should be spotted on a level section of the unloading track and isolated from moving cars. Brakes must be applied, chocks must be in place, the tank car must be grounded and caution signs put in place. Before unloading operations begin, make certain all personnel are wearing proper personal protective equipment.

Illustration of a General-Purpose Tank Car



Note: Most of our older cars have 2" eductors and 1" vent valves.
Our newer cars have no bottom outlets. Bottom unloading is not recommended.

1. Vent pressure in tank car by opening the vent valve and ensure the vent is free and clear throughout the entire unloading process.
2. Open the manway cover and inspect the benzene. Refer to the paragraphs on steam heating benzene tank cars, if necessary.
3. Benzene is ready to be unloaded when the temperature in the tank is 45° (7°C) to 50° F (10°C). Confirm receiving storage tank will contain the entire contents of car and is properly vented.
4. Connect the pump discharge to the receiving storage tank. Make sure all fittings are tight. Leak check fittings.
5. Open the eductor outlet valve.
6. Blow backward through the eductor with nitrogen to confirm the eductor is open.
7. Connect the pump suction to the eductor pipe valve as shown in the appropriate diagram of the tank car.
8. Start the pump and empty the tank car. Be sure car is properly vented or that the contents are being displaced with nitrogen or another acceptable inert gas.
9. Stop the pump after making certain the car is empty.
10. Blow the transfer lines clear of benzene with nitrogen or inert gas.
11. Disconnect all hoses, nozzles, and associated fittings connected to the car. Collect and properly dispose of any dripped benzene.
12. Close all openings on the car except for coil inlet and outlet caps on external coil cars, if so equipped.
13. Carefully blow out the steam coils. Do not replace steam inlet and outlet caps on external coil cars, if so equipped. Let them hang by their safety chains to permit drainage. If the car is equipped with interior coils, the inlet and outlet caps must be replaced before shipment.
14. Remove chocks, safety signs, and ground wire.

Benzene Tank Car Unloading Guidelines – Top Unloading by Inert Gas

Strategically place all signs and placards before operations begin. Tank cars should be spotted on a level section of the unloading track and isolated from moving cars. Wheels should be chocked, brake set, the car must be grounded and caution signs put in place. Before unloading operations begin, make certain all personnel are wearing proper personal protective equipment.

1. Vent pressure in tank car by opening the vent valve and ensure the vent is free and clear throughout the entire unloading process.
2. Open the manway cover and inspect the benzene. Refer to the paragraphs on steam heating benzene tank cars, if necessary.
3. Benzene is ready to be unloaded when the temperature in the tank is 45° (7°C) to 50° F (10°C). Make sure the receiving tank is vented and will receive the entire contents of the car.
4. Open the eductor pipe valve.
5. Make sure the eductor pipe is open by blowing nitrogen or another inert gas backwards through the eductor.
6. Connect the discharge line to the eductor pipe valve.
7. Connect the inert gas line to the vent valve. A relief valve must be included in the line. Pressure must be regulated to a maximum of 80% of the relief device setting.
8. Close the manway cover and secure it. Make sure all fittings are tight. Leak check fittings.
9. Check to see that all valves in the discharge line are open; slowly turn on the inert gas.
10. Empty the car. When the pressure falls, or when gas begins to rush through the discharge line, turn off the inert gas.
11. Slowly vent the pressure from the tank car preferably through the unloading line to the tank.
12. Close the eductor pipe valve.
13. Blow transfer lines clear of benzene with inert gas.
14. Remove all hoses, nozzles, and fittings from the car and replace all caps or plugs tool tight except coil inlet and outlet caps, if so equipped. Collect and properly dispose of any dripped benzene.
15. Carefully blow out the heater coils. Do not replace steam inlet and outlet caps, if so equipped. Let them hang by their safety chains to permit drainage.
16. Remove chocks, safety signs, and ground wire.

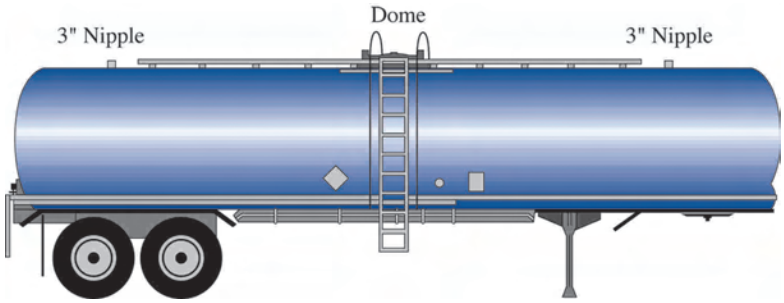
Handling Information (continued)

Benzene Tank Truck Unloading Guidelines

The methods for unloading tank trucks are similar to those used for tank cars. The tank truck must conform to DOT specifications. DOT Regulations (49 CFR 177.834) require that the tank truck be attended by a qualified person at all times during unloading. This person must have an unobstructed view of the cargo tank and be within 25 feet of the tank truck. The truck engine should be shut off, unless it is required to power the off-loading pump; the handbrake must be set; the wheels chocked and tank truck grounded before unloading.

Before unloading operations begin, make certain all personnel are wearing proper personal protective equipment. It is recommended that the tank truck be spotted on an impervious surface, and ideally within an impervious bermed containment area.

Illustration of an MC-306 Tank Truck



Bottom Unloading By Pump

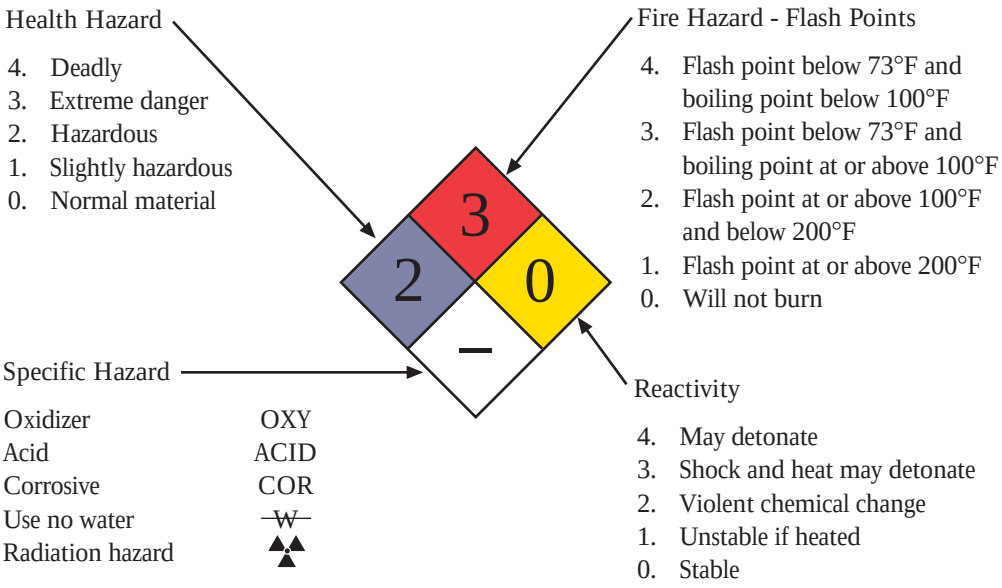
1. In this method, the benzene is unloaded through the valves on the bottom of the tank truck and pumped to the receiving tank.
2. Internal and external valves in the bottom of the tank truck must be in good working order and leak-free to help prevent spillage or the potential for personal exposure.
3. The emergency cut off handles can be used to close the internal bottom valve in the event of a leak in the fittings on the bottom of the tank truck.
4. Monitor all lines for leaks.
5. Tank truck must be vented or product displaced by nitrogen or other suitable inert gas to prevent pulling a vacuum on the tank truck.

Bottom Unloading By Pressure

1. Connect a non-reactive gas to the top of the tank truck to pressurize it. This will push the benzene out the bottom unloading valve into the receiving vessel.
2. Be certain to keep the pressure below the rating of the safety valve on the trailer.
3. The dome on the tank truck is kept closed to hold pressure in the tank truck.
4. Pressure is maintained until the unloading procedure is complete.
5. Monitor all lines for leaks.
6. Once the non-reactive gas is shut-off and disconnected and transfer line closed, the tank truck should be depressurized using the 1" vapor valve.

Health Hazard & Toxicity Information

Health Hazard & Toxicity Information



National Fire Protection Association Ratings for Benzene

Health	2
Flammability	3
Reactivity	0

Eyes

Contact with the liquid or vapor causes eye irritation. Symptoms of eye irritation may include pain, tearing, reddening, swelling and impaired vision. Corneal injury may result from contact with the liquid.

Skin

Contact with the liquid may cause skin irritation. Symptoms of skin irritation may include pain, reddening, swelling and blistering. Prolonged or repeated contact may cause the skin, through a solvent-like action, to become dry and cracked and produce a rash. Benzene may be absorbed through the skin in harmful amounts; for more information, see the discussion on the next page regarding inhalation exposure.

Ingestion

May be harmful or fatal if swallowed. Ingestion can irritate the stomach, causing nausea, vomiting and diarrhea. Because of its low viscosity, benzene can be sucked into the lungs when swallowing or vomiting. Once in the lungs, removal is very difficult and even small amounts can cause severe respiratory tract injury or death.

Health Hazard & Toxicity Information (continued)

Inhalation

Benzene is toxic and causes cancer. Inhalation and contact with the skin should be avoided. Inhaling benzene at concentrations above the recommended exposure limit may be irritating to the nose, throat and respiratory tract and may produce blood disorders (anemia) and nervous system effects. Nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness and disorientation. Exposures to even more benzene may produce respiratory depression, tremors or convulsions, loss of consciousness, coma or death. Overexposure to high concentrations of benzene vapor can also cause serious disturbances of heart rhythm especially if combined with adrenalin-like drugs.

Repeated or prolonged overexposure to benzene vapors has been associated with the development of genetic damage in workers and laboratory animals. This same type of high inhalation exposure has also been associated with various blood diseases in humans ranging from severe anemia to leukemia (a form of cancer), diseases that can be fatal. Also, in animal research studies, after repeated and prolonged overexposures, adverse effects were observed in the reproductive organs but these effects did not affect fertility. Furthermore, maternal overexposures in animals have caused adverse effects in their developing offspring that were related to growth, but no malformations were observed. The available information on the effects of benzene on human reproduction is limited and uncertain.

Please consult the Sunoco, Inc. MSDS for additional information.

First Aid

It is recommended that employees working in an area where contact with benzene is possible are trained and knowledgeable in appropriate first aid procedures. Immediate first aid treatment is critical to minimize effects.

Deluge-type safety showers with quick-opening valves should be immediately accessible in all working areas, and all personnel should be familiar with their location and operation. Safety showers should be supplied with tempered water. If the safety shower is in a remote area, it is suggested that the shower be alarmed and tied into a central monitoring facility. Moderate pressure water hoses and eye wash fountains should also be located strategically within work areas.

Skin Contact

Remove contaminated clothing and shoes. Flush skin with water. Follow by washing with soap and water for 20 minutes. If irritation occurs, get medical attention. Do not reuse clothing until cleaned.

Eye Contact

Flush with large amounts of water for at least 15 minutes, separating and lifting the upper and lower eyelids occasionally. Get medical attention immediately.

Inhalation

Remove victim to fresh air and provide oxygen if breathing is difficult. Get medical attention.

Ingestion

Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid to the lungs. Get medical attention.

Note to Physician: If more than 2.0 milliliters per kilogram of body weight has been ingested and vomiting has not occurred, emesis should be induced with supervision. Keep victim's head below hips to prevent aspiration. If symptoms such as loss of gag reflex, convulsions, or unconsciousness occur before emesis, gastric lavage using a cuffed endotracheal tube should be considered.

At the end of the exposed individual's shift, a "Urine Phenol" should be sent for laboratory analysis per the OSHA Standard in 29 CFR 1910.1028.

Engineering Controls/ Personal Protective Equipment

Engineering Controls

Benzene should be used with adequate ventilation to keep exposure to airborne contaminants below the exposure limit. Local exhaust ventilation may be necessary to control any air contaminants to within OSHA's Permissible Exposure Limit (PEL) during the use of this product. Use explosion-proof ventilation equipment.

Personal Protective Equipment

A comprehensive industrial hygiene plan reduces the likelihood of unnecessary exposure to benzene and other chemicals in the industrial environment. This includes a ready supply of gloves and other protective wear for employees working with benzene and atmospheric monitoring in areas where exposure is possible. For first aid, the facility should have an eyewash and safety shower.

Personal protective equipment (PPE) must be used to prevent direct skin and eye contact and to reduce the potential for inhalation exposure. Employees can be protected against skin contact by using Polyvinyl alcohol, Viton®, Safety 4H, or Teflon® gloves. Gloves of other chemically resistant materials may not provide adequate protection. Where splashing is possible, full chemically resistant protective clothing (e.g., acid suit) and boots are required. The following materials are acceptable for use as protective clothing: Polyvinyl alcohol (PVA), Viton®, and Teflon®. The eyes and face should be protected with ANSI Z87.1 or equivalent splash goggles and a full face shield or a full face respirator.

The need for a respirator and respirator selection depends upon the airborne concentrations of benzene in the workplace. Use only NIOSH certified respiratory equipment. When exposures are up to ten (10) times the exposure limit, a half-mask air purifying respirator with organic vapor cartridges is acceptable. For exposures up to fifty (50) times the exposure limit, a full-face air purifying respirator with organic vapor cartridges is acceptable. For exposures greater than fifty (50) times the exposure limit, a positive pressure-demand full-face supplied air respirator or SCBA must be worn. Exposure should not exceed the cartridge limit of 1000 ppm. Protection by air purifying respirators is limited.

If the exposure is above the IDLH (Immediately Dangerous to Life and Health) or if there is the possibility of an uncontrolled release, or exposure levels are unknown, then use a positive pressure-demand full-face supplied air respirator with escape bottle or SCBA. Wear a NIOSH-approved (or equivalent) full-facepiece airline respirator in the positive pressure mode with emergency escape provisions. For non-fire emergencies, positive pressure SCBA and structural firefighter's protective clothing will provide only limited protection. Firefighters should wear a self-contained breathing apparatus (SCBA). When respirators are used at a facility, the employer is responsible for implementing a respiratory protection program (OSHA Standard 1910.134 in 29 CFR).

With any type of personal protective device, safe practices and habits are crucial to effective protection. Therefore, a thorough education program should be in place to properly train employees on the safe use of personal protective equipment. A personal protective device used incorrectly will not afford the protection for which it was designed. The OSHA standard 1910.132 in 29 CFR requires employers to determine the appropriate PPE for each hazard and to train employees on how and when to use it.

Exposure Limits/ Exposure Monitoring

Exposure limits or exposure guidelines have been established by various regulatory agencies or professional organizations regarding allowable concentrations of benzene in the work environment. Exposure guidelines are reviewed regularly by occupational health professionals and are changed when new information dictates. Employers working with benzene must keep themselves informed of the most current guidelines and regulations governing exposure.

The American Conference of Government Industrial Hygienists (ACGIH), a voluntary standards setting organization, has adopted a Threshold Limit Value (TLV), and the Occupational Safety and Health Administration (OSHA) has set a Permissible Exposure Limit (PEL) for benzene.

ACGIH and OSHA have set an exposure limit for the entire work shift. A time-weighted average (TWA) is a concentration to which it is believed nearly all workers may be repeatedly exposed for 8 hours a day, 40 hours a week, without adverse effect. ACGIH and OSHA have also set an exposure limit for a 15-minute TWA, which is referred to as the Short Term Exposure Limit (STEL).

Benzene exposure limits are:

OSHA PEL:	8 hour TWA	1 ppm
OSHA PEL:	STEL	5 ppm
ACGIH TLV:	8 hour TWA	0.5 ppm
ACGIH TLV:	STEL	2.5 ppm

Exposure Monitoring

Airborne exposure monitoring for benzene must be conducted in order to properly assess personal exposures and effectiveness of engineering controls. Initial exposure monitoring should be conducted by an industrial hygienist or person specifically trained and experienced in sampling techniques. Contact an AIHA Accredited Laboratory for advice on sampling methods.

Fire Fighting

Benzene vapors are heavier than air and may spread along the ground to a remote ignition source.

Products of benzene combustion include carbon monoxide, carbon dioxide and other potentially toxic chemicals.

Personal protective equipment, including self-contained breathing apparatus, should be worn to prevent contact with benzene liquid and vapor.

Portable extinguishers, with a Class B or C rating, should be used on small fires. These typically include extinguishing agents like carbon dioxide and dry chemicals.

Since benzene is only slightly soluble in water, foam approved for use on hydrocarbons is recommended for larger fires.

Water spray should be used for protecting and cooling exposures.

Application of water onto a benzene fire could result in an increased rate of benzene vapor production, and, at least momentarily, result in an increase in fire intensity. Water run-off from firefighting operations could carry benzene and flaming benzene streams to otherwise unaffected/uninvolved areas.

Run-off should be contained to prevent the spread of fire. Benzene or water contaminated with benzene should be kept from entering sewers and waterways. Run-off should be collected for proper disposal.

If benzene or water contaminated with benzene enters sewers or waterways, take appropriate action as described in Spill Control section.

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA standard 1910.156 in 29 CFR .

Spill Control

A number of factors will determine the proper course of action in the event of a spill or leak of benzene. The most important factor to consider is whether or not available personnel have the ability to properly handle the spill based on the size and location of the spill. A responsible individual should determine if materials and information are available to enable them to safely and effectively deal with a spill situation. In preparation for accidental spills, it is advisable to have a written procedure and personnel trained to deal with such emergencies. There are a few important things to remember when dealing with a benzene spill:

- Because of benzene's hazard classification, preventing environmental releases is of the utmost importance. The reportable quantity (RQ) for benzene is 10 pounds. This means that if 10 pounds or more of benzene are released to the environment in any 24 hour period, it must be reported to the National Response Center (NRC) immediately (phone 1-800-424-8802). Additional notification of state and local agencies may be necessary, see "Regulatory Issues: Emergency Release Notification" section.
- When faced with a benzene spill, first ensure the safety of personnel. Benzene has a very low flash point. All potential ignition sources must be eliminated. If it is determined that an environmental release is taking place, spill control procedures should be implemented.
- Determine if benzene is still leaking and if it can safely be prevented from leaking further, i.e., by closing a valve or shutting off a pump. Since benzene freezes at about 41.9°F (5.5°C), some leaks may be stopped by freezing the area of the leak. Once it has been determined that either the leak has been stopped or it is impossible to do so, action must be taken to prevent the spill from spreading any further. Spills should be contained with booms or earthen dikes. Only non-sparking tools should be used to collect absorbents.

Spill Control (continued)

- To avoid water pollution, water should not be used to flush or clean the area. Any release of benzene or benzene water to a waterway or to a storm sewer must be reported promptly to local authorities so that downstream drinking water intakes can be closed. If benzene water enters a process sewer, notification should be made to the associated wastewater treatment operations so that protective measures can be implemented such as bypassing to storage or blocking intakes to the treatment plant. Benzene is miscible in water to a concentration of 0.06% by weight, at which point undissolved benzene will float.
- Personnel responding to a spill should be trained in spill control and emergency response procedures and have available adequate personal protective equipment, materials and tools necessary to stop the flow of product. Defensive control actions can be taken by people with proper training in building dams and dikes to control the flow of product, and plugging sewer drops and drains. Materials such as oil, dry sand, vermiculite or absorbent pads can be used to control or absorb.
- Benzene-contaminated soil and materials (such as clothing or absorbent materials) should be collected and placed into IA2 open-top-lidded steel drums for disposal at a licensed incinerator or secured hazardous waste landfill upon fulfillment of the required land disposal restriction treatment standards. Uncontaminated product can be recovered by returning to the manufacturer (Sunoco) in the IA2 container. It may be possible to treat benzene contaminated water in biological wastewater treatment plants. However, high concentrations are toxic to the biological population, and the facility must ensure that such treatment is authorized by any permits held by the treatment plant and any applicable laws.

The above recommendations are important points to take into consideration when determining the proper course of action when a benzene spill takes place, particularly in the event of a minor spill that can be handled by available personnel. If employees are required to clean up spills, they must be properly trained and equipped. The OSHA standard 1910.120 in 29 CFR may be applicable.

In some situations, e.g., where the spill is too large, or in a location where an environmental release is imminent, either into the soil or water, outside assistance may be required. In this event, contact:

Sunoco Chemicals (800) 964-8861

In the event of a transportation emergency contact:

CHEMTREC (in the USA) 1-800-424-9300 CANUTEC (in Canada) 613-996-6666

These 24 hour services will provide instructions on handling emergency situations involving spills.

Additional Spill Control / Response Information can be found in Section 6 (Accidental Release Measures) of the Sunoco, Inc. Material Safety Data Sheet, as well as the following publications:

1. Department of Transportation 2004 Emergency Response Guidebook (Guide # 130)
2. Association of American Railroads / Bureau of Explosives Emergency Action Guide (Guide for Benzene)
3. Association of American Railroads / Bureau of Explosives Emergency Handling of Hazardous Materials in Surface Transportation

Pollution Prevention

Sunoco encourages users of benzene to implement aggressive pollution prevention programs to reduce the quantity of benzene and other hazardous materials in their wastes, as well as to minimize the potential for release of benzene to the environment via spills and other mechanisms. Sunoco endorses the application of the pollution prevention hierarchy in such programs, stressing source reduction through process efficiency, internal recycling and other means. In the absence of feasible source reduction alternatives, recovery, recycling and reuse should be considered. Disposal should be the last option considered. Most state environmental agencies now have pollution prevention experts who can provide technical assistance or refer inquiries to industry experts. The American Chemistry Council is also a valuable resource of information regarding pollution prevention programs.

Waste Handling & Disposal

The Resource Conservation and Recovery Act of 1976 (RCRA) was passed to promote safe management of hazardous wastes. Discarded benzene, spilled benzene, and materials contaminated with commercial chemical product benzene are considered hazardous waste (EPA Waste Code U019) and are banned from land disposal unless treated to meet the Land Disposal restrictions levels of 40 CFR 268.40. The treatment level for U019 wastewaters (<1% TOC and <1% TSS) is 0.14 mg/l, and the treatment standard for nonwastewaters (>1% TOC and >1% TSS) is 10 mg/kg. Contaminated materials would include, for example, filters, rags or other materials contaminated with spilled benzene.

Drums should be empty as defined by RCRA before they leave the user's facility. Empty drums can be reconditioned by a reputable reconditioner, or incinerated. Drums destined for incineration should be punctured or crushed to prevent reuse.

CAUTION: Under no circumstances should empty drums be burned or cut open with a gas or electric torch as hazardous decomposition products may be generated. Drums should be cut or destroyed only by mechanical means.

RCRA and its implementing regulations are complex and may vary from state to state. Some state regulations may be more stringent than federal regulations. Therefore, check with the regional USEPA office and/or state environmental regulatory office before managing and disposing of waste benzene.

Regulatory Issues

The following is a brief compilation of noteworthy regulatory issues related to benzene. The user is responsible for understanding and complying with applicable statutes and regulations. Users may also want to consult legal counsel to discuss their specific applicability. For additional information, contact the Sunoco Product Safety Department at (610) 859-1120.

Title III of the Superfund Amendments and Reauthorization Act (also known as Emergency Planning and Community Right to Know Act [EPCRA])

Section 302: Extremely Hazardous Substances - Emergency Planning

Benzene is not considered an extremely hazardous substance under Section 302.

Section 304: Emergency Release Notification

Benzene is not classified as an extremely hazardous substance and emergency releases are not reportable under EPCRA; however releases are reportable under CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) with an RQ of 10 pounds. See Spill Control section for additional information. [See 42 USC § 11004 and 40 CFR Pt. 355]

Sections 311 and 312: MSDS Submission and Inventory

If benzene is present in the facility in quantities equal to or greater than 10,000 pounds, facilities may have to submit MSDSs to the State Emergency Response Commission (SERC), Local Emergency Planning Committee (LEPC) and the local fire department. In addition, facilities may also have to submit an annual inventory form (Tier I or Tier II report) detailing the maximum amount of each chemical present at any one time, estimating the average daily amount at the facility, and identifying the location of these substances at the facility. The annual inventory form must be submitted by March 1 for chemicals at the facility the previous year. A variety of exemptions from reporting are noted. [See 42 USC 40 § 11021 and 40 CFR Pt. 370]

Section 313: Annual Reporting Obligations

Benzene is regulated under Title III of the Superfund Amendments and Reauthorization Act (SARA Title III), otherwise known as the Emergency Planning and Community Right to Know Act (EPCRA), which requires annual reporting of releases to the environment of listed substances. If a facility has 10 or more full time employees (or a total of 20,000 hours worked for all full and part time employees), is in Standard Industrial Classification (SIC) Codes 20 through 39, 10 (except 1011, 1081, and 1084), 12 (except 1241) 4911, 4931, 4939, 4953, 5169, 5171, or 7389, and manufactures or processes (including repackage) 25,000 pounds or more of benzene in a year, or if the facility otherwise uses 10,000 pounds or more a year, the facility must submit annual reports (Form A or R) to USEPA and state regulatory agencies regarding the quantities of benzene released from the facility. Persons who sell or distribute mixtures or trade name products containing benzene must notify their customers of the presence and concentration of benzene in their product if it is present in concentrations greater than 0.1%. The annual reporting deadline is July 1 of each year. [See 42 USC § 11023 and 40 CFR Pt. 372]

EPA Risk Management Program

Benzene is not considered a flammable or toxic substance under the provisions of the EPA RMP regulation, 40 CFR Part 68.

Regulatory Issues (continued)

Clean Air Act

Benzene is identified by the USEPA as a hazardous air pollutant (HAP) under the Clean Air Act Amendments (CAA) of 1990. The USEPA develops emission standards based on the maximum available control technology (MACT) for facilities that emit 10 tons per year of any individual HAP such as benzene or 25 tons per year of total HAPs. NESHAP (National Emission Standards for Hazardous Air Pollutants) and MACTs applicable to benzene are in 40 CFR Parts 61 and 63. Facilities may also be subject to state air permitting processes under Title V of the CAA. In addition, benzene is regulated as a volatile organic compound (VOC). [See 42 USC § 7412]

Toxic Substances Control Act

Section 4: Testing

The EPA is given the authority under Section 4 of TSCA (40 CFR 799) to require testing of chemical substances and mixtures. There are presently no testing requirements under Section 4 for benzene.

Section 8 (b): Chemical Substances Inventory

To be used in a commercial application or as a component in a commercial product, a material has to be listed on the TSCA Chemical Substances Inventory (40 CFR 704, 710, 720, and 723). Benzene is listed on this inventory.

Clean Water Act

The USEPA developed ambient water quality criteria for benzene and other substances for the protection of aquatic life, human health, aesthetics and recreation. For each listed substance, states are required to adopt water quality standards based on the USEPA's criteria. The standards then drive the development of National Pollution Discharge Elimination System (NPDES) permit requirements for facility effluent. [See 40 CFR 131]

In addition, benzene is also named as a toxic pollutant under the CWA. The USEPA set effluent standards for toxic pollutants for a number of specified industries including organic commodity chemicals. [See 40 CFR 401.15 and 40 CFR Pt. 414 Sub Pt. F]

29 CFR 1910.119

Benzene has been identified as a covered flammable chemical under the OSHA Process Safety Management Rule, 29 CFR 1910.119, by virtue of its Flash Point of less than 100° F. Plants and operating units containing greater than a threshold quantity (10,000 pounds) of benzene will be required to comply with the fourteen elements of the PSM regulation.

29 CFR 1910.1028

OSHA addresses benzene in specific standards for several different industries, including 29 CFR 1910.1028 for the general industry. This regulation's applicability is dependent on the benzene exposure level. If occupational exposure is above the OSHA action level of 0.5 ppm for an 8-hour Time-Weighted Average (TWA) for 30 days or more per year, or above the 8-hour TWA of 1 PPM or the Short Term Exposure Limit (STEL) of 5 PPM for 10 days or more per year, then specific monitoring, air sampling, training, medical examinations and other requirements apply. Depending on exposure levels, OSHA-mandated signs may be required in loading/unloading areas.

Appendix Of Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ASTM	American Society of Testing and Materials
CAA	Clean Air Act Amendments of 1990
CAS	Chemical Abstract Services
CFR	Code of Federal Regulations
CWA	Clean Water Act
DOT	Department of Transportation
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act (also known as SARA Title III)
FDA	Food and Drug Administration
HAP	Hazardous Air Pollutant
LEPC	Local Emergency Planning Committee
MACT	Maximum Achievable Control Technology
MSDS	Material Safety Data Sheet
NIOSH	National Institute of Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
OSHA	Occupational Safety and Health Administration
PELs	Permissible Exposure Limits
RCRA	Resource Conservation and Recovery Act of 1976
SARA	Superfund Amendments and Reauthorization Act
SERC	State Emergency Response Commission
SIC	Standard Industrial Classification
TLV	Threshold Limit Value
TSCA	Toxic Substances Control Act
TWA	Time-Weighted Average
USC	United States Code
VOC	Volatile Organic Compound

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