Table of Contents

VORANOL™ Polyether Polyols .................................................................................. 3
Part One: Handling Precautions and Health Hazards ......................................... 4
  Handling Precautions Summary ........................................................................ 4
Part Two: Unloading and Storage Procedures ....................................................... 6
  Top Unloading .................................................................................................... 10
  Drum and Bulk Storage of VORANOL Polyether Polyols ............................... 10
Part Three: Dow and Product Stewardship ......................................................... 14
Index .................................................................................................................... 15
VORANOL™ Polyether Polyols

Manufacturers of rigid and flexible polyurethane foams appreciate the breadth of polyether polyols available from Dow. VORANOL polyether polyols offer an extensive selection of performance and processing attributes for use in rigid and molded foam, cast elastomer and isocyanate product formulations.

The VORANOL family of polyether polyols includes:
- Diols
- Triols
- Sucrose/glycerin-initiated
- Co-polymer polyols
- Amine-initiated
- Mannich-based

This guide describes practices, procedures and potential hazards associated with handling and storing VORANOL polyether polyols.

CAUTION: VORANOL polyether polyols must be handled and stored with care and only by knowledgeable and experienced personnel who are familiar with the potential hazards associated with the handling, shipment and storage of polyurethane chemicals. Always consult your Safety Data Sheet (SDS) before handling VORANOL polyether polyols.

Additional Considerations
The recommendations in this guide are based on the results of numerous tests and actual experience in the field, and are believed to be accurate and reliable. However, since the specific circumstances associated with the customer’s use of VORANOL polyether polyols are unknown to Dow and are beyond its control, the company cannot guarantee that adherence to these recommendations will ensure absolute safety.

Available Quantities and Delivery of VORANOL Polyether Polyols
VORANOL polyether polyols are available in bulk quantities (via tank truck or tank car) and in steel, non-returnable, 55-gallon drums. Bulk shipments and systems are recommended because they are typically more economical than drums and because they significantly reduce the possibility of product contamination and drum disposal issues.

Other Raw Materials
This guide provides information only for those VORANOL polyether polyols used in rigid and flexible polyurethane foams. If you purchase isocyanate products for your polyurethane formulations, you may request safe handling and storage literature, including an SDS, from your Dow representative. If you use other polyurethane raw materials in your formulations, request recommendations for handling, storage and disposal from the appropriate suppliers.

Important Phone Numbers
For more information about specific operations and procedures, matters relating to the safe use, handling and storage of VORANOL polyether polyols, or to request product literature or SDSs, contact Dow’s Customer Information Center:
United States and Canada: 1-800-441-4DOW (4369)
Mexico: 958-00-441-4DOW (4369)
The Dow Distribution and Emergency Response Center nearest you:
In Midland, Michigan: (989) 636-4400
In Freeport, Texas: (979) 238-2112
For transportation spills, call CHEMTREC: 800-424-9300
Part One
Handling Precautions and Health Hazards

VORANOL™ polyether polyols can be handled safely if simple precautions are understood and practiced.

Toxicity, Handling Precautions and First Aid
All polyols should be handled with appropriate caution and in strict accordance with manufacturer recommendations. Skin and eye contact should be avoided. Appropriate eye protection should be worn whenever polyols are handled or used. For certain materials, skin protection is also recommended.

Before using a specific polyol, consult the appropriate SDS for that material. SDSs for VORANOL polyols are shipped to each customer and can also be requested from your Dow representative or the Dow Customer Information Center United States and Canada: 1-800-441-4DOW (4369), Mexico: 958-00-441-4DOW (4369)

Skin Contact
Prolonged exposure with most polyols is not likely to cause a significant skin irritation. Protective gloves are not required when working with many VORANOL polyols for brief periods of time. Use gloves impervious to this material when prolonged or frequently repeated contact could occur. If hands are cut or scratched, use gloves impermeable to this material even for brief exposures. Use gloves with insulation for thermal protection, when needed.

Gloves are recommended for handling amine-initiated and Mannich-based polyols because these materials have shown a slight to severe potential for irritation when in continuous contact with the skin. There is no evidence that any of the materials are absorbed through the skin in acutely toxic amounts. First Aid: If polyols contact the skin, wash with soap and plenty of water. If skin irritation occurs, consult medical personnel.

Eye Contact
Many VORANOL polyols cause slight temporary irritation if they contact the eyes. Safety glasses are recommended for minimum eye protection.

As stated on SDSs and product labels, chemical goggles are recommended for handling amine-initiated and Mannich-based polyols because these materials can cause moderate to severe irritation and injury to the eyes. First Aid: If eyes are contaminated with polyol, wash thoroughly with plenty of low-pressure flowing water. For amine-initiated and Mannich-based polyols, continue washing for a prolonged period (15 minutes). If irritation occurs, consult medical personnel.

Inhalation
Because of their low vapor pressure, VORANOL polyols do not pose a significant inhalation hazard when handled at room temperature. Under most conditions of use, good general ventilation will be adequate and no respiratory protections are needed. If materials are heated, or if a fine mist is generated, local ventilation and respiratory protection may be required. First Aid: If any adverse effects occur, move the affected person to fresh air and obtain medical attention.

Ingestion
VORANOL polyols are low to very low in acute oral toxicity. Most LD50 values range from 2.0 grams to greater than 10 grams per kilogram of body weight for laboratory animals. A few have oral LD50 values between 1000 and 2000 mg/kg. Swallowing small amounts of these polyols is not likely to cause injury. Although swallowing large amounts of polyols may cause toxic effects, the possibility of such ingestion is unlikely with proper industrial handling and use. First Aid: If large amounts of polyol are swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

Handling Precautions Summary
To minimize hazards associated with the handling, use and storage of polyurethane chemicals and polymers:

- Never work alone when using or handling reactive chemicals.
- Do not inhale vapors or mists. Be sure work areas are adequately ventilated to control vapors below employee exposure limits established by Occupational Health and Safety Administration (OSHA) in the United States or Workplace Hazardous Materials Information System (WHMIS) in Canada. Respiratory protection should be worn when there is a potential to exceed the exposure limit requirements or guidelines.
- Avoid skin and eye contact with all formulation chemicals. Be sure workers are equipped with personal protective equipment.
- When working with materials such as isocyanates in combination with VORANOL polyether polyols, request and reference recommendations for safe handling from all suppliers.
Fire and Explosion

VORANOL™ polyether polyols are low in volatility and have flash points (Pensky-Marten Closed Cup) of 230°F to 500°F (110°C to 260°C). Polyols are classified as Class III B combustible liquids as defined in the Codes and Standards Manual of the National Fire Protection Association (NFPA) and are not considered serious fire hazards. However, in the presence of an existing fire, or under the proper conditions of heat and oxygen, VORANOL polyols will burn and can explode if heated to decomposition temperatures in a confined area. During a fire, smoke may contain unidentified toxic and/or irritating compounds, in addition to the original material. Do not use a direct water stream to extinguish a fire as it may spread the fire. Violent steam generation or eruption may occur if water is applied directly to hot liquids. Spills of organic liquids on hot fibrous insulations may lead to lower auto-ignition temperatures, with possible spontaneous combustion as a result.

Fires involving polyols can be readily extinguished with water fog, carbon dioxide, foam, or dry chemical extinguishers. Personnel fighting polyol fires should wear a positive-pressure, self-contained breathing apparatus.

Spill Containment and Cleanup

Spills of polyol on concrete or metal surfaces can cause slipping hazards. Personnel engaged in cleanup of spills should observe appropriate skin and eye protection practices. Minor Spills: Small spills on hard surfaces can be wiped or mopped up. They can also be absorbed by using materials such as dirt or sand, and then swept up for disposal. Large and Major Spills: When large spills occur, the polyol should be contained by creating ditches or dikes with absorbent material. The polyol can then be pumped into containers, such as drums or tank trucks, for disposal. Examples of major spills include overturned tank trucks or tank cars, and ruptured storage tanks. In the event of a major spill, or moderately large spills in which there is doubt or uncertainty regarding cleanup procedures, contact Dow’s Distribution and Emergency Response Center nearest you:

In Midland, Michigan: (989) 636-4400
In Freeport, Texas: (979) 238-2112
Or call: CHEMTREC1-800-424-9300 (U.S./Canada)

Drum Decontamination and Disposal

Only properly trained and equipped personnel should be permitted to participate in drum decontamination and disposal operations.

Examine each shipment for damaged drums. If damaged drums are found, they should be closely inspected for leaks. Leaky drums should be removed to a well-ventilated area and the contents transferred to other suitable containers.

For All Drums: Do not dump the contents of any drums into sewers, on the ground or into any body of water. All disposal methods pertain only to the product as shipped and must be in compliance with all federal, state/provincial and local laws and regulations. Waste characterizations and compliance with applicable laws are the sole responsibility of the waste generator.

For Unused and Contaminated Product: The preferred options include sending product to a licensed, permitted recycler, reclaimor, incinerator, or destroying it by some other thermal destruction device.

For containers carrying products with a high pH (>10), such as amine-initiated and Mannich-based polyols, which are not to be recycled: Do not reuse containers. Crush and dispose of empty containers in compliance with federal, state/provincial and local laws and regulations. Offer empty containers to licensed reconditioner for destruction, or crush and dispose of in compliance with all federal, state/provincial and local laws and regulations.

For containers carrying products with a low pH (<10): Offer empty container to licensed reconditioner for reuse, or crush and dispose of it in compliance with all federal, state/provincial and local laws and regulations.

Only trained and experienced personnel, wearing full protective equipment, should carry out these procedures.

1. All liquid should be drained from drums. Do not hammer, strike, weld, braze, solder, grind, or expose empty containers to heat, sparks, or flames because this could emit dangerous fumes.
2. Drums must be turned upside down and drained before disposal. Waste polyol should be disposed of in compliance with federal, state/provincial and local laws and regulations.
3. Except as stated above (i.e., polyols with a high pH), polyols are typically not considered hazardous materials; therefore, drip-dry drums can usually be reconditioned or landfilled at an approved waste facility.

Polyol Disposal

Containers, residues, drain and rinse fluids, and waste polyols should be disposed of in compliance with all federal, state/provincial and local laws and regulations (e.g., an approved incinerator). Landfill disposal of polyol is not recommended. Because of the chemical’s water solubility, landfill disposal could contaminate potable water resources and/or waterways. Waste polyol and waste isocyanate must be kept widely separated.
Part Two
Unloading and Storage Procedures

Unloading Procedures
Although not officially classified as a hazardous material under the U.S. Department of Transportation (DOT) Hazardous Materials Regulations, polyether polyols do pose a potential hazard to the health and safety of unloading personnel. Thus, tank trucks, tank cars and drums carrying polyether polyols should be unloaded in strict accordance with both the manufacturer’s recommendations and all established on-site safety procedures.

Unloading Steps and Precautions for Tank Trucks and Tank Cars

Tank Trucks

**CAUTION:** Only properly trained and equipped personnel should be permitted to unload tank trucks. Operators should wear appropriate eye and skin protection when handling polyols or engaged in cleanup procedures. (See “Toxicity, Handling Precautions and First Aid” and “Spill Containment and Cleanup,” pages 4-5).

VORANOL™ polyether polyols are shipped in stainless steel tank trucks, designed for bottom unloading only. Typically, the maximum net weight of these trucks may not exceed 40,000 to 50,000 pounds, depending on state/provincial over-the-road weight regulations. Only the following equipment should be used for unloading and must be provided on each dedicated common carrier:

- External heating panels to heat product in transit
- Hoses and fittings to meet requirements
- Pressure and temperature gauges
- Valves, vents and inlets

A 20 psig pad of dry inert gas, preferably nitrogen, is recommended to transfer the product from the tank truck into the receiving vessel. If process is not sensitive to moisture, compressor air is fine.

Alternatively, the product may be pumped from the tank truck with a commercial-quality centrifugal or positive displacement pump. However, care must be taken to prevent formation of a vacuum in the tank truck.

A dry gas regulator capable of providing 3 to 5 psig positive pressure at all times may be used. The size of the regulator should slightly exceed the volumetric capacity of the pump. To ensure that the tank truck is not damaged, a properly sized vacuum relief valve should be installed.

Unloading Steps and Precautions:

1. Position the trailer so there is a slight incline towards the trailer outlet and chock the wheels.

2. Carefully check the storage tank into which the contents of the truck are to be unloaded to be certain that it contains the intended polyether polyol and not some other chemical or compound. Also, check the gauge on the storage tank to be sure that there is sufficient room to receive the entire contents of the tank truck.

3. Check all product identification, bulk tags and security seals to be certain that the product being unloaded is the intended polyether polyol product and there has been no tampering with the load. These tags are usually attached to product outlets, valves with cable seals.

4. Check the temperature of the contents. To maintain product quality and specifications, the temperature of the product must be kept within the recommended range for shipping and storage:
   - 85°F - 150°F (29°C - 66°C) for diols and triols
   - 120°F - 190°F (49°C - 88°C) for sugar/glycerine and amine-initiated polyols
   - 120°F - 160°F (49°C - 71°C) for Mannich-based polyols

   These temperatures should be maintained at all times, even during transit. If, at the time of unloading, the temperature is found to be slightly below the recommended minimum level, turn on the trailer’s heating system and allow the water to circulate until the temperature of the contents reaches the recommended range. If the temperature of the contents has dropped well below the recommended level, especially for an extended period of time, be sure to notify your Dow representative.

   **CAUTION:** Carefully watch the thermometer during heating. Do not allow the temperature of the contents to rise above 140°F (60°C) for diols and triols, 180°F (82°C) for sucrose/glycerine and amine-initiated polyols or 150°F (66°C) for Mannich-based polyols.

5. Use only clean and dry lines, hoses and fittings for unloading. Discharge hoses should be made of either flexible metal, Teflon® fluorocarbon or Viton® fluoroelastomer, which can safely withstand unloading pressures. Ensure the trailers’ internal and external valves are in the closed position.
6. Place a bucket below the trailer connection and remove the cap or plug from the discharge connection and attach the unloading hose.

7. Check all receiving lines to be sure they are clean, dry and unobstructed. Also, be sure that all receiving valves are closed.

8. Attach the discharge hose to the appropriate receiving line.

9. If a sample is to be drawn, attach a set of fittings and stainless steel tubing to the sample connection. If necessary, apply dry nitrogen pressure of 3 to 5 psig (0.2 to 0.34 atm) to the tank truck. Open the sample valve and draw off approximately 1 to 5 gallons of product into a clean, dry container. Set this aside for proper disposal (see “Polyol Disposal,” page 5). Then draw off the sample to be analyzed into another clean, dry container. After the sample has been drawn, flush the fittings and line with nitrogen, then cap the fittings until next use.

**CAUTION:** Do not breathe vapors or mist. Wear protective clothing and equipment, including gloves, freshly laundered, waterproof clothing, eye protection and an approved respirator.

10. If on-site nitrogen is to be used, attach the line to the nitrogen inlet connection on top of the trailer. This line should be equipped with a pressure gauge, a safety valve set at 30 psig and a pressure regulator set at 25 psig. When the nitrogen line has been attached, pressurize the tank truck to 25 psig.

**CAUTION:** Carefully control the tank truck pressure by monitoring the gauge on the pressure/vacuum relief valve or the gauge next to the nitrogen inlet connection. Do not exceed 25 psig purge gas pressure to unload the tank.

11. Check the storage tank to be sure it has been adequately depressurized or vented to permit the free flow of incoming product. The vent on the storage tank should be equipped with a vent scrubber to prevent possible escape of vapor during unloading.

**CAUTION:** It is essential that the unloading operation be monitored continuously. Do not exceed 25 psig on the tank truck. In the event of compressor failure, on-site air or nitrogen may be introduced into the dry air system to effect discharge. A fitting is typically provided for this purpose. However, this procedure should be used only in the event of compressor failure. In an emergency, the product may be unloaded through the dip-tube connection located on top of the tank shell.

12. Open all valves on the receiving line to the storage tank, then open the discharge valves on the tank truck.

13. Continue discharging until the tank truck is empty. When emptied, the pressure gauge will show a drop in pressure, while the dry nitrogen/air will release through the storage tank vent. Also, the unloading hose will quiver slightly as the dry nitrogen air blows the line clear of most remaining material.

14. When unloading has been completed, close all receiving line valves, then close the discharge valves on the tank truck. First, close the inner valve on the tank truck, then close the outer valve. Keep the tractor/trailer purge gas system going until the tank truck has been repressurized to a minimum of 8 to 10 psig. Do not exceed the limit of the pressure safety valve on the tank truck.

15. Depressurize the discharge or transfer hose prior to disconnection. Vent the line through either the receiving tank vent system or the rear sample valve on the tank truck. Disconnect, clean and store the unloading line and cap or plug the discharge outlet.

**CAUTION:** Unloading must be closely monitored, particularly if there is no automatic cutoff in the unloading line. For example, if dry nitrogen/air is allowed to continue entering the tank after unloading has been completed, internal pressure in the tank could increase sharply, resulting in serious structural damage to the tank.

**CAUTION:** The customer should not clean the tank truck, nor should the manway be opened for inspection. The cleaning and inspection of the tank truck should be handled by the shipper under carefully controlled conditions designed to safeguard personnel and equipment. UNDER NO CIRCUMSTANCES SHOULD PERSONNEL ENTER ANY EMPTY TANK TRUCK.
Tank Cars

**CAUTION:** Only properly trained and equipped personnel should be permitted to unload tank cars.

VORANOL™ polyether polyols may be shipped in any one of several carbon steel tank cars of different size and capacity. However, all are pressurized (usually with 25 to 30 psig of nitrogen) and designed for either top or bottom unloading. In general, tank car capacities range from 23,000 gallons (185,000 net pounds) to 25,000 gallons (205,000 net pounds). They are insulated with either polyurethane foam or fiberglass and may be heated with hot or tempered water (a 50/50 glycol/water solution is preferred).

A 25 to 30 psig pad of dry inert gas, preferably nitrogen, is recommended to transfer the product from the tank car into the receiving vessel. The use of dry air is not recommended, as dry air may cause oxidation, which can darken the product. Alternatively, the product may be pumped from the tank car with a commercial-quality centrifugal or positive displacement pump. However, care must be taken to prevent formation of a vacuum in the tank car.

A dry gas regulator capable of providing 3 to 5 psig positive pressure at all times may be used. The size of the regulator should slightly exceed the volumetric capacity of the pump. To ensure that the tank car is not damaged, a properly sized vacuum relief valve should be installed.

**Unloading Steps and Precautions:**

1. Verify that the proper car is being unloaded and that the product it contains is the intended polyether polyol product. Check the car number, product identification tags and any commodity stenciling against the bill of lading or other appropriate document. It is recommended that a sample of the contents be taken to make absolutely certain that the product is the intended polyether polyol product (see Step 13). Product identification tags are usually attached to the seals on the unloading connections or latch pins.

2. Check the storage tank into which the contents of the car are to be unloaded to be certain that it contains the intended polyether polyol product and not some other chemical or compound. Check the gauge on the storage tank to be sure that there is sufficient room to receive the entire contents of the tank car.

3. Climb the ladder to the platform area on top of the car. (Note: Each unloading apparatus on Dow tank cars is located under sealed insulated bonnets or covers on both the top and bottom of the car). Remove the seals from the latch pins and open the bonnets. When the covers are open, check to see that all valves are in the closed position.

4. Check the temperature of the contents by removing the cap from the thermo-well and inserting a thermometer. To maintain product quality and specifications, the temperature of the product must be kept within the recommended range for shipping and storing:
   a. 85°F - 150°F (29°C - 66°C) for diols and triols
   b. 120°F - 190°F (49°C - 88°C) for sugar/glycerin and amine-initiated polyols
   c. 120°F - 160°F (49°C - 71°C) for Mannich-based polyols.

   These temperatures should be maintained at all times, even during transit. If, at the time of unloading, the temperature is found to be slightly below the recommended minimum level, circulate hot or tempered water (a 50/50 glycol/water solution is preferred) through the tank car heating coils until the temperature of the contents reaches the recommended range. If the temperature of the contents has dropped well below the recommended minimum level, especially for an extended period of time, be sure to notify your Dow representative.

5. If the temperature of the contents is found to be higher than the recommended maximum level, turn on the tank car’s water cooling system, if available, and allow the water to circulate until the temperature of the contents reaches the recommended range.
7. Use only clean and dry lines, hoses and fittings for unloading. Discharge lines should be made of flexible metal, Teflon® fluorocarbon or Viton® fluoroelastomer, which can safely withstand unloading pressures. 

8. Check the valve handle on the bottom outlet connection to be sure it is in the closed/locked position. Typically, tank cars transporting polyether polyols are equipped with a Jamesbury Wafer-Sphere or other butterfly-style valve.

9. Slowly remove the plug from the valve flange. The area between the plug and flange should be dry and free of product. If the product has leaked during transit, there may be a small amount of material in this area. This should be taken up and placed in a container for disposal. (See “Polyol Disposal,” page 5).

10. After the plug is removed, connect the discharge assembly (i.e., hose, piping) to the discharge valve. Be sure the discharge assembly is clean and dry.

11. Attach the unloading line to the discharge assembly.

12. Remove the nitrogen inlet valve plug using a backup wrench or pair of wrenches (one to hold the assembly and one to loosen and remove the plug). Attach a pressure application assembly to the nitrogen inlet valve. Next, attach the on-site dry nitrogen/air (i.e., -40°F [-40°C] dew point) line to the assembly. The dry nitrogen/air line should be equipped with a pressure gauge, a safety valve set at 30 psig and a pressure regulator set at 25 psig. When the nitrogen line has been attached, open the valve and pressurize the tank car.

13. If a sample is to be drawn, check to be sure that the car has a minimum pressure of 5 psig (0.34 atm). (If necessary, apply dry nitrogen/air pressure). Attached a fitting with a sample port to the bottom of the car. Slowly open the sample valve and flush approximately 1 to 5 gallons of product to clear the “sample leg.” This material should be collected in a clean, dry container and set aside for proper disposal. (See “Polyol Disposal,” page 5). Next, draw off the sample to be analyzed into another clean, dry container. Flush the sample container with dry nitrogen/air before closing. Samples may also be obtained from the bottom charge valve by installing a sampling device in the discharge hose/piping assembly. After the sample has been drawn, close the sample valve, remove the sampling device, reinstall the plug and flush the line and fittings with dry nitrogen/air. Finally, cap and store the fittings until next use.

14. Check the storage tank to be sure it has been adequately depressurized or vented to permit the free flow of incoming product. The vent on the storage tank should be equipped with a vent scrubber to prevent the possible escape of vapor during unloading. Storage tank pressure should be carefully monitored during unloading.

15. Release the valve handle locking mechanism on the discharge valve, then open the discharge valve itself (1/4 turn is “full open”). Open the valves on the receiving line and storage tank.

16. Continue discharging until the tank car is empty. When emptied, the pressure gauge will show a drop in pressure, and dry nitrogen will release through the storage tank vent. Also, the unloading hose will quiver slightly as the dry nitrogen blows the line clear of most remaining material.

17. When unloading has been completed, close the discharge valve on the tank car. Be sure the locking mechanism is in the locked position. Close the receiving line valves. Keep the purge gas on until the tank car has been represurized to a minimum of 10 psig. Do not exceed the limit of the pressure safety valve on the tank car or 50 psig, whichever is less.

18. Depressurize the transfer hose prior to disconnection. After removal, clean and store the hose and cap, or plug the discharge outlet. Finally, close the nitrogen inlet valve, depressurize the dry nitrogen hose, remove the pressure application assembly and reinstall the plug in the nitrogen inlet valve.
Top Unloading
If necessary, polyether polyol tank cars may be top unloaded through the 2-inch or 3-inch ball valve on top of the car. Procedures for top unloading are essentially the same as for bottom unloading with one exception: The top discharge valve has no locking mechanism.

Preparation for Return
All fittings and plugs must be wrench tight and all securement pins must be affixed to their respective device. If the manway was opened during the unloading process, it must be closed and all securement bolts must be wrench tight.

Unloading Steps and Precautions for Drums
Only properly trained and equipped personnel should be permitted to unload drums. Before unloading, operators should be thoroughly familiar with the potential hazards associated with the handling and storage of polyether polyols, and should request and read the appropriate SDS.

1. Conventional stainless steel drum pumps may be used to unload drums.
2. Equip the drum vent with a dry air or dry nitrogen breather to prevent collapse of the drum during unloading. This attachment will also prevent moisture contamination of the contents.
3. When not in use, pump lines should be protected from moisture by fitting a plug or cap into the open end.
4. Portable pumps, lines and fittings should be carefully rinsed, dried and stored in a dry location.

Bulk Storage
A properly designed bulk storage system for VORANOL polyether polyols must be designed to accomplish at least the following:
- Permit safe handling of the material
- Provide temperature control
- Prevent contamination of the product
- Minimize the hazards of combustibility

An integral factor in the success of any bulk storage system is the establishment of safe work procedures. Before considering any storage system, the designer must be thoroughly familiar with hazards and necessary precautions for handling the materials to be stored.

A practical design includes not only the physical equipment layout, but also a plan for personnel safety in all areas of the operation. In addition, designers must consider all applicable insurance requirements, as well as governmental codes and regulations. All appropriate state and local agencies should be consulted during each stage of planning and construction.

General Guidelines
- All equipment and facilities, as well as their installation, should conform to the specifications and requirements of appropriate federal, state/provincial and local codes and ordinances.
- All equipment and materials should be compatible with the product to be handled and should be installed in strict compliance with manufacturer recommendations.
- All systems should be bonded and grounded. Bonding and grounding cables should be available at all loading and unloading stations.
- All electrical equipment, such as motors and switches, as well as their installation and use, should conform to codes established by Underwriters Laboratories (UL).
- Waste control, disposal and air emission control measures should be carefully considered. Proper systems and operational controls should be instituted and carefully maintained.
- Utilities, including air, water, steam, electric power and means of waste disposal, should be provided for both system operation and cleaning.
- All liquid bulk storage systems should be hydrostatically tested prior to lining, insulation or use.

Drum and Bulk Storage of VORANOL™ Polyether Polyols

Drum Storage
Whenever possible, drums containing VORANOL polyether polyols should be stored indoors. The temperature in storage areas should be kept above 68°F (20°C). If drums are received frozen, be sure the contents are completely thawed and mixed before using.

Thawing may be accomplished by allowing the drums to sit in a warm storage area or by using a drum heater. During warm weather, drums may be stored outdoors. However, drums should be stored in such a manner as to prevent water from collecting on the drum tops. This may be accomplished by covering the drums with a tarpaulin or by stacking them on their sides.
Bulk Storage Equipment
The equipment described below is suitable for use in bulk storage systems for VORANOL™ polyether polyols. However, these are merely components of typical systems and must not be considered as a finished design. Other equipment similar to the items listed can be tested for performance and may give equally good results.

Drains
All equipment should be provided with drains and should be designed to drain completely. Piping should slope toward low points equipped with drains.

Tank areas should be diked. However, there should be no open drains within the diked areas.

Dual-Service Equipment
Equipment to be used for two or more products must be designed so that it can be drained and blown dry between products. Manifolds should not be used. Instead, switchhose and quick-coupler connections should be made between dual-service equipment and individual product lines.

Electrical
Explosion-proof wiring and equipment should be used in all areas where flammable vapors or dusts are likely to be present. Electrical equipment should be grounded, and electrical work must conform to all applicable codes and ordinances. When ordering electrically operated equipment, specify the type of electrical service available.

Filters
Filters should be equipped with elements that are suitable for the product and desired flow rate. Twenty-micron, cotton-wound elements with voile-covered steel mesh core are recommended.

Foundation
Depending on loading and soil conditions, reinforced concrete pads, concrete rings, reinforced concrete piers or crushed stone rings may be used. If soil conditions are unknown, soil testing is advisable. Vertical tank bottoms should be coated and, if outdoors, should be sealed to the foundation with asphalt. If ring foundations are used, centers should be filled with compacted, oiled sand.

Gaskets
Non-graphited gaskets impregnated with Teflon® fluorocarbon or braided Teflon® fluorocarbon may be used. Envelope-type gaskets made of Teflon fluorocarbon are also considered suitable.

Heat Exchanger
Heat exchangers should have an area of 2 to 3 square feet per gallon per minute. A Struthers Wells or comparable exchanger is considered acceptable.

This recommendation applies for straight polyols only, as amines in some polyol formulations may solubilize the copper or brass exchanger tubes.

Heating
In general, VORANOL polyether polyols should be maintained at the following temperatures:
- 85°F - 150°F (29°C - 66°C) for diols and triols
- 120°F - 190°F (49°C - 88°C) for sugar/glycerin and amine-initiated polyols
- 120°F - 160°F (49°C - 71°C) for Mannich-based polyols

Refer to the SDS for each product for specific maintenance temperatures. Storage temperatures may vary within these ranges. Since polyols are viscous, handling is easier at higher temperatures.

To heat uninsulated indoor tanks, an industrial space heater may be adequate. For exposed tanks, it is recommended that hot or tempered water (a 50/50 glycol/water solution is preferred) be circulated through an exchanger. The water may be heated with steam or by a large industrial water heater. (A Crane CS-100-270 or comparable heater is suggested). Pipelines may also require insulation, heat tracing or both to maintain recommended product temperatures.

Hoses
Hoses for permanent, continuous service with polyols should be made of flexible seamless metal (bronze, steel or stainless steel) or Viton® fluoroelastomer.

Level Indicators
A tank-top-mounted level indicator should be used to measure the product level in the tank and to determine inventory.

Meters
Suitably sized meters should be used and should contain no synthetics other than Teflon® fluorocarbon and Viton® fluoroelastomer.

Pad Gas
For pad gas, dry nitrogen is preferred. However, oil-free air supplied by an air compressor and dryer is acceptable, but discoloration may occur. Either gas should have a maximum dew point of -40°F (-40°C).

Paint
All steel equipment used outdoors should be carefully cleaned and coated with a suitable primer.
**Piping**
Schedule 40 seamless carbon steel pipe (A53) and welded pipe joints with flanges and flanged valves are preferred. Threaded couplings and valves may be used if tape made of Teflon® fluorocarbon is used on all threaded fittings. Tape must be applied carefully. No pipe dopes may be used.

Line sizes should be determined by product flow rate, system design and pump specifications. Normally, 3-inch diameter line is satisfactory. For short, simple systems, 2-inch line may be more suitable. For longer, more complex systems, 4-inch line may be required. Line sizes should be established in conjunction with the pump supplier, keeping the diameter to the practical minimum.

Pipeline insulation and heating or cooling may be required if lines are outdoors or in an area where normal room temperatures are not maintained.

**Pressure Control Valves**
Pressure in the polyol tank should be regulated by a Fisher S-201, or type 912-3-106, or comparable PCVs.

**Pressure Gauges**
Gauges should be provided at the pump, before and after filters, and near the process. A sealed diaphragm filled with a nonhydrocarbon fluid should protect them. Gauges are also advisable on steam and air lines and on equipment where gases or liquids are handled (e.g., at chillers or heat exchangers).

**Pumps**
Pumps should be steel or stainless steel. Steel pumps should have stainless steel shafts and sleeves. All should have mechanical seals and should be complete with base, coupler, coupling guard and drive motor.

Positive displacement pumps are preferred for viscous materials. If used, they normally require a gear reducer to achieve the proper pump speed. Centrifugal pumps are satisfactory for less viscous materials. The type of pump required depends on the product viscosity at desired pumping temperatures, and on system design.

Depending on desired flow rates, two pumps may be desirable for each system.

Truck unloading pumps should have a capacity of 100 to 150 gpm. If lower rates are desired for process pumps, a second, suitably sized pump should be used.

**Relief Valves**
Storage tanks containing VORANOL™ polyether polyols should be equipped with the following valves:

- **Pressure-vacuum (P-V) vents for tanks**: Necessary for each storage tank; relieve or terminate outdoors.
- **Relief valves for positive displacement pumps**: Each positive displacement pump should be equipped with a relief system set at a maximum of 125 psig, provided that all parts and equipment are rated for a working pressure of 150 psig. If not, the relief should be set at 75 percent to 90 percent of the system’s lowest maximum working pressure.
- **Line relief valves**: Each line section that can be closed off by valves while full of liquid should have a relief valve that relieves toward the tank. A small orifice bypass to the tank can be used as an alternative, with the final section relieving into the tank. Settings for these reliefs should be the same as those for pumps.

Each storage tank must be provided with a pressure-vacuum vent valve that, to prevent accumulation of vapors, should relieve or terminate outdoors.

**Sample Valves**
1-1/4-inch sample valves that terminate in a stainless steel nipple should be provided in each bulk storage system.

**Strainers**
Steel-cased, dual-line strainers with 100-mesh stainless-steel reinforced wire-screen baskets are recommended.

Units should also be equipped with control valves that permit one side to continue in operation while the other is being serviced. All unloading or process lines should be equipped with strainers.

**Tank Insulation**
Storage tanks located outdoors, where they may be exposed to temperature extremes, can be insulated with a 1- to 1 1/2-inch thickness of sprayed polyurethane foam or a 2-inch thickness of fibrous glass. An effective weather cover, such as corrugated aluminum, should shelter outdoor tanks.

Tanks located indoors, where normal room temperatures are maintained, require no insulation. If rooms for interior storage tanks have been insulated with plastic foam, the insulation should be covered with an effective flame barrier as recommended by the foam manufacturer.

Insulation should be completed prior to any lining to prevent lining damage. If this is not practical, any welding on the tank required for insulation must be completed prior to lining.
**Tank Linings**

Tank linings are desirable to prevent the pickup of rust or iron, which can cause product discoloration. If a lining is to be used, surface preparation and lining application methods are of prime importance and should be in strict accordance with the lining manufacturer’s recommendations. Only experienced lining applicators, licensed or approved by the lining manufacturer, should be considered for application work.

Surfaces should be prepared and coated within an eight-hour period while proper temperature and humidity controls are maintained. In no case, however, should lining be applied on a surface once any evidence of rust has been detected. If linings are applied in the shop, extra care is required during transportation and erection of the tank to prevent lining damage. If any damage does occur, it should be properly repaired prior to using the tank.

Inorganic zinc linings, such as CarboZinc 11® or Dimetcote 4®, or epoxy barrier linings such as Phenoline 373® or Phenguard® are considered suitable in storage tanks for VORANOL™ polyether polyols.

**Tanks**

Tanks should be sized to meet plant and user needs. Minimal capacity equivalent to 150 percent of normal monthly bulk receipt is suggested.

Tanks should be welded, vertical or horizontal cylindrical units made of carbon steel (A283C steel) and built to API 650 Code. They should be designed and constructed to hold the specified product safely even when filled to absolute capacity.

Tanks should be equipped with the following openings:

- One 20-inch roof manway (optional)
- One 20-inch shell manway 12 inches above the floor
- One 3- or 4-inch roof nozzle for the vent
- Three 1-1/2-inch roof nozzles for the gauge
- One 2-inch shell nozzle near floor leading to a dished sump for the drain
- Two 3- to 4-inch shell nozzles, 12 inches above floor for inlet and outlet; inlet and outlet 90 degrees apart; inlet may be at the top of the tank
- One 1-inch, 3,000-pound threaded coupling in the shell, 35 inches above the floor for thermometer well

In the design of tanks to be lined, minimal radii recommended by the lining manufacturer must be observed. Full fillet interior welds should be utilized, and all splatter must be ground smooth. Welds must be continuous and should have no undercuts or porosity. The tank manufacturer should be responsible for providing proper radii and welds and for removing all splatter. The lining contractor should be responsible for other surface preparation.

Tanks should be water tested to design pressure and then dried, brush sandblasted inside, and cleaned. A silica gel charge should be placed inside the tank prior to sealing for shipment. Exterior scale should be removed and the exterior primed with one coat of red lead primer. Silica gel charges in tanks must be removed, and the system must be thoroughly cleaned, dried and purged with dry pad gas prior to use.

All tanks should be equipped with a stripping connection so the tank can be completely emptied for cleaning, inspection or repair.

**Temperature Indicators**

Product temperatures may be accurately monitored with a dial-type thermometer inserted into a suitable thermometer well.

**Valves**

Cast steel, malleable iron or 316 stainless steel 150 psig valves are considered suitable for tank nozzles. Steel, malleable iron, or iron 125 to 150 psig valves may also be used on lines. Gate, ball or plug valves may be used, provided no internal lubrication is required. Valve packing, if required, should be a non-graphited material impregnated with Teflon® fluorocarbon or braided Teflon® fluorocarbon. Also, ball valves should have seats of Teflon® fluorocarbon.

**Ventilation**

Indoor storage systems should be housed in a separate room equipped with exhaust fans and suitable intakes.
Part Three
Dow and Product Stewardship

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. Our product stewardship program rests with each and every individual involved with Dow products – from the initial concept and research to the manufacture, use, sale and disposal of each product.

While you are responsible for safety procedures in your company, we can assist you with questions and concerns. Dow Environmental, Health and Safety (EH&S) specialists can provide a variety of product stewardship services and advice to Dow customers.

Waste Handling
Dow can provide names of information resources to help you identify waste management companies.

Safety Training
Dow can arrange safety training programs to review proper handling and storage procedures in easy-to-understand terms. We can also conduct safety audits to check the effectiveness of your equipment and handling procedures.

Regulatory Issues
Dow can help you stay on top of changing regulations. Our involvement in government affairs and industry associations helps us constantly monitor new and upcoming regulations.

Dow can direct you to this information through seminars and company visits, during which we’ll also answer specific questions about local, state/provincial and federal regulatory activities.

For Additional Information
For additional information, contact your Dow representative or the Dow Customer Information Center in your area:

United States and Canada: 1-800-441-4DOW (4369)
Mexico: 958-00-441-4DOW (4369)

Or visit our website at www.dowpolyurethanes.com.
Index

Air emission control: ................................................. 10
Amine-initiated: ....................................................... 3, 4, 5, 6, 8, 11
Bill of lading: ......................................................... 8
Bottom unloading: .................................................. 6, 8, 10
Bulk: ................................................................. 3, 6, 9, 10, 11, 12, 13
Bulk storage: ....................................................... 9, 10, 11, 12
Car number: ......................................................... 8
Caution signs: ......................................................... 8
Combustibility: ....................................................... 10
Commodity stenciling: ........................................... 8
Contaminated product: .......................................... 5
Cooling: ............................................................... 8, 12
Customer Information center: .................................. 3, 4, 14
Decontamination: .................................................. 5
Diols: ................................................................. 3, 6, 8, 11
Discharge hose: .................................................... 6, 7, 9
Drum decontamination and disposal: ...................... 5
Drum storage: ....................................................... 10
Electrical: ............................................................ 10, 11
Explosion: ........................................................... 5, 11
External heating panels: ........................................ 6
Eye protection: ..................................................... 4, 5, 7
Filters: ............................................................... 11, 12
First aid: ............................................................. 4, 6
Fittings: .............................................................. 9, 10, 12
Formulations: ...................................................... 3, 11
Frozen: ............................................................... 10
Gaskets: ............................................................. 11
Hazardous/heated: ................................................. 4, 5, 6, 8, 9, 11, 12
Heating coils: ...................................................... 8
High pH: ............................................................. 5
Leak: ................................................................. 5, 9
Level indicators: ................................................... 11
Max. net weight: .................................................. 6
Nitrogen: ............................................................ 6, 7, 8, 9, 10, 11
OSHA: ............................................................... 4
Pad gas: ............................................................. 11, 13
Paint: ................................................................. 11
Pressure control valves: ........................................ 12
Pressure gauges: ................................................... 12
Product identification tags: .................................... 8
Product quality: .................................................... 6, 8
Product stewardship: ............................................ 14
Pump: ............................................................... 5, 6, 8, 10, 12
Reactive chemicals: ............................................. 4
Receiving vessel: .................................................. 6, 8
Reconditioner: ..................................................... 5
Regulation: .......................................................... 5, 6, 10, 14
Regulatory issues: .................................................. 14
Relief valves: ........................................................ 12
Safe handling: ..................................................... 4, 10
Safety: ............................................................... 3, 4, 6, 7, 9, 10, 14
Safety training: .................................................... 14
Signs: ................................................................. 8
Skin protection: .................................................... 4, 6
Specifications: ..................................................... 6, 8, 10
Spill containment and cleanup: .............................. 5, 6, 9
Stack: ............................................................... 10
Storage: ............................................................. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
Strainers: ............................................................ 12
Tank car: ............................................................ 3, 5, 6, 8, 9, 10
Tank insulation: ................................................... 12
Tank truck: .......................................................... 3, 5, 6, 7
Tanks: ............................................................... 5, 11, 12, 13
Temperature gauges: ............................................ 6
Temperature indicators: ....................................... 13
Thawing: ............................................................ 10
Top unloading: ..................................................... 10
Toxicity: ............................................................. 6
Triols: ............................................................... 6, 8, 11
Unload: .............................................................. 6, 7, 8, 9, 10, 12
Valves: .............................................................. 6, 7, 8, 9, 12, 13
Vapor pressure: ................................................... 4, 7, 8, 9, 11, 12
Vent scrubber: ..................................................... 7, 9
Ventilation: ........................................................ 13
Vents: ............................................................... 6, 12
Weight regulations: .............................................. 6
Workplace Hazardous Materials: ........................... 4
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