# Dow Butylene Oxide Safe Handling and Storage

## 24-Hour Emergency Hotlines

- **In Case Of Transportation Emergency Call CHEMTREC**
  - 1-800-424-9300
  - International (call collect) 703-527-3887

- **The Dow Chemical Company**
  - (Local) 989-636-4400
  - (Toll-free) 1-800-258-2436

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Product Information

Applications
1,2-Butylene oxide is primarily used as a chemical intermediate or raw material for the production of other chemicals. As an alkylene oxide it reacts readily with compounds containing an active hydrogen atom such as alcohols, amines, and acids. Butylene oxide affords hydrophobic properties and may be used to promote miscibility with hydrocarbon oils. Butylene oxide derivatives are used in the following products and applications:
- Fuel Additives
- Lubricants and greases
- Oil field drilling chemicals
- Nonionic surfactants
- Polyurethanes
- Butylene glycols and their derivatives (polybutylene glycols, mixed polyglycols, glycol ethers, glycol esters)
- Stabilizer for chlorinated solvents

This brochure provides information on the physical properties, storage, and handling of 1,2-butylene oxide. Some specific uses and handling situations may require special considerations. The Material Safety Data Sheet is available through the Dow Customer Information Group (http://www.dow.com/assistance/dowcig.htm).

Table 1

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS Number</td>
<td>106-88-7</td>
</tr>
<tr>
<td>EINECS Number</td>
<td>203-438-2</td>
</tr>
<tr>
<td>IUPAC Name</td>
<td>1,2-Epoxybutane</td>
</tr>
<tr>
<td>Chemical Family</td>
<td>Alkylene Oxides</td>
</tr>
</tbody>
</table>
| Common Names        | 1,2-Butylene Oxide
|                     | 2-Ethyloxirane |
|                     | 1,2-Butylene epoxide |
|                     | 1,2-Butene oxide |

Table 2 – Vapor Pressure and Density vs. Temperature for 1,2-Butylene Oxide

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Vapor Pressure mmHg</th>
<th>Density, g/cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>51.7</td>
<td>0.851</td>
</tr>
<tr>
<td>10</td>
<td>87</td>
<td>0.84</td>
</tr>
<tr>
<td>20</td>
<td>140</td>
<td>0.83</td>
</tr>
<tr>
<td>30</td>
<td>218</td>
<td>0.819</td>
</tr>
<tr>
<td>40</td>
<td>328</td>
<td>0.808</td>
</tr>
<tr>
<td>50</td>
<td>478</td>
<td>0.796</td>
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<tr>
<td>60</td>
<td>679</td>
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<tr>
<td>70</td>
<td>940</td>
<td>0.773</td>
</tr>
<tr>
<td>80</td>
<td>1275</td>
<td>0.761</td>
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<tr>
<td>90</td>
<td>1695</td>
<td>0.748</td>
</tr>
<tr>
<td>100</td>
<td>2214</td>
<td>0.736</td>
</tr>
<tr>
<td>110</td>
<td>2846</td>
<td>0.723</td>
</tr>
<tr>
<td>120</td>
<td>3604</td>
<td>0.709</td>
</tr>
<tr>
<td>130</td>
<td>4506</td>
<td>0.695</td>
</tr>
<tr>
<td>140</td>
<td>5564</td>
<td>0.681</td>
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<tr>
<td>150</td>
<td>6797</td>
<td>0.665</td>
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Table 3 – Physical Properties of Dow Alkylene Oxides

<table>
<thead>
<tr>
<th>Properties</th>
<th>Values: Butylene Oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS Number</td>
<td>106-88-7</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>72.12</td>
</tr>
<tr>
<td>Boiling Point °C at 760 mm Hg</td>
<td>63.3</td>
</tr>
<tr>
<td>Vapor Pressure, mm Hg at 25°C</td>
<td>176</td>
</tr>
<tr>
<td>Freezing Point, °C</td>
<td>-129.28</td>
</tr>
<tr>
<td>Specific Gravity, 25/25</td>
<td>0.826</td>
</tr>
<tr>
<td>Density, lb/gal, 25°C</td>
<td>6.89</td>
</tr>
<tr>
<td>Refractive Index, 25°C</td>
<td>1.381</td>
</tr>
<tr>
<td>Viscosity, centipoise at 25°C</td>
<td>0.400</td>
</tr>
<tr>
<td>Auto-Ignition Temperature, °C in Air at 1 Atm</td>
<td>439</td>
</tr>
<tr>
<td>Flash Point (TAG - Closed Cup), °C</td>
<td>-22</td>
</tr>
<tr>
<td>Explosive Limits, % by Volume in Air at 25°C</td>
<td></td>
</tr>
<tr>
<td>Upper Explosive Limit</td>
<td>19.0</td>
</tr>
<tr>
<td>Lower Explosive Limit</td>
<td>1.7</td>
</tr>
<tr>
<td>Specific Heat at 0°C, Cal/gm °C</td>
<td>0.480</td>
</tr>
<tr>
<td>Heat of Vaporization (1 Atm), Btu/lb</td>
<td>177.0</td>
</tr>
<tr>
<td>Heat of Combustion at 25°C liquid, Btu/lb</td>
<td>15,336</td>
</tr>
<tr>
<td>Solubility, g/100 g at 20°C</td>
<td>Complete</td>
</tr>
<tr>
<td>Acetone</td>
<td>Complete</td>
</tr>
<tr>
<td>Benzene</td>
<td>Complete</td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>Complete</td>
</tr>
<tr>
<td>Diethyl Ether</td>
<td>Complete</td>
</tr>
<tr>
<td>Methanol</td>
<td>Complete</td>
</tr>
<tr>
<td>Water</td>
<td>9.5</td>
</tr>
</tbody>
</table>

1 Typical property values; not to be construed as sales specifications.
Specify Dow Oxides for Quality, Value, and Confidence

When you specify DOW Butylene Oxide – you gain the resources and experience of an industry leader. For more than a century, Dow has provided quality chemical products, raw materials, and processes to its industrial and commercial customers. Specifying Dow products assures you of consistently high product quality and outstanding value for every dollar you spend on chemical raw materials.

Quality

An ongoing program of production quality control helps to assure that shipment-to-shipment consistency is maintained. In addition, certificates of analysis are provided for each shipment and periodic statistical quality data are available for ease in tracking the quality of product delivered to each customer.

Research and Development
Dow is a leader among global chemical companies in making a commitment to continuous improvement of products and processes. This commitment helps to assure continued low cost and innovative products that are delivered safely – with an emphasis on customer awareness for proper use. Dow Technical Service & Development Department personnel can answer your technical questions quickly and accurately.

Industrial Hygiene and Safety
Dow is a recognized leader in human and environmental safety and toxicology. Extensive laboratory and field testing programs provide up-to-date information and safe-handling guidelines covering the use of Dow products. For first time users of Dow oxides, a program is in effect to help ensure that you are adequately prepared to safely handle the product(s).

Physical Hazard Information
1,2-butylene oxide is a vapor explosion hazard. Both liquid and vapor are extremely flammable. The vapor is heavier than air and can travel long distances. Ignition or flashback could occur. Avoid static discharge. Flammable mixtures may exist within the vapor space of containers at room temperature. Flammable concentrations of vapor can accumulate at temperatures above the flash point. This product is thermally stable under recommended storage conditions, but can decompose at elevated temperatures. Elevated temperatures can cause hazardous polymerization. Polymerization could result in a rapid, uncontrolled buildup of pressure and heat. Polymerization can be catalyzed by acidic pH, water, acids, alkali metal hydroxides, anhydrous metal chlorides (aluminum/iron/tin, etc.), bases, basic pH, and salts.

Avoid contact with oxidizing materials, acids, bases, water, and clay-based absorbents. Avoid two-phase storage with water; a slow, exothermic (heat generating) reaction may be initiated. Electrically bond and ground all containers and equipment before transfer or use of this material. For more information, request the Safety Data Sheet from the Dow Customer Information Group (http://www.dow.com/assistance/dowcig.htm).

Figure 1 – Vapor Pressures of Alkylene Oxides

Health Hazards, Personal Protective Equipment, and First Aid

1,2-butylene oxide is a potentially hazardous material. Personnel involved in handling butylene oxide should be trained about the specific hazards of the chemical and about decontamination procedures in the event of overexposure. A well-designed training program includes instruction in the proper way to wear, use, clean, and maintain each piece of protective equipment. Review the Material Safety Data Sheet prior to working with butylene oxide.

Ensure that personal protective equipment as specified in the Material Safety Data Sheet is available for emergency response.

Eye Protection
Use chemical goggles. If exposure causes eye discomfort, use a full-face respirator. Direct exposure to butylene oxide may cause moderate eye irritation and slight corneal injury. Vapors of butylene oxide may cause eye irritation experienced as mild discomfort and redness.
If butylene oxide gets into the eyes, flush thoroughly with water for several minutes. If contact lens were worn, remove after initial 1-2 minutes of eye washing and then continue flushing for several additional minutes. If effects occur consult a physician, preferably an ophthalmologist.

**Skin Protection**

Use protective clothing chemically resistant to this material. Selection of specific items such as face shield, boots, apron, or full body suit will depend on the task. **Hand protection:** Use gloves chemically resistant to this material. Examples of preferred glove barrier materials include: Butyl rubber; Chlorinated polyethylene; Polyethylene; Ethyl vinyl alcohol laminate (“EVAL”); Polyvinyl alcohol (“PVA”); Styrene/butadiene rubber. Examples of acceptable glove barrier materials include: Natural rubber (“latex”); Neoprene; Nitrile/butadiene rubber (“nitrile” or “NBR”); and Polyvinyl chloride (“PVC” or “vinyl”).

**NOTICE:** The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials, as well as the instructions/specifications provided by the glove supplier.

Prolonged skin contact may cause burns and repeated contact may cause severe burns. If skin is exposed all clothing covering the affected area should be removed and the area washed with flowing water or a shower. Anything which could hold oxide in contact with the skin such as watches, rings, or other jewelry needs to be removed. Put on a complete change of clothing.

Do not wear contaminated clothing until it has been properly cleaned. Discard contaminated leather articles such as shoes or belts in a proper manner because oxide cannot be effectively removed from leather articles.

Prolonged or widespread skin contact may result in absorption of potentially harmful amounts.

**Inhalation Protection**

Butylene oxide vapor may cause severe irritation to the nose, throat, and lungs. Prolonged excessive exposure may cause serious adverse effects, even death. In areas with poor ventilation, leaks or spills may result in accumulation of lethal concentration. Signs and symptoms of excessive exposure may be anesthetic or narcotic effects.

**Respiratory protection** should be worn when there is a potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive-pressure supplied-air will depend on the specific operation and the potential airborne concentration of the material. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus.

In confined or poorly ventilated areas, use an approved self-contained breathing apparatus or positive pressure air line with auxiliary self-contained air supply. The following should be effective types of air purifying respirators: Organic vapor cartridge.

Should a person or persons be overcome from inhalation of butylene oxide, they should be removed to fresh air at once by a responder properly equipped with appropriate personal protective equipment. Treat for shock if necessary. If not breathing give artificial respiration using rescuer protection. If breathing is difficult oxygen should be administered by qualified personnel.

**Ingestion**

Butylene oxide has low toxicity if swallowed. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; however swallowing larger amounts may cause injury. If butylene oxide is ingested seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

**Systemic Toxicity**

Repeated excessive exposure may affect the following organs: peripheral nervous system, respiratory tract.

Butylene oxide has been shown to produce benign and malignant tumors in rats but not mice. These tumors occurred only following high exposure levels which first produced chronic upper respiratory tract irritation. Butylene oxide is not believed to pose a carcinogenic risk to humans when handled as recommended. The International Agency for Research on Cancer (IARC) has classified 1,2-butylene oxide as a possible human carcinogen (category 2B).
General Design Considerations

Systems for unloading, handling, and storing butylene oxide require the same analysis and design expertise as systems for other hazardous chemical products. The following information lists general considerations important in designing such systems.

Fragile devices such as glass or plastic sight and gauge glasses, bull’s eye flow indicators, and other devices subject to failure from shock should not be used in piping systems, vessels, or equipment in oxide service.

Expansion joints or flexible connections should not be used in fixed or permanent oxide piping installations.

Gaskets of spiral-wound stainless steel with flexible graphite or PTFE filler and circumferential internal and external metal retaining rings are preferred for pipe and vessel flanges. Metal-reinforced flat flexible graphite gaskets are also acceptable in class 150 and 300 service. Valve bonnet gaskets and pump body gaskets must be of spiral-wound stainless steel with flexible graphite or PTFE filler, or metal reinforced flat flexible graphite gasket.

Very few elastomers are suitable for liquid oxide service. CHEMRAZ® 505 and KALREZ® Spectrum™ 6375 are acceptable for butylene oxide. Santoprene® 271-73 may be used for hose and manway gaskets.

Generally, insulation is not needed on oxide transfer piping and equipment. If required, select an insulation material that is neither reactive with, nor soluble in the oxide being used. Known acceptable materials include glass foam, expanded perlite, and certain polyurethane-type insulating materials. Other insulation materials should be tested prior to use.

Vessels

Storage vessels, pressure vessels, and equipment that will contain butylene oxide at operating pressure above 15 psig (1.02 bar) should be designed in accordance with ASME (American Society of Mechanical Engineers) Boiler and Pressure Code or equivalent standards.

Storage and process tanks designed to contain butylene oxide with operating pressures less than 15 psig should be designed in accordance with API (American Petroleum Institute) standard 620 or equivalent standards. The design pressure of API 620 tanks should be as high as practical, at least 5 psig for tanks larger than 50 feet in diameter and a minimum of 10 psig for smaller tanks. Requirements for vessel storage, including secondary containment, are presented in NFPA 30. Considerations in site selection and tank spacing include proximity to other flammable material storage facilities, nearby sources of ignition, accessibility for fire fighting equipment, and impact of a vapor cloud explosion on nearby areas. Installations should comply with NFPA 30 and NFPA 70 regarding these issues. These standards are intended to ensure that tanks possess sufficient structural strength and pressure relief systems to prevent catastrophic loss of contents in either normal service or under fire conditions.

Storage tanks should be situated within containment systems that are equipped to provide detection and control of an accidental release of butylene oxide. Storage tanks and facilities for loading and unloading butylene oxide from tank cars or trucks should have spill retention walls, dikes, or curbs to direct spills into containment areas, which are sufficiently remote to accommodate safe recovery or disposal. If tanks are grouped, the pond should hold 110% of the largest tank’s capacity, or be large enough to accommodate a volume of deluge water that allows adequate time to detect and rectify a significant leak or spill. The routing of butylene oxide to the impounding area should avoid possible ignition sources, and should not expose other storage or process systems to damage in the event that the spillage is ignited. Routing through underground lines with fire seals is preferred. Containment system design and operation should conform to NFPA 30.

Instrumentation to the unloading station should warn the operator of the potential for overfilling and activate a totally independent flow shut-off device if overfill is imminent. The device should not be used as a regular operating tool for determining tank level. Bulk storage tanks should be vented to a containment device, such as a scrubber, which eliminates discharges of butylene oxide vapors to the atmosphere. The containment device should be designed to prevent the passage of a flame from one container to another.

All tanks and vessels should be protected from over-pressure. Pressure relief systems should employ dual installation, three-way pressure relief valves, so one valve is in service at all times. Discharge from pressure relief valves should not be manifolded and should be directed away from equipment, piping, and personnel. Design of safety valves should consider the possibility of fire damage to the vessel being protected. Rupture discs, used in conjunction with pressure relief valves, should be provided with a bleed-type opening between the disc and valve, and the connection should be piped into the relief valve discharge piping through a restricting orifice. A combustible gas detector that activates an alarm should be placed downstream from the bleed return and relief valves.
Figure 2 – Typical Pressure Storage Tank Configuration

This figure illustrates a typical configuration, and is not intended to be used as a design specification. Qualified professionals must exercise engineering judgment to establish site specifications that meet applicable requirements.

- Pressure Safety Valve
- Tank Support
- Tank Drain
- Safety Railing
- Manway
- Level transmitter with Output Gauge
- Outlet Line
- Approved Ground
- Filter
- Pump
- Pressure Gauge with Diaphragm Seal
- Pressure Controller (Split Range)
- Pressure Control Valve
- NFPA Identification Code
- Block Valve
- Check Valve
- Containment Dike
- Temperature Indication
- Level Transmitter

Design all vessels so that butylene oxide cannot free-fall through the vapor space of the vessel. One design that has been found effective is to install dip legs with siphon breakers in vessels where entry is through the upper portion of the vessel. Design all tanks and equipment to eliminate stagnant areas where little or no fluid turnover occurs in either the vapor or liquid. Flat-bottomed pressure storage tanks should be designed with foundations that will withstand the compression load of the tank full of water, and should be reinforced with a head stiffening ring and anchored around the bottom.

The number of vessel nozzles should be held to a minimum. Special attention should be given to all normally active nozzles in the liquid zone, as these should be fitted with motor-operated emergency block valves. Both local and remote operation of the valves should be provided. The valves should fail closed in the event of instrument air or electrical failure. The closure rate of the emergency block valves should be adjusted so as to prevent hydraulic shock upon closure. Level devices such as differential pressure, radar or guided wave radar are preferred.
Emissions resulting from loading and unloading operations should be controlled using contained systems; vapor balancing and product recovery are the preferred methods. Vents may be directed to flares or incinerators, provided they are remotely located and are designed with flame arrestors and associated instrumentation to prevent flashback.

Instrumentation situated on or in butylene oxide tanks and vessels should meet electrical classification NFPA 497A Class I, Division 2 Group B guidelines. Instrumentation should be designed so that butylene oxide will not make contact with energized electrical connections and will not enter air supply lines because of a ruptured diaphragm or other failure.

The minimum recommended instrumentation for butylene oxide vessels is:
- Temperature, levels, and pressures indication gauges (recording instruments are preferred).
- Audio-visual alarms for high temperature, high and low pressure, and high-fill-level limits.
- A second high-fill-level device set to actuate an alarm at a higher level than the first and to automatically close the motor-operated block valve in the fill line.
- An automatic pad and depad system using nitrogen as the pad gas on all storage vessels. Devices to prevent backflow should be installed in the nitrogen supply line as well as the process lines. A high-purity nitrogen supply should be used and must not contain ammonia or amines.

Flammable (combustible) gas detectors should be uniformly dispersed around equipment containing propylene oxide. The dispersion pattern should ensure coverage regardless of wind direction. Locating detectors at low points near drainage structures and outlets in process and storage areas is also advisable.

**Piping**

The piping system should comply with the latest edition of American Society of Mechanical Engineers/American National Standards Institute (AMSE/ANSI) B31.3. The following key points should be considered in any butylene oxide piping installation:

- Piping should be welded and flanged. Minimize potential leak points by minimizing the number of valves, flanges, couplings, etc. Use of threaded connections is not recommended. Integrally reinforced fittings or reinforcing pads should be used for branch connections 1-1/2 inches and under in size. All pipe nipples used for instrumentation and test connections should be of minimum schedule 80 thickness.

- Stream tracing should not be installed on butylene oxide piping. Piping systems should not be manifolded together with systems containing other products. The design of piping systems should prevent backflow of process materials into storage facilities, and should allow for pressure relief due to liquid expansion in the entire system, as well as sections that can be isolated using valves. All inactive terminal connections in oxide piping should be plugged or blinded. No galvanized piping should be used in butylene oxide service.

- Lines that are buried should be of welded construction. Flange connections should not be used, except in valve boxes with access for service. Cathodic protection should be provided for buried lines.

**Valves**

Valves should meet fire-tested design requirements to API607. Ball valves should have self-relieving seats, due to potential thermal expansion from trapped liquids.

**Pumps**

Properly instrumented seal-less pumps (canned pumps) are recommended, except in cases where they may be run dry (i.e. unloading of shipping container operations). Centrifugal pumps with bodies and wetted parts constructed of cast steel or stainless steel may be used. Double mechanical seals with buffer fluid or double-dry gas seals and monitoring instruments are recommended. The seals should be fitted with carbon stationary elements and tungsten rotating elements. The resilient or compressible components of the seal assembly should be of fluoroelastomer (for example, CHEMRAZ® 505® and KALREZ® Spectrum™ 6375). Pumps with double-dry gas seals should have provisions made for venting the pump before starting.

- Pumps should be installed within dike or curbed areas, with the dike or curb sloped to direct any leaks or spills to a secondary containment area. Pumps should not be located in the same primary containment area with storage tanks.

- Seals-less pumps, such as magnetic drive pumps, are also acceptable for use in butylene oxide service. Care should be taken to ensure that the pumps are not run dry to prevent damage to the pump.

- Pumps used to unload butylene oxide should be sized accordingly, considering the excess flow check valves that are installed on the rail cars and trucks. Interlocking grounding devices with alarms should be used with transfer system to provide an automatic shutdown if the grounding is lost. An interlock should also be used to prevent over-flowing the storage tank.

All pumps should be protected against abnormal temperature rise by a high-temperature alarm and shutdown. The sensing element should be of a Class I, Group B* electrical classification and preferably should be located in the pump body. Locating the device immediately adjacent to the discharge piping before the first block valve may be a suitable alternative.
Delivery and Transfer

Prior to delivery, customers should be prepared to safely receive, off-load, and store butylene oxide. To promote safety and security Dow will make deliveries only to sites with which it is familiar or has otherwise been assured that the personnel are capable of safely handling butylene oxide. In general, this normally means that the site will be visited and reviewed by a representative from Dow prior to its first delivery.

It is important to carefully instruct all personnel involved in plant design and the handling of butylene oxide on the properties of this material. Because the degree of hazard varies from one operation to another, individual situations should be carefully evaluated to determine all appropriate safety measures.

A variety of vessels – including rail tank cars and tank trucks – are used to transport butylene oxide. All appropriate national and international regulations must be met.

For regulatory requirements concerning unloading and storage of hazardous chemicals, Title 49 of the Code of Federal Regulations, the United States Department of Transportation (DOT), should be consulted. Because governmental requirements may differ between local, state, federal, or other sovereign authorities, review all applicable laws and regulations before designing and installing a storage and unloading facility.

Considerations for Delivery

The following are some considerations designed to help prepare for an initial bulk delivery to a new facility. For specific information about hardware, you may want to contact Dow.

- Has Dow visited your facility and reviewed your bulk butylene oxide handling and storage facility?

 NOTE: Dow may decline to deliver to a facility until an on-site review is conducted to verify that the facility meets Dow’s minimum standards.

- Was the off-loading piping and valve system pressure-tested to ensure that it is leak-free? If water was used for the pressure test, how was the system dried?

- Was the off-loading pump tested with liquid after installation?
- Is a written off-loading procedure available to employees?
- Was the procedure reviewed by the off-loading operator? Will operator use it as a checklist for off-loading?
- How will the vehicle be managed for spill containment?

 NOTE: Any water in the system can create quality and safety problems.

- Are there valve position changes required to secure the containment system? If so, are they described in the off-loading procedure?
- Are spotting, choking, and brake securement requirements clearly identified?

 NOTE: It is recommended that the spill-containment volume is large enough to hold 110% of the contents of the vehicle scheduled for off-loading.

- Is the appropriate personal protective equipment available to the operator before off-loading? Is the equipment specified in a procedure?
- Are the safety shower and eye wash stations immediately accessible in the off-loading area?
- Are the safety showers and eye wash stations tested before any connections are made to the vehicle?
- Is the off-loading area cordoned off or barricaded to keep unauthorized personnel and vehicles out?
- How will the vehicle’s electrical ground be verified?
- Has the off-loading operator receive training on the hazards of the product and reviewed current Material Safety Data Sheets (MSDS)?
- Will a check be made of the vehicle’s number, seals, and product identification tag (on the off-loading line) to verify the product against both the invoice and Certificate of Analysis?

 NOTE: Product stencils and accompanying documents on rail cars must be checked.

- Will a sample be drawn and analyzed prior to off-loading?
NOTE: If so, what precautions will be taken to avoid personnel exposure?

- Are all lines and vessels properly labeled and identified?
- If connections will be made on the top of the transport vehicle, is protection against falls adequate?
- Was the oxygen level in the storage tank checked and verified to be below 2%?
- Are all terminal lines plugged (blinded) to prevent spills from an accidental valve opening (e.g., sampling and blow-down lines)?
- Are fire extinguishers and a deluge or fire water monitor(s) (water cannon(s)) available in the immediate area?
- Is there a communication link to the control room? How will it be maintained during off-loading?
- Have calculations been made and confirmed to ensure that the load will fit into the available tank space?

How will the transfer of the load into the tank be monitored to verify movement of product when the pump is started and to ensure that the product is going to the correct locations? How will the movement of vapors through the vapor return line to the vehicle be established and verified?

NOTE: At any sign of safety relief valve activation, the transfer shall be stopped and the cause of the safety valve opening shall be investigated.

- Is the off-loading procedure clear about the location and size of the liquid and vapor lines?
- If dry disconnects are used, are they locked in place by securing the arms in a closed position?
- When opening the valves on both the vent and liquid sides, will a careful check for leaks be made?
- Are flammable (combustible) gas detectors installed at strategic points to sound an alarm if a leak occurs?
- What is the pressure inside the storage tank?

NOTE: If it is at a pressure that exceeds the vehicle safety system, the pressure relief valve will open and a vapor cloud will be released. Relief pressure can vary, depending on the type of vessel used by the supplier.

- After the transfer is initiated, is the operator required to stay within 7.6 meters (25 feet) of the connections until the load is completely transferred?

DOT 177.834 requires operator attendance for truck and rail unloading operations. It is recommended for all transfers. Consult applicable regulations for the geography in which the 1,2-butylene oxide is being unloaded.

NOTE: If a rail car is involved, how will it be monitored?

- How will the operator know when the vehicle is empty so that the pump can be shut down after it loses suction pressure?
- If the liquid line will be blown clear prior to disconnection, how will the nitrogen be regulated to not exceed the pressure at which the vehicle’s safety system begins to relieve? What steps will be followed if a blow-down is performed?

NOTE: Hoses should not be left hydraulically full.

- What procedure will be used to ensure all liquid and vapor return lines on the car and piping system are correctly blown clear, depressurized, and blocked to secure the system and the delivery vehicle?
- When disconnecting the fitting, does the procedure require the use of appropriate protective gear?
- How will the hoses be secured to keep them clean and contamination-free for the next load?
- How will the operator ensure that the fall restraint, chocks, ground strap, and barricades are removed (and that the placards are reversed and derail and warning signs are removed before releasing a rail car)?
- Rail cars and some intermodal containers have top discharge lines; establishing pump suction requires specific operating procedures. The procedures must either utilize the pressure in the car upon arrival or provide the pressure to push the product out of the car to flood the pump suction. How will this be managed?

- When inert gas is used as a motive force for product transfers, we recommend installing safety relief valves downstream of pressure control regulators or control valves sized to protect the transport tank against regulator failure. The relief valves on the shipping container are not sized for regulator failure.
- When pressure is used for unloading, the gas supply shall have a regulator and a safety valve with adequate capacity installed to prevent overpressure of the transport container.
- The pressure safety valve shall be installed downstream of the gas supply regulator.

Note: The transport container pressure safety valve, if present, does not fulfill this requirement.

- Is there verification of re-sealing?
- What mechanism is in place that allows the operator to factor any learning experiences into the next off-loading experience to continuously improve performance?
Figure 3 – Typical Tank Car Dome Configuration
This figure illustrates a typical configuration, and is not intended to be used as a design specification. Qualified professionals must exercise engineering judgment to establish site specifications that meet applicable requirements.

1. Straight Ball Valve with Dry Disconnects on the two liquid valves and vent line (nitrogen) valve.
2. Gauging Device
3. Safety valves can range from 75 psig to 247.5 psig depending on the tank car.
4. Eduction Pipe
5. Support
6. Thermowell (optional)
7. Sample Line (optional)
Rail Cars
Butylene oxide is typically shipped in DOT 105J300 rail cars, which are rated for 300 psig. They are constructed of welded carbon steel, insulated with four inches of fiber-glass, and covered by a 11 gauge steel jacket. The jacket heads on each head are 1/2-inch thick for protection in the event of a transportation emergency.

The only piping attachments to the cars are made through a 20-inch manway nozzle on top of the center of the car. External piping and valves are protected by a metal housing with a cover that is secured with a locking pin. Sketches of the layout of these attachments are shown in Figures 4 and 5.

Liquid is removed through a 2-inch valve connected to dip pipes terminating near the bottom of the car in a shallow sump that contains about 10 gallons of liquid. The head space vent is through a 2-inch valve with piping that terminates just below the manway flange. Both liquid and vapor lines are equipped with excess flow check valves that restrict flow to about 125 gpm, but will not function to protect against slow leaks in plant piping.

NOTE: While loading, if flow shuts off after having started, the excess flow valve may be checking. When this occurs, shut off flow and restart slowly, transferring at a slightly lower flow than previously used.

There is also a magnetic float gauging device that measures the liquid level for the upper half of the car only. A working platform surrounds the dome and is about 12 feet 6 inches from the ground. Consider using additional fall protection devices. Cars are commonly equipped with a pressure relief safety valve that can be set as low as 75 psig.

CAUTION: Do not exceed 60 psig on the tank car, as this may cause premature relieving of the pressure relief safety valve.

Figure 4 – Typical Tank Car Configuration
This figure illustrates a typical configuration, and is not intended to be used as a design specification. Qualified professionals must exercise engineering judgment to establish site specifications that meet applicable requirements.
Figure 5 – Typical Tank Car Unloading System Configuration
This figure illustrates a typical configuration, and is not intended to be used as a design specification. Qualified professionals must exercise engineering judgment to establish site specifications that meet applicable requirements.

1. Excess Flow Check Valves
2. Pressure Relief Valve
3. Tank Car Sample Valve (optional)
4. Magnetic Level Gauge
5. Rigid Pipe with Swing Joints
6. Pressure Gauge
7. Sample Points
8. Double Seal Leak Detector
9. Centrifugal Pump
10. Emergency Block Valve
11. Ground Wires
12. Indicating Ground Detector
13. High-Temperature Shutdown
14. Sprinkler System
15. Combustible Gas Detector Alarm
16. Below-Grade Grounding System
17. Grounding Clamp
Considerations for Unloading Tank (Rail) Cars

Figure 5 shows a typical unloading set-up for butylene oxide.

- The site should be safely remote from traffic, general activity, and ignition sources.
- The surface should be sloped to provide drainage into a containment area for spill control.
- The rail car should be connected to a common earth ground. Interlocking grounding devices and alarms should be used with the transfer system to provide automatic shutdown if the ground is lost.
- All fixed components of the unloading system must be located outside an area that complies with the appropriate codes and standards to provide adequate physical clearance.
- All electrical equipment, including phones, radios, and intercom systems in the unloading area, should comply with the appropriate codes and standards.
- The unloading facility and the dome area of the rail car should have some form of fire protection device, such as an automatic sprinkler system. It is recommended that flammable (combustible) gas detectors are strategically placed in the general area. Dry-powder fire extinguishers should be present and a firewater monitor should be located within 40 feet of the car dome.
- Counter-balanced steep pipe swing joints for tank car liquid and vent connections are preferred. Dedicated flexible stainless steel hoses are also acceptable. If flexible hoses are used, a storage area from the hoses should be provided that will protect them from damage and contamination. A documented hose testing program is recommended, as they are probably the most vulnerable part of the unloading system. All hoses should be pressure tested prior to each use. Emergency block valves in the liquid and vapor piping should be capable of activation from both the elevated platform and ground level. If a pump is used, provide a stop switch at the remote location.
- Eye wash and safety shower stations should be located on both ground and platform level. Provide personal protective equipment and have appropriate tools stored nearby.
- All transfer lines should be properly identified, so that proper alignment can be made.
- To prevent rolling during unloading operations, the car’s hand brake must be set and the wheels must be chocked.
- To protect a car from other traffic on the rails during unloading, a derail device should be positioned on the track at least 50 feet (where practical) from the end of the car being protected.
- Per DOT regulations, a warning sign (blue background with white letters) must be attached to the rail about four feet beyond the derail device. If unloading at night, a blue lantern is to be hung on the warning sign. If the track is active from both directions, a derail device, sign, and lantern should be placed at each end of the tank car.
- All regulations, including DOT attendance requirements, must be followed. For additional safety, a person should be stationed close enough to maintain visual contact with the car during the unloading operation.
- Unloading hoses and arms should be disconnected when there is no one in attendance or when transfer is stopped.

Tamper evident seals are applied to all shipments of butylene oxide. Shippers are encouraged to apply tamper evident seals on residue rail cars returning to Dow.

General Guidelines for Unloading Tank (Rail) Cars

1. Confirm that the rail car contains butylene oxide, i.e., perform a positive ID check or check shipping documentation such as the car number, the DOT placards, the car label, and other shipping documentation.
2. Per DOT regulations, place a blue caution sign (or lantern) on the track. Put a blue lantern on the flag if the job is being done at night. Put the derail device in the derailing position. Chock the wheels. Set the hand brake. Activate the barricade system and operational lights.
3. Attach the lower ground cable to the body bolster and confirm that the ground interlock is active. Extend and secure the loading rack to the top of the car. Open the dome cover and attach the upper grounding cable to the dome.
4. Check that the bulk tag correctly identifies the contents as butylene oxide. Sampling the car can confirm product identity and determine if the material is suitable for unloading (see page 18, “Sampling Equipment”).
5. Ensure that appropriate measures are taken to prevent storage tank overflow.
6. Connect the liquid and vent lines to the car. Open the bleed valves at the tank car end. Purge air from the unloading and vent lines with nitrogen and pressure lines (maximum 60 psig). Pressure test the lines adequately, i.e., for about one minute. If the pressure does not hold, search for leaks with soap suds or other leak-detecting fluids, and correct leaks.
7. Open the vapor valve on the tank car and determine the car pressure, which may range from 10-40 psig. Confirm that the liquid and vapor valves at the storage tank are open. Equalize the pressure on the two tanks by opening the final vapor block valve at the rail car rack.
8. Open the liquid line on the rail car, at the rack, and at the pump. Start the unloading pump. Check the pump for leaks and proper operation. Tank cars may be off-loading using nitrogen pressure of 40-50 psig in lieu of pumping.

CAUTION: Do not exceed 60 psig in the tank car, as this may cause premature relieving of pressure relief safety valve.

9. As soon as the car is empty, stop the unloading pump. Avoid allowing the pump to run dry to prevent damage to the mechanical seal.
10. Clear the liquid unloading line into the car by purging with nitrogen. Close the liquid valve on the car and empty the liquid line from the car into the storage tank by continuing to purge with nitrogen. Close the rack liquid valves, the pump valves, and the liquid inlet valve into tank. Close the vapor line into the tank. Adjust the nitrogen pressure in the car to the 10-15 psig range and close the vapor valve on the car and rack. Bleed down and disconnect the loading lines. Cap them and secure them to the loading ramp. Replace the plugs in the rail car valves. Secure the magnetic gauge.
The site should be safely remote from traffic, general activity, the unloading facility and the rear area of the truck should. 316 stainless steel pipe loading arms with swivel joints for truck loading. The tank truck should be properly electrically grounded. All electrical equipment, including phones, radios, and intercom systems in the unloading area, should comply with the appropriate codes.

**Tank Trucks**

Acceptable tank trucks to transport butylene oxide are defined in 49 CFR 173.243. Different types of dedicated trailers are used by suppliers to transport butylene oxide in North America. Typically DOT-407/MC307 type trailers are used. DOT 412 or MC331 trailers are also be acceptable provided they have a 2” liquid discharge connection and a 1 ½” ground level vent connection, both equipped with OPW Kamvalok® dry disconnect fittings. Safety valve pressure settings of commonly used butylene oxide tank trucks can vary from 25-260 psig, depending on the specifications used to design and manufacture the vessel. Contact Dow for specific details.

Butylene oxide trailers are commonly equipped with a dial thermometer and a pressure gauge. All liquid and vent connections are typically located at the back, behind the rear wheels, however, some trailers may have curb side center discharge. Typical fittings are 2-inch dry disconnect.

Trailers may not be loaded completely full because they must comply with maximum load restrictions determined by state and federal regulations. Prior to loading, the trailer is purged with nitrogen. After loading, a residual nitrogen blanket of about 10 psig will be left on the trailer.

The shipping location shall verify that no fittings extend beyond the protection of the steel chassis and bumper before releasing the truck for shipment.

All required product identification tags, seals, and transportation placards shall be affixed to the trailer before it leaves the shipping location.

**Considerations for Unloading Tank Trucks**

- The site should be safely remote from traffic, general activity, and ignition sources.
- Consider the use of road barricades and warning lights to restrict traffic or other operations from the unloading area.
- The surface should be sloped to provide drainage into a containment area for spill control.
- The tank truck should be properly electrically grounded. Interlocking grounding devices and alarms should be used with the transfer system to provide automatic shutdown if the ground is lost.
- All electrical equipment, including phones, radios, and intercom systems in the unloading area, should comply with the appropriate codes.
- The unloading facility and the rear area of the truck should have some form of fire protection devices, such as an automatic sprinkler system. It is recommended that combustible gas detectors are strategically placed in the general area. Dry-powder fire extinguishers should be present and a firewater monitor should be located within 40 feet of the trailer.

**General Procedures for Unloading Tank Trucks**

1. Make sure the unit is spotted correctly and that its wheels are chocked, its brakes are set, and the road barricades are up. Turn on the flashing lights or other visual warning systems at the road entrance.
2. Place a placard on the windshield or steering wheel of the truck to warn against moving the vehicle, or remove the keys and place in a secure area. Direct the driver to wait in a designated area. The driver should not remain in the cab.
3. Attach the lower ground cable to the carriage support and confirm that ground interlock is active.

4. Confirm that the trailer contains butylene oxide, i.e., check the trailer number, the DOT placards, the trailer label, and shipping documentation. Sampling the trailer can confirm product identity and determine if the material is suitable for unloading.

5. Ensure that appropriate measures are taken to prevent storage tank overflow.

6. Connect the unloading line to the truck liquid line.

7. Connect the vent-back (vapour) line to the truck.

8. Pressure the lines, with the trailer valves closed, to 20 psig to conduct a pressure check. Isolate the unloading lines with appropriate block valves and observe the pressure for about one minute. If the pressure does not hold, search for leaks with soap suds or an equivalent leak detecting liquid and make necessary repairs. Vent down slowly as indicated in 9.

**CAUTION:** Do not exceed the pressure of the trailer safety valves.

9. Confirm that the vent and liquid inlet valves at the storage tank are open. Slowly equalize the pressure on the truck and the vapor line to the truck.

10. Open the valves in the liquid line on the tank truck, at the emergency block valve at the pump suction, and discharge. Check for leaks and proper operation.

11. When pressure is used for unloading, the gas supply shall have a regulator and a safety valve with adequate capacity installed to prevent overpressure of the transport container. The pressure safety valve shall be installed downstream of the gas supply regulator. Note: The transport container pressure safety valve, if present, does not fulfill this requirement. If pressuring off the butylene oxide with nitrogen, make certain that the nitrogen is dry and contains less than 2% oxygen. Then open the tank vent line to an appropriate scrubber and pressure the truck with nitrogen. Open the liquid line to begin the transfer.

**CAUTION:** Low-pressure trucks may not be suitable for pressure off-loading. Provide provisions to ensure that the tank truck is protected against vacuum to prevent collapsing the cargo tank during the unloading operation. It is important to ensure that the vent valves and piping between the receiving tank, or the nitrogen pressure source, and the transport trailer are open and unrestricted before opening the liquid valves and transferring liquid. If nitrogen is used as the motive force, it should be opened first to supply pressure to the tank trailer before opening the liquid discharge valves.

12. As soon as the trailer is empty, stop unloading pump. Avoid allowing the pump to run dry to prevent damage to the mechanical seal.

13. Clear liquid unloading line into the truck by purging with nitrogen. Close the liquid valve on the truck and empty the liquid line from the truck into the storage tank by continuing to purge with nitrogen. Close the pump valves, the emergency block valves, and the liquid inlet valve into the tank. Close the vapor line into the tank. Adjust the nitrogen pressure in the transport trailer to the 10-15 psig range and close the vapor valve on the tank and at the load rack. Bleed down and disconnect the loading lines. Cap and secure the hoses. Place caps on truck piping. Hoses need to be stored in a secure location. Remove the upper ground cables. Check the trailer DOT or regulatory placards to see that they are properly affixed and in good condition. Remove the wheel chocks, take down the barricade, turn off the visual warning system, and release the truck to the driver.

The receiving location shall verify that no fittings extend beyond the protection of the chassis, bumper, or steel frame before releasing the truck from the site.

**ISO Containers**

Acceptable portable containers used to transport butylene oxide are defined in 49 CFR 172.242, 49 CFR 173.243, 49 CFR 172.101. The T7 ISO tank with a 4 bar (58 psig) pressure rating is preferred.

Butylene oxide is shipped in other types of containers, such as IM101 and IM105 portable tanks, which contain approximately 4,000-6,000 gallons of product, shipped under nitrogen blanket of between 15-30 psig. Unloading valves are typically located at the rear of the tank (see Figure 6).

- ISO tank materials of construction shall be 304 or 316 stainless steel. All valves, flanges, nozzles, and wetted metallic components shall be 304 or 316 stainless steel construction.
- ISO tank bottom discharge outlets shall be equipped with three serially fitted and mutually independent shut-off devices.
- Liquid outlet size: 3”-119 mm, DN80 flange; this may be reduced to 2” for some locations.
- The recommended vapor connections are 63mm (2 inch) DN50 or 48mm (1.5 inch) DN40.
- The recommended liquid transfer hose size is 63mm (2 inches) for the liquid connection.
- The recommended min. vapor hose size is 38mm (1 1/2 inches)

**Recommended Gaskets**

**Pipe and flange gaskets:**

- Spiral wound: 316L Stainless Steel (UNS S31603); Filler: PTFE; Inner Ring: 316L Stainless Steel (UNS S31603); Centering Ring: Carbon Steel (with corrosion protection); ASME B16.20 (B16.5 & B16.47-A); Class 150; Nominal 5,000 PSI seating stress.
- Grooved metal; 316L stainless steel (UNS S31603); PTFE; Thickness: 5.0mm; class 150; G4S-3240-68.
- Grooved flat profile metallic core (4.00mm) with soft gasket sealing material on either face (0.35mm each). Loose locating ring, 316L Stainless Steel (UNS S31603).

DO NOT APPLY ANY LUBRICANTS OR ANTI-SEIZE COMPOUNDS TO FACES OF GASKETS OR FLANGE FACES.
Recommended Elastomers
Tank manway and hose gaskets:
- Santoprene® 271-73 is recommended for tank manway and hose gaskets.
O-rings and seals:
- CHEMRAZ® 505 and KALREZ® Spectrum™ 6375 are acceptable for butylene oxide.

ISO Tank Shipments and Unloading Guidelines
The ISO tank shipments and unloading procedures are similar to the tank truck procedures on the preceding page this document.

Material and/or Container Return Guidelines
Always contact Dow if there is reason to suspect the product has been tampered with or damaged while en route to your facility.

For safety and security reasons, DO NOT RETURN THE PRODUCT WITHOUT PRIOR CONSULTATION WITH AND APPROVAL from Dow.

Figure 6 – Typical IMO Tank Configuration
This figure illustrates a typical configuration, and is not intended to be used as a design specification. Qualified professionals must exercise engineering judgment to establish site specifications that meet applicable requirements.

Nozzle Connection Size
1. The tanks have 3” flanged bottom outlet valves (There is a 3” internal footvalve, a 3” secondary valve, and a blind flange on each tank.) The outlet valves are located on one end of the tank.
2. The tanks usually have 2” vent valves located on top of the tank.

Pressure (min. & max.)
1. 1,2-Butylene Oxide ships in T7 4 bar (58 psig) ISO tanks from Freeport.

Temperature (min. & max.)
1. The product will arrive at ambient temperature.
Sample Handling

Personal Safety Equipment
Protective equipment requirements for sampling propylene and butylene oxide are determined by the potential for exposure due to sampling procedure, sample container, and process conditions. Chemical goggles are recommended for all sample handling. Other protective gear, such as gloves, hardhat, respirator, and/or faceshield may be specified depending on the sampling conditions. For more detailed information on protective equipment refer to the Material Data Safety sheet.

Other Safety Considerations
1. A safety shower with eyewash capability should be located near the sample point.
2. The area around the sample location should be free of ignition sources and other hazards.
3. Sampling containers should be dedicated to propylene oxide or butylene oxide service to minimize the chance of contamination or possible violent reactions.
4. Only the amount of sample needed for analysis should be collected, and any residue must be disposed of according to applicable rules and regulations.
5. Avoid smoking areas, control rooms, and areas where “hot work” is in progress when transporting samples to the laboratory.
6. All laboratory equipment used in analyzing oxide samples (such as the ventilation hood and refrigerator) should conform to electrical standards equivalent to Class I, Division 1, Group B of the NFPA 70, National Electrical Code.

Sampling Equipment
Three different methods are recommended for sampling alkylene oxides – onstream analytical equipment, safety coated glass bottles, or stainless steel cylinders.

Onstream Methods
Onstream equipment has the advantage of minimizing personal exposure levels and does not expose samples to the air. (Because of its hygroscopic nature, oxide – in an open sampling system – will pick up water from the air, thus indicating a high water content.)

Manual Methods:
Safety Coated Glass Bottle Method:
A typical in-line sample point is shown in Figure 7. This system minimizes the dead volume and allows the sample to be collected with very little purging.
- The caps on the bottles should have a polyethylene seal to prevent contamination from a glued or paper seal.
- To minimize personnel exposure, surround the sample point with a box connected to a vacuum source. The airflow volume must be great enough to create the same velocity across the open door face as is required in the laboratory hood.
- Due to the hygroscopic nature of oxides, samples will often indicate a high water content when this method is used.

Stainless Steel Cylinder Method
- The sample cylinder should be of stainless steel and conform to DOT–3E 1800 regulations.
- PTFE tape should be used on the screwed connections.
- A relief valve should be provided on the cylinder assembly.
- The cylinder should contain a dip tube to prevent it from filling hydraulically.
- The cylinder should be clearly marked as to contents and date sampled.
- The cylinder may be evacuated, connected to a low dead volume sample connection, filled, and then disconnected; or connected to a constant recycle flow-through system, flushed, filled, and then disconnected.

Figure 7 – Typical In-Line Sample Point
Regulatory Summary for 1,2-Butylene Oxide

Section 8(a) Toxic Substances Control Act (TSCA)
Reporting requirements established for persons who manufacture, import, or process. ................................................................. X

Section 8(d) Toxic Substances Control Act (TSCA)
Submission of health and safety studies to the EPA required ................................................................. X

Section 311 Clean Water Act
Spillage in navigable waters is regulated by the procedures established by this provision................................................................. X

Section 112 Clean Air Act
Identified as a Hazardous Air Pollutant ................................................................. X
National Emissions Standards for Hazardous Air Pollutants
National emissions standards for hazardous air pollutants (NESHAPs) are issued to limit the release of specified HAPs from specific industrial sectors.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
A release equal to or exceeding the reportable quantity (RQ) prescribed must be reported immediately. RQ in lbs = 100. ................................................................. X

Sections 311 and 312 Superfund Amendments and Reauthorization Act (SARA)
The “Hazard Categories” established for Community Right-to-Know reporting requirements are: immediate health hazard, delayed health hazard, fire hazard, reactive hazard ................................................................. X

Section 313 Emergency Planning and Community Right to Know Act of 1986
Annual reporting of releases to the environment required ................................................................. X

American Industrial Hygiene Association (AIHA)
The AIHA has set a Workplace Environmental Exposure Level (WEEL) of 2 ppm ................................................................. X

International Agency for Research on Cancer (IARC)
The IARC considers to have sufficient evidence of carcinogenicity in experimental animals and is listed as an animal carcinogen, category 2B (possible human carcinogen) ................................................................. X

Department of Transportation (DOT)
The DOT Hazardous Materials Table identifies as a flammable liquid and hazardous substance ................................................................. X

National Fire Protection Association (NFPA)¹
Hazard Ratings: Health 2, Flammability 3, Reactivity 1 ................................................................. X

Occupational Safety and Health Administration (OSHA) Hazard Communication Standard
On the Floor List of OSHA Hazardous Chemical Substances ................................................................. X

NIOSH Registry of Toxic Effects of Chemical Substances (RTECS) Identification Number: EK3675000

Product Stewardship
Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products - from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice
Dow strongly encourages its customers to review both their manufacturing processes and their applications of Dow products from the standpoint of human health and environmental quality to ensure that Dow products are not used in ways for which they are not intended or tested. Dow personnel are available to answer your questions and to provide reasonable technical support. Dow product literature, including safety data sheets, should be consulted prior to use of Dow products. Current safety data sheets are available from Dow.