VORANATE™ T-80
Toluene Diisocyanates

Safe Handling & Storage Guide
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VORANATE™ T-80 TDI Products

VORANATE™ T-80 TDI products are designed for use in a variety of flexible slabstock applications, molding applications and formulated systems applications. Flexible polyurethane foam made from these TDI products are used for furniture, bedding, and automotive seating and padding. VORANATE™ T-80 TDI products are also used in the production of elastomers, coatings, adhesives, semi-flexible foams, and carpet underlay and backing. This guide describes safe handling practices, procedures and potential hazards associated with handling and storing these TDI products.

What is TDI?

TDI is the standard abbreviation for toluene diisocyanate. VORANATE™ T-80 Type I and Type II TDI are part of the family of quality aromatic isocyanates available from Dow. Both Type I and Type II are a mixture of 2,4- and 2,6-isomers of TDI in a ratio, by weight, of 80 percent and 20 percent, respectively. Type I is a low-acidity grade while Type II is a high-acidity grade. See Table 1, Table 2 and Figure 1 on pages 5-7 for typical physical properties, specifications and densities.

Summary of Safe Handling Information for TDI Products

Pure, high-quality TDI products from Dow are shipped in specially designed tank trucks and tank cars. Bulk TDI shipments are regulated by transportation regulations globally such as the United States Department of Transportation (DOT) and the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). Personnel who handle or store bulk product must be trained and must comply with global applicable regulations.

CAUTION: TDI products are potentially hazardous materials that must be shipped, handled and stored with care, consistent with the safety recommendations and precautions outlined on the product labels and described in the Safety Data Sheets (SDSs) as well as in this guide.

The recommendations given in this guide are based on the results of numerous tests as well as practical, in-the-field experience, and are believed to be accurate and reliable. However, as the specific circumstances associated with a customer’s use of TDI are unknown to Dow and are beyond its control, Dow cannot guarantee that adhering to these recommendations will ensure absolute safety. To request SDSs, or to find out more about specific operations and procedures relating to safe handling, shipping, unloading, storage, use or disposal, contact the Dow Customer Information Group (CIG) using the appropriate regional contact information provided on page 52.
# Part One – Properties and Specifications, Handling Precautions, Health Effects and First Aid

## Table 1: Typical Physical Properties of TDI

<table>
<thead>
<tr>
<th>Properties¹</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Weight</td>
<td>174.2</td>
</tr>
<tr>
<td>Physical Form</td>
<td>Colorless to pale yellow liquid</td>
</tr>
<tr>
<td>Odor</td>
<td>Very sharp and pungent</td>
</tr>
<tr>
<td>Density (@ 20°C)</td>
<td>10.2 lb/gal</td>
</tr>
<tr>
<td></td>
<td>1222.25 kg/m³</td>
</tr>
<tr>
<td>Specific Gravity (25°C/77°F)</td>
<td>1.22</td>
</tr>
<tr>
<td>Boiling Point</td>
<td></td>
</tr>
<tr>
<td>@ 10 mm Hg</td>
<td>120°C (248°F)</td>
</tr>
<tr>
<td>@ 760 mm Hg</td>
<td>250°C (482°F)</td>
</tr>
<tr>
<td>Viscosity @ 25°C (77°F)</td>
<td>2.5/3</td>
</tr>
<tr>
<td>cSt/mPa.s</td>
<td></td>
</tr>
<tr>
<td>Freezing Point</td>
<td>14°C (57°F)</td>
</tr>
<tr>
<td>Flash Point</td>
<td></td>
</tr>
<tr>
<td>Cleveland Open Cup</td>
<td>132°C (270°F)</td>
</tr>
<tr>
<td>Pensky-Martens Closed Cup</td>
<td>126°C (259°F)</td>
</tr>
<tr>
<td>Tag Open Cup</td>
<td>132°C (270°F)</td>
</tr>
<tr>
<td>Refractive Index (25°C)</td>
<td>1.5662</td>
</tr>
<tr>
<td>Specific Heat, Btu/lb, °F</td>
<td></td>
</tr>
<tr>
<td>@ 68°F</td>
<td>0.35</td>
</tr>
<tr>
<td>@ 212°F</td>
<td>0.41</td>
</tr>
<tr>
<td>Specific Heat, cal/g, °C</td>
<td></td>
</tr>
<tr>
<td>@ 20°C</td>
<td>0.35</td>
</tr>
<tr>
<td>@ 100°C</td>
<td>0.41</td>
</tr>
</tbody>
</table>
Table 1 – Continued

<table>
<thead>
<tr>
<th>Thermal Conductivity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>@ 50°C</td>
<td>0.068 Btu/hr•ft²•°F</td>
</tr>
<tr>
<td>@ 100°C</td>
<td>0.063 Btu/hr•ft²•°F</td>
</tr>
</tbody>
</table>

Heat of Evaporation

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Btu/lb</th>
<th>cal/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ 121°C (250°F)</td>
<td>131</td>
<td>73</td>
</tr>
<tr>
<td>@ 197°C (355°F)</td>
<td>121</td>
<td>67</td>
</tr>
</tbody>
</table>

Decomposition Temperature

<table>
<thead>
<tr>
<th>Temperature</th>
<th>287°C (530°F)</th>
</tr>
</thead>
</table>

Vapor Density (air = 1)

<table>
<thead>
<tr>
<th>Density</th>
<th>6.0</th>
</tr>
</thead>
</table>

Vapor Pressure mm Hg (20°C)

<table>
<thead>
<tr>
<th>Pressure</th>
<th>0.01</th>
</tr>
</thead>
</table>

1 Typical properties, not to be construed as specifications.

Table 2: Specifications\(^1\) for VORANATE™ T-80 TDI

<table>
<thead>
<tr>
<th>Properties(^2)</th>
<th>Type I Low-Acidity Grade</th>
<th>Type II High-Acidity Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assay (wt % TDI) min.</td>
<td>99.5</td>
<td>99.5</td>
</tr>
<tr>
<td>Acidity (wt % HCl) max.</td>
<td>0.0040</td>
<td>0.0120</td>
</tr>
<tr>
<td>Hydrolyzable Chloride (wt %) max.</td>
<td>0.0070</td>
<td>0.0150</td>
</tr>
<tr>
<td>Total Chloride (wt %) max.</td>
<td>0.06</td>
<td>0.07</td>
</tr>
<tr>
<td>Color (APHA) max.</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Isomer Content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% 2,4-Isomer</td>
<td>79-81</td>
<td>79-81</td>
</tr>
<tr>
<td>% 2,6-Isomer</td>
<td>19-21</td>
<td>19-21</td>
</tr>
</tbody>
</table>

1 Specifications are subject to change.

2 Refer to ASTM International D 1786
Handling Precautions

All personnel should consult the appropriate regional SDS and understand the safety precautions in this guide before using any TDI product.

To protect product quality and minimize the hazards associated with their use, follow the recommended guidelines listed below.

- Only knowledgeable and experienced personnel should handle and store TDI products.
- Avoid exposing TDI to strong bases or to active hydrogen-containing compounds, such as water, ammonia, amines and alcohols. Exposure to these materials could result in violent rupture of restricted lines or closed vessels due to the liberation of heat and/or the generation of carbon dioxide gas.
- Take care to prevent TDI spills and protect from flame and heat generated in operations such as welding. These conditions can lead to the release of potentially harmful concentrations of isocyanate vapors and harmful decomposition/combustion byproducts.
Moisture Control

The most common, hazardous contaminant of any TDI product is water. At room temperature, water reacts readily with isocyanate to form both an insoluble urea compound and large quantities of carbon dioxide gas. This insoluble urea derivative deposits on the surfaces of the equipment in which it is formed. This could lead to significant cleaning costs as techniques like hydro blasting may become necessary. If not addressed on time, it is likely that deposits could flake off resulting in further contamination during loading/unloading operations.

Lines, orifices, pressure relief valves, safety valves, filtration units and instrumentation can become plugged thus closing or restricting the vessel, and the liberated carbon dioxide gas can create a serious pressure hazard. In short, water or moisture can produce sufficient carbon dioxide gas to rupture the container.

Even relatively small amounts of water can cause significant problems. For example, at standard temperature and pressure, as little as one fluid ounce (30 ml) of water can release as much as 1.5 cubic feet (40 liters) of carbon dioxide.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- Avoid contact of this product with water during handling and storage.

- To protect TDI from atmospheric moisture, blanket all containers with a dry (\(-40^\circ\text{C} [-40^\circ\text{F}]\) dew point), inert gas pad. Dry air with the same dew point also may be used. However, nitrogen is the recommended dry, inert pad or purge gas for TDI, if discoloration is a concern in the intended application (subsequent manual references to dry gas padding should also be considered with this caveat regarding discoloration).

- If TDI has been, or is suspected of having been, contaminated with water, do not tightly close vessels containing these products. If contamination is suspected, see “Spills and Leaks – Containment and Cleanup,” pages 14-18 or “Pressurized Drums,” page 19, for more information. After opening containers for sampling, inspection or partial withdrawal, re-blanket them with a pad of dry nitrogen or dry air.

- Additional vessel nozzles in gas phase should be opened and padded with dry air to prevent moisture contamination. If employing nitrogen to prevent moisture contamination, it is very critical to ensure that there will be not a suffocation risk. The air/nitrogen/fumes should be guided to a safe place. The best is to place it under a roof outside of building.
• Thoroughly clean and dry equipment and containers, then purge with dry, inert gas. The purge gas, in addition to being moisture-free, must also be free of oil and rust. Filter traps should be installed in the gas lines to remove these and other contaminants.

• It is important to note that when hydraulic pressure maintenance tests are conducted on TDI containers, water is used as an agent. It is important to ensure that no moisture is retained in the container following these tests.

• Inspect directly. In cold climate water may stay in valves in the form of ice and not be picked up by humidity measurement devices. Direct checks by operators and manual removal of water/ice is important.

• For small installations, manifold cylinders of dry nitrogen arranged into banks may be adequate. However, larger installations may call for a nitrogen generator or a tie-in to existing plant inert gas systems. It is very critical to ensure that there will be not a suffocation risk when nitrogen is used as mentioned above.

• If plant air must be used, purification equipment such as oil traps, a bauxite absorber (to keep oil out of the drying beds) and an air dryer should be installed between the compressor and the isocyanate system. When using a desiccant-type air dryer in conjunction with an air compressor, lower the temperature of the air before entry into the air dryer. Compression of air will increase its relative humidity. Hot air may purge the moisture from the desiccant and force it through to the product. An entrainment separator ("knock-out pot") should be added between the cooler and the air dryer. Also, a final filter and a back-pressure regulator should be fitted directly in front of the isocyanate system. Stainless steel pipe or tubing should be used between the filter and the system.

• Instruments for detecting the failure of the drying equipment for the purge gas are strongly suggested when large quantities of isocyanate are handled and stored. Several different moisture-detecting instruments are commercially available.

• When lines leading to and from the storage tanks are not in use, they should be tightly capped to prevent moisture from coming in contact with residual product in the lines. This will also prevent problems that may occur if small insects/animals get entrapped in the system.

• Containers may also have residual water when they are new or when they have been subject to testing. It is important to ensure that the containers are thoroughly dried before product transfer occurs.
Temperature Control

TDI should be stored at temperatures between 18°C (65°F) and 40°C (104°F). TDI can freeze around 14°C (57°F). If this happens, re-melting and re-mixing may be necessary (see following paragraphs for more details). Prolonged storage of TDI at higher temperatures may cause the NCO content and viscosity to vary from product specifications.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- All outside transfer lines, storage tanks, tank trucks and tank cars should be insulated and equipped for even and uniform heating. Electrical heat tracing is an efficient solution in cold areas. Storage temperatures can be maintained by equipping storage tanks with either a heat exchanger installed in the storage tank recycle line or an external plate coil mounted on the outside of the tank.

CAUTION: Heat exchangers installed in the recycle line increase the risk of product contamination from exchanger tube leaks. If the heat exchange fluid contains water, care should be taken to avoid contamination of the isocyanate.

- Before using TDI that has been stored for a lengthy period of time, warm, mix thoroughly and inspect TDI to be sure that no solids are present.

CAUTION: Do not breathe vapor. Vapor is extremely irritating if inhaled. See current SDS for more information.

- If TDI freezes (freeze point is approximately 14°C [57°F]), the 2,4- and 2,6-isomers may separate. Since the 2,4-isomer melts at a higher temperature than the 2,6-isomer, the supernatant liquid in contact with the crystals will have a higher 2,6-isomer content than the completely liquid product. Also, since the 2,6-isomer reacts more slowly with compounds having an active hydrogen than does the 2,4-isomer, the supernatant liquid will have a slower reaction rate than the materials as a whole. This could cause serious processing difficulties.
• If TDI does freeze, it should be warmed to a maximum temperature of 40°C (104°F) and thoroughly mixed. Any handling of TDI should be done with proper personal protective equipment. Do not heat TDI above 40°C (104°F) as discoloration and dimerization may occur. Also, at temperatures above 100°C to 120°C (212°F to 248°F), TDI will trimerize in an exothermic reaction to form isocyanurates. This reaction may furnish enough heat to increase product temperature to 175°C (347°F), which can cause carbodiimides formation and subsequent formation of carbon dioxide gas. In a closed or restricted vessel, this could lead to an explosive rupture.

Contamination by Strong Bases
The presence of strong bases – even in small amounts – can cause any isocyanate to react to form isocyanurates and carbodiimides. The carbodiimide formation is accompanied by the generation of carbon dioxide, which may present a pressure hazard.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

• Avoid any contact between isocyanate and strong bases, such as sodium, potassium hydroxide or alkoxides. Such compounds catalyze the rapid formation of isocyanurates and carbodiimides. Normally, the trimerization reaction occurs first, furnishing heat to cause the carbodiimide reaction to occur. This second reaction generates carbon dioxide and forms a hard solid or foam, which can only be removed from the vessel or line by mechanical means.

WARNING: The liberation of carbon dioxide in a tightly closed or restricted vessel may result in a violent rupture. Consider the use of pressure rupture discs which will afford more protection than pressure sensitive valves as they are less prone to fouling. Note that pressure relief devices may be plugged by reacted isocyanate/urea formation.

• One source of contamination by strong bases is industrial cleaners or cleaning agents. Do not use sodium or potassium hydroxide or other strong bases in the cleaning of lines or vessels.
Contamination by Amines and Other Active Hydrogen-Containing Compounds

The primary dangers of contamination by amines and other active hydrogen-containing compounds are product contamination and heat generation.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- Avoid contamination of TDI by such compounds as alcohols, glycols, polyols, phenols, amines, amides and acid anhydrides. These compounds will react readily with isocyanate to form their corresponding addition products. Although reactions caused by contamination from amines or other active hydrogen-containing compounds do not release a gas, they do release considerable quantities of heat. This could ultimately lead to the homopolymerization of the isocyanate to carbodiimides, with a concurrent release of carbon dioxide, which will cause pressure. Contamination by heavy metal salts can also cause homopolymerization.

- In the event of significant contamination, the exothermic reaction could sharply increase the mixture’s temperature. This could result in the secondary reaction of trimerization – an exothermic process – which, in turn, could raise the temperature of the mixture above 175°C (347°F). This forms a hard solid or foam that can be removed from the vessel or line by mechanical means only. At this temperature, another secondary reaction – the homopolymerization of the isocyanate to carbodiimides – can occur with a concurrent release of carbon dioxide. Finally, the release of quantities of carbon dioxide – especially in a closed or restricted vessel – could lead to a violent rupture.

**CAUTION:** Exercise caution in the case of significant contamination to avoid the hazards of sharp exotherm and violent rupture. Cleaning attempts should follow checks conducted to ensure that reaction has stopped. Proper personal protective equipment must be used.
Fire and Explosion Hazards

**CAUTION:** If TDI has been contaminated, irreversible changes may have occurred and restoring the product to its original quality will be impossible. Do not add any reagent to try to stop any reaction with the contaminant. Safe disposal of contaminated product is recommended.

The flash point of TDI is 126°C (259°F) per Pennsky-Martens Closed Cup ASTM D93 test and the flammability limits in air are 0.9 percent to 9.5 percent. Consequently, TDI will burn in the presence of an existing fire or high heat source and adequate oxygen.

The low volatility of isocyanate minimizes the potential hazard of explosion. However, under fire conditions where a large concentration of isocyanate vapor is generated, an explosion could occur.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- Under fire conditions, isocyanate will generate irritating and hazardous vapors and fumes. Thus, firefighting personnel must wear an approved, positive-pressure, self-contained breathing apparatus and impervious clothing including footwear, helmet and gloves. All personnel should stay out of low areas where gases (fumes) can accumulate. The fire area must be isolated and non-emergency personnel kept out of the area. Downwind personnel must be evacuated.

- In the event of a TDI fire, use carbon dioxide, foam or a dry chemical extinguisher. For fires covering large areas, alcohol-resistant foams are preferred. General purpose synthetic foams or protein foams may function, but less effectively. Water is not recommended, but it may be used in very large quantities as a fine spray when other extinguishing agents are not available. The reaction between water and isocyanate may be vigorous. When spraying water, do not use a direct water stream as it may spread the fire.

- Fight fire from protected location or safe distance. Consider use of unmanned hose holder or monitor. Use water spray to cool fire-exposed containers and fire-affected zone until fire is out.

- Immediately withdraw all personnel from area in case of rising sound from venting safety device or container discoloration. Move container from fire area if this is possible without hazard.

- Once the fire is out, any TDI leaks or spills should be promptly cleaned up. If possible, contain fire run-off water. Fire water run-off, if not contained, may cause environmental damage. Review the “Accidental Release Measures” and “Ecological Information” sections of the product safety data sheet.
Spills and Leaks – Containment and Cleanup

In considering the various aspects of spills and leaks, it is necessary to distinguish between minor incidents, such as those that may occur in a laboratory or workshop, and large spills that involve, for example, a storage tank or bulk road tanker. Perhaps the most important criterion for distinguishing between the two is the ability of personnel to deal with the occurrence, rather than the actual scale of the incident. Hence, a minor spill or leak could be defined as one that can be dealt with using existing equipment and personnel, while a large spill may require outside assistance from the supplier, the police, fire services or other emergency response personnel. However, even minor incidents are potentially as hazardous as large spills, especially if they are not handled correctly.

In the event of a large spill, call Dow’s Distribution and Emergency Response Center in Freeport, Texas, at (979) 238-2112, or in Midland, Mich., at (989) 636-4400, or CHEMTREC at 1-800-424-9300. Call these numbers at any time for advice and/or assistance in containing or cleaning up spills and leaks of any size. (See “Large Spills,” page 17.)

The European Diisocyanate and Polyol Producers Association (ISOPA) website also provides useful information such as emergency response numbers and focal points for countries in Europe. For other global regions, please refer to the local jurisdictional Safety Data Sheet for relevant emergency contact numbers.

TDI spills and leaks should be contained by diking, if necessary, and cleaned up only by properly trained and equipped personnel. All others should leave the contaminated area immediately. Protective equipment should include an approved, positive-pressure, self-contained breathing apparatus and impervious clothing including footwear, helmet and gloves. In addition, all work areas should be equipped with safety showers and eye baths. Any isocyanate accidentally spilled or leaked onto the skin should be quickly washed off.
In some situations, TDI spills can reach underground levels and contaminate sewers and ditches. Underground systems such as sewage pipelines can get clogged by foam and rupture violently in these cases due to reaction of TDI with water.

In cold weather conditions, TDI can freeze below 14°C [57°F]). Careful handling is needed to prevent accidental spills and leaks. Refer to handling of “Solidified Spills”, page 18.

**Minor Spills and Leaks**

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- All spills and leaks should be immediately contained to prevent further contamination of the surrounding area.

- Ventilate the contaminated area. Open all doors and windows. To avoid inhaling the vapors of either isocyanate or the decontamination byproducts, workers should wear approved, positive-pressure, self-contained breathing apparatus.

- Dike the spill with sand, absorbent clays, etc. If there are standing pools of TDI, the liquid may be transferred into closed-top, but not sealed, containers for disposal. Any equipment and containers used must be clean and dry. Properly decontaminate all equipment after use.

- If the leak’s source is a damaged or leaking drum, it should be moved to an isolated, well-ventilated area. One way to control the leak when it is on the side of the drum is to re-position the drum so it is lying horizontally and the hole is on the top of the drum, temporarily stopping the leak. The contents can then be transferred to other suitable, leak-free containers. The damaged drum or container should be decontaminated and destroyed. Also, the new container should be blanketed with a dry gas pad after ensuring that it is completely water-free (see “Moisture Control,” page 8) and then monitored to help ensure atmospheric moisture does not cause over-pressurization.

- If the leak’s source is a damaged or leaking stationary container (e.g., storage or holding tank), it should be temporarily patched and the contents transferred to other suitable, leak-free containers. The new containers should be blanketed with a dry gas pad after ensuring that it is completely water-free (see “Moisture Control,” page 8) and then monitored to help ensure that atmospheric moisture does not cause over-pressurization.
• After diking is completed and liquid pools have been recovered, promptly cover the leak or spill completely with dry absorbent material, such as vermiculite, sand or an all-purpose commercial oil absorbent. Shovel the absorbent into an open container and cover, but do not seal. Then, remove the containers to a location where the neutralization process can be safely completed. Cover the drum but DO NOT SEAL TIGHTLY – it is very important to allow venting of any generated CO₂. Remove the drums to a safe site, away from the operating area, for neutralization.

• Soak the absorbent mixture in the container with a decontaminant solution of 5 percent ammonia in water and allow it to stand for at least 48 hours. Stir the mixture occasionally to ensure complete mixing.

  **WARNING:** Considerable heat, which could cause ignition, may be generated when the aqueous ammonia solution is first applied. After standing for 48 hours, however, the drum may be closed (though not pressure tight) and properly disposed of. To limit heat generation during the neutralization process, soak small quantities of the absorbent/isocyanate mixture in separate containers.

• Shovel the absorbent/TDI mixture from the floor, then mop the floor with a suitable decontamination solution (see below for two suggested solutions), allowing the solution to stand for at least 10 minutes. Be sure the area is well ventilated, both during and after cleanup. If ammonia is used, good general ventilation is necessary to prevent vapor exposure.
  • Formulation 1: sodium carbonate 5-10%; liquid detergent 0.2-2%; water to make 100%.
  • Formulation 2: ammonia solution 3-8%; liquid detergent 0.2-2%; water to make 100%.

  **CAUTION:** If ammonia solution is used, use good ventilation to prevent vapor exposure. Ensure that the decontaminating solution does not freeze and can be readily used if needed in cold weather conditions.

• As a precaution, test the atmosphere for residual isocyanate vapor. Instruments designed for TDI monitoring are commercially available. Examples of direct reading instruments that may be used for the detection of TDI include the SafeAir direct reading colorimetric badge (Morphix Technologies), the Sure Spot Active Sampler (Scott Instruments) and the NextStep Isocyanate gas monitor (Scott Instruments). In Europe, direct reading instruments from Scott Bacharach are used [http://www.scotthealthsafety.com/EMEA/en/Resources/About/contacts.aspx](http://www.scotthealthsafety.com/EMEA/en/Resources/About/contacts.aspx). In addition, Draeger brand products are widely used.
Large Spills

**CAUTION:** Decontamination and cleanup of large spills can be a complex and hazardous operation, and all the details and operating procedures are not outlined below. Local emergency crews and trained personnel should be called to handle large spills.

In the event of a large spill, a state of emergency should be declared for the affected area. This usually requires the involvement and close cooperation of various local emergency response services, such as police and fire units. Therefore, contingency arrangements and safe handling and decontamination procedures should be discussed in detail with emergency response personnel in advance of actual emergency situations. A written emergency plan for large spill control should be in place with periodic drill practices scheduled before actual emergency situations occur.

**Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.**

- In the event of a large spill (such as an overturned tank truck or tank car, ruptured storage tank, etc.) or a moderately large spill about which there is doubt, immediately alert local emergency response service units. Then call Dow’s Distribution and Emergency Response Center in Freeport, Texas, at (979) 238-2112, or in Midland, Mich., at (989) 636-4400, or CHEMTREC at 1-800-424-9300. For Europe, ISOPA also provides emergency contact numbers for different EU countries and focal points in many cases (www.isopa.org). Call these numbers at any time for advice and/or assistance in containing or cleaning up spills and leaks of any size.

- All persons not properly equipped with impervious clothing and air-supplied respirators should immediately leave the site of the spill and remain upwind. Only properly trained and equipped personnel should attempt to isolate or contain the spill.

- To contain the spill temporarily, minimize vapor contamination of the air, and “buy time” until the spill can be properly diked and the necessary decontamination materials assembled, cover the isocyanate with a coating of 3 percent protein (firefighting) foam. (Most firefighting services have protein foams or similar foam systems.) The foam may have to be reapplied every 30 minutes until effective neutralizing materials can be obtained. Plastic sheeting may also be used to cover the spill and minimize emissions.
CAUTION: Under certain circumstances, water is an acceptable decontaminant for isocyanate. However, mixing water and isocyanate in confined areas even in small amounts is hazardous (see “Moisture Control,” page 8). Protein and other water-based foam systems, therefore, should be used only in open areas. Also, be sure the equipment is producing good quality foam before applying the mixture to the spill.

• If possible, prevent further leakage or spread of the leaked material. Dike the spilled material with vermiculite, sand or an all-purpose commercial oil absorbent. Special efforts should be made to prevent the spilled material from entering waterways or drains, including lakes, rivers, streams or sewers. If spilled material does enter waterways or drains, notify local authorities immediately.

Solidified Spills

One or more of several methods may be used to remove solidified TDI, depending upon the surface on which the material has been spilled.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

• Depending upon the surface on which the material has been spilled, workers may use one of the decontamination solutions described on page 16 and a broom to remove films or traces of TDI on surfaces as described below. Workers involved in this operation must be properly equipped with appropriate safety equipment (including chemical goggles and respirators, possibly an air-supplied respirator) and protective clothing (including waterproof coveralls, boots and gloves). Refer the appropriate jurisdictional safety data sheet to ensure proper usage of all necessary protective equipment. After use, carefully wrap the broom in plastic to contain the isocyanate. Dispose of the wrapped broom properly (one method is incineration). In disposal of any wastes, be sure all applicable regulations are met.

• On roadways and other surfaces where damage must be kept to a minimum, solidified TDI may be removed by the use of machines (that can be used to re-level the surface of the road) or sandblasting. If sandblasting is used, the contaminated sand must be carefully collected, placed in open-top containers and removed for subsequent decontamination and disposal. In such cases, an outer layer of urea may conceal unreacted TDI and it is highly critical that appropriate safety precautions are taken by workers involved in cleaning operations. If it is suspected that some unreacted TDI is still present, care must be taken to repeat the absorption process before removal of solids is repeated. Workers must be properly equipped with appropriate safety equipment.
equipment (including chemical goggles and either a self-contained breathing apparatus or, preferably, an air-supplied respirator) and protective clothing (including coveralls, boots and gloves). Selection of specific items will depend on the operation.

- Completely cover the spilled material with the decontamination solution. Allow the solution to remain in place for at least an hour, and then cover the spill with enough absorbent material to soak up all the liquid. Shovel this material into open-top containers, and then remove to a safe, well-ventilated area for decontamination and disposal.

- Wash the contaminated area with large amounts of a decontamination solution. If indoors, thoroughly ventilate the decontaminated area to remove all traces of vapor.

- When cleanup and decontamination have been completed, the area should be carefully inspected by properly trained and equipped personnel. When safe working conditions have been re-established, remove and decontaminate or dispose of protective equipment and return to normal operation.

**Pressurized Drums**

In the event that a pressurized drum (e.g., those misshapen due to the presence of carbon dioxide gas) is observed, a potentially dangerous situation exists due to the potential of rupture creating a projectile. **Do not attempt to move the drum.** The area near the drum should be evacuated of all personnel and the drum should be monitored, from a safe distance for a potential rupture.

Taking action like covering with a tarpaulin and puncturing may ultimately be appropriate, but only when adequately trained personnel and suitable protective equipment are available, and when such actions are approved by trained emergency response personnel assessing the situation.

Contact Dow’s Distribution and Emergency Response Center in Freeport Texas, at 1-979-238-2112, or CHEMTREC for transportation emergencies at 1-800-424-9300. Call any of these numbers at any time – day or night – for advice and/or assistance in safely mitigating the situation. For emergency situations in Europe, the ISOPA website provides useful information such as emergency response numbers and focal points for countries. For other global regions, please refer to emergency numbers provided in local, jurisdictional safety data sheet.
Decontamination and Disposal

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

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

After emptying drums, remaining TDI products may be neutralized by the following procedures:

• Remove emptied drums from the work area to a well-ventilated location or outdoors.

• Remove all bungs. Fill drums with water. Wear protective equipment and keep face away from bungholes while filling. Do not reinstall bungs.

• Allow drums to stand undisturbed for 48 hours or until residual TDI has been completely converted to solid urea. Refer to disposal method on the SDS and product label.

• Scrap all drums by draining, triple-rinsing with water, and holing or crushing to prevent reuse. Dispose in an approved landfill or by other procedures approved by applicable authorities.

• Dispose of the drain and rinse fluid according to all federal, state, provincial and local regulations. In the United States, TDI is listed as a hazardous waste under Resource Conservation and Recovery Act (RCRA). Users of TDI should be aware of and follow the disposal provisions of that act, as well as other state and local environmental control regulations.

Environmental Considerations

In the aquatic or terrestrial environment, the movement of TDI is expected to be limited by its reaction with water to form predominantly insoluble and unreactive polyurea (polyurea crusts). Under conditions of a spill, toluenediamine is expected to be a very minor hydrolysis product. TDI vapor in the atmosphere is expected to be oxidized as a volatile organic compound (VOC) without the formation of hydrolysis products. Therefore, TDI is not expected to move in soil or persist in the environment. While it ranges from moderately toxic to practically non-toxic to many fresh water organisms, it is reported to be highly toxic to at least one species of marine fish, the red sea bream. The 96-hour LC50 is 0.1-1 mg/L for this species.
Handling Precautions Summary

To minimize hazards associated with the handling and storage of polyurethane chemicals, follow the precautions listed below:

- 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 Safety and Health Administration (OSHA) in the United States, Workplace Hazardous Materials Information System (WHMIS) in Canada, or applicable regional/national/local regulatory agencies. When needed, have personnel wear approved respiratory protective devices, particularly when handling isocyanate or amines.

- Avoid skin and eye contact with all formulation chemicals. All personnel must be properly equipped with impervious clothing and eye protection.

- Candidates for employment where occupational exposure to isocyanate may occur should be examined for pulmonary function with particular emphasis on allergic history including asthma or other diseases that may impact lung function. Employment in an isocyanate area may present a health risk to individuals with a history of respiratory problems or allergies.

- Handle freshly polymerized parts with care as they could contain residual TDI monomer. Be aware of the potential hazards of toxic vapors and of the heat of cure.

- Keep isocyanate neutralizer on hand for quick decontamination of work areas in the event of small spills or leaks.

- Never expose isocyanate in containers to water, amines or other reactive chemicals.

- Never expose polyurethane chemicals in closed containers to elevated temperatures.
Health Effects and First Aid

**NOTICE:** The information and recommendations that follow are presented in good faith. However, since this information and the recommendations are provided without charge, and since use conditions are not within Dow’s control, Dow does not guarantee any results from the use of the information or the recommendations; no warranty, express or implied, is given. It is the Customer’s responsibility to determine that its workplace and practices comply with law and applicable safety standards. It is important to refer to a current, local jurisdictional product safety data sheet for detailed guidance and latest recommendations – the appropriate jurisdictional safety data sheet can provide key information such as Risk and Safety phrases required in the EU.

Hazard and Exposure Guidelines

The potential hazard of a material is based on the toxicity, an individual user’s susceptibility, and on the likelihood and level of exposure. Responsible users of chemical and industrial materials must be concerned not only with the inherent acute and chronic toxicity of such materials, but also with the potential for exposure under specific use conditions. In general, exposure controls must be more rigorous for hazardous substances such as TDI which has very low exposure limits as discussed in the following paragraphs.

While there are potential hazards associated with such materials as catalysts and blowing agents, perhaps the primary hazard in polyurethane chemical applications using TDI is associated with the TDI component itself, particularly the inhalation of TDI vapors. Because of the potential hazards posed by TDI vapors, exposure limits have been established regarding allowable TDI vapor concentrations in the work environment.

The user should refer to the applicable local safety data sheet for applicable occupational exposure guidelines (see page 50 for regional information sources). In the United States, vapor levels of TDI must be controlled according to standards established by OSHA. The OSHA permissible exposure limit (PEL) for TDI is 0.02 ppm as a ceiling limit. Dow has also set a 0.02 ppm ceiling as its industrial hygiene guide (IHG). A ceiling limit is defined as the maximum concentration that should not be exceeded during the exposure. Because allergic sensitization may result from even brief exposure to high concentrations of TDI, it is important that vapor levels be controlled below the ceiling limit.
Other global advisory groups have exposure guidelines for TDI. The American Conference of Governmental Industrial Hygienists (ACGIH) adopted a threshold limit value (TLV) for TDI of 0.005 ppm as an 8-hour time-weighted average (TWA) with 0.02 ppm as the short-term exposure limit (STEL). The TWA is the concentration to which it is believed nearly all workers may be repeatedly exposed for 8 hours a day, 40 hours a week, without adverse effect. ACGIH defines a STEL as a 15-minute TWA exposure that should not be exceeded at any time during a workday even if the 8-hour TWA is within the TLV. Other restraints of a STEL are: a) exposure at the STEL should not be longer than 15 minutes; b) exposure at the STEL should not be repeated more than four times per day; and c) there should be at least 60 minutes between successive exposures at the STEL.

While these exposure guidelines represent current thinking and are believed to be conservative, they offer no guarantee of absolute safety. It is imperative that personnel working with TDI fully understand the hazards associated with its use and are familiar with procedures to minimize these hazards. Exposure guidelines are reviewed regularly so users of these chemicals need to keep fully informed of current regional guidelines and regulations. See the respective regional SDS for current and specific product information. To obtain SDSs for TDI products made by Dow, call Dow’s CIG (see page 52 for contact information).

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- All employees must be periodically retrained in the use of all protective and emergency equipment as well as in preventive procedures.

- Regularly inspect and repair exhaust and other ventilating equipment. TDI and other toxic vapor levels in the work environment are best controlled by properly designed and maintained process and exhaust equipment. Combined with safe work procedures, properly designed equipment in good working order can maintain vapor levels within acceptable limits. Also, work area atmospheres should be tested periodically by trained industrial hygienists using equipment specifically designed for that purpose to be sure that airborne TDI vapors are controlled to acceptable levels.
WARNING: Available information indicates that the lowest detectable odor level of TDI is approximately 0.05 ppm even though different detectable levels have been reported up to as high as 2 ppm. Because even the lowest detectable odor threshold reported for TDI is significantly higher than the OSHA PEL, odor cannot be relied on to warn of hazardous airborne concentrations of TDI. Vapor levels must be monitored using equipment specifically designed to measure airborne TDI levels.¹

- In some operations where TDI is used, respiratory protection may be needed to prevent inhalation of vapors. The type of respirator needed depends on each specific situation. Each company should assess employees’ specific and unique exposure conditions to determine what is appropriate for its particular job and work environment.

- An air-supplied respirator (airline respirator or self-contained breathing apparatus) must be used in situations of unknown TDI concentrations and in situations with a high exposure potential. This includes emergency situations such as spills or leaks. However, under certain conditions, a properly fitted air-purifying respirator equipped with an organic vapor sorbent can provide adequate protection. This type of air-purifying respirator should be used only after an evaluation of the work environment by an industrial hygienist or other qualified occupational health and safety specialist. The range of TDI concentrations in the workplace must be known and shown not to exceed the limit for the respirator used. Information is available on respirator cartridge capacity for TDI.² However, it is not possible for a respirator user to detect when the respirator cartridge capacity for TDI is exhausted. Therefore, cartridges must be changed on a regular schedule, which should be established after monitoring for TDI levels.

- The most crucial factor is respirator face piece fit and seal. Personnel must be properly fitted for their respirator face piece as well as trained in how to wear the respirator and how to check for proper seal.

• In the United States, companies are required by law to have a written respiratory protection program, which should comply with the U.S. Code of Federal Regulations 29CFR 1910.134. This regulation is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The American National Standards Institute (ANSI) Standard – Practices for Respiratory Protection Z88.2-1992 – provides general guidance. It sets forth accepted practices for respirator users, provides information and guidance on selection, use and care of respirators, and has recommended requirements for establishing and regulating respirator programs.

• Skin and eye contact with TDI and other polyurethane chemicals may result in injury and, in some cases, sensitization. Therefore, it is essential that operating and ventilating equipment be properly designed and maintained, and that all procedures for the safe handling and storage of these materials be fully understood and followed. Impervious clothing, gloves, boots and chemical goggles or face shield must be worn whenever TDI is handled or whenever there is any possibility of exposure. Protective clothing and accessories recommended are meant for use when handling TDI and should not be inappropriately used (workers should not take the protective gear home; they should not wear it and eat etc.). Guidance for selecting appropriate chemical impervious clothing for working with TDI is summarized in a publication from the Center for the Polyurethanes Industry (CPI).³

• Eye wash fountains and safety showers should be installed and kept in working condition in areas where contact with TDI can occur. It is important that the number and location of such units be designed to serve both individual and multiple-employee exposures.

• A medical surveillance program for employees should be designed to detect any evidence of adverse effect due to TDI exposure.

Health Hazards, Preventive Measures and First Aid
The health hazards of TDI and first aid are summarized below. Please note however that it is important to refer to a current, local jurisdictional product safety data sheet for detailed guidance and latest recommendations – the appropriate jurisdictional safety data sheet can provide key information such as Risk and Safety phrases required in the EU.

To ensure that you have the most recent information, a current SDS should be obtained and reviewed before any TDI product is used. SDSs for TDI products produced by Dow are available by contacting Dow’s CIG – see detailed contact references provided on page 52.

All employees working in areas where contact with TDI is possible should be thoroughly trained in the administration of emergency first aid. Experience has demonstrated that prompt administration of such aid can be important in minimizing the possible adverse effects of accidental exposure.

Inhalation

Health Hazards and Preventive Measures

TDI exposure may cause allergic respiratory response. Excessive vapor concentrations of TDI (both heated and unheated) are readily attainable and may cause serious adverse effects when inhaled, even death. Excessive exposure to TDI may cause severe irritation of the upper respiratory tract and lungs, fluid in the lungs, permanent decrease in lung function, neurological disorders, cholinesterase depression and gastrointestinal distress. Re-exposure to extremely low isocyanate concentrations may cause allergic respiratory reactions in individuals already sensitized. Asthma-like symptoms may include coughing, difficulty breathing and a feeling of tightness in the chest. Occasionally, breathing difficulties may be life threatening. Effects may be delayed. Therefore, an approved respiratory protective device must be worn if there is any possibility of exposure to unknown vapor concentrations.

CAUTION: Exposure to heated TDI can be extremely hazardous, not only because high vapor concentrations are formed, but also because condensation may form airborne droplets. If the product is heated or sprayed as an aerosol, airborne concentrations sufficient to cause irritation of the eyes, upper respiratory tract and lungs may be encountered upon single exposure. An air-supplied respirator must be worn whenever there is any possibility of exposure to unknown concentrations of airborne isocyanates.

First Aid/Medical Treatment

Promptly move the affected person away from the contaminated area to fresh air. If not breathing, administer artificial respiration (if by mouth to mouth, rescuer protection such as a pocket mask should be used). If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.
**Note to physician:** Maintain adequate ventilation and oxygenation of the patient. TDI exposure may cause asthma-like (reactive airways) symptoms. Bronchodilators, expectorants, antitussives and corticosteroids may be of help. Treat bronchospasm with inhaled beta2 agonist and oral or parenteral corticosteroids. Respiratory symptoms, including pulmonary edema, may be delayed. Persons receiving significant exposure should be observed 24-48 hours for signs of respiratory distress. If you are sensitized to diisocyanates, consult your physician regarding working with other respiratory irritants or sensitizers.

**Skin Contact**

*Health Hazards and Preventive Measures*

Prolonged contact may cause severe skin irritation with local redness and discomfort. Skin contact may cause an allergic skin reaction. Animal studies have shown that skin contact with isocyanates may play a role in respiratory sensitization. All skin contact must be prevented. Impervious clothing, including chemical aprons, gloves, footwear and goggles or face shield should be worn whenever there is any possibility of direct contact with isocyanate. Work safety clothing and other personal protective equipment should be maintained in the workplace and should not be taken home to avoid potential exposure. Also, safety showers should be installed and kept in working condition, in and near all work areas where TDI is used.

*First Aid/Medical Treatment*

Remove material from skin immediately by washing with soap and plenty of water. Remove contaminated clothing and shoes while washing. Seek medical attention if irritation persists. Wash clothing before reuse. An MDI skin decontamination study demonstrated that cleaning very soon after exposure is important, and that a polyglycol-based skin cleanser or corn oil may be more effective than soap and water. This may also apply to other isocyanates. Discard items which cannot be decontaminated, including leather articles such as shoes, belts and watchbands.

**Eye Contact**

*Health Hazards and Preventive Measures*

TDI exposure may cause severe eye irritation and moderate corneal injury. TDI vapor may cause eye irritation experienced as mild discomfort and redness. Chemical goggles should be worn whenever TDI is handled or when there is any possibility of contact with TDI liquid or mist. If exposure causes eye discomfort, a full-face respirator should be used. In the event of contact, immediate decontamination with water will assist in preventing injury. Eye baths in good working condition should be available in all areas where TDI is used.
First Aid/Medical Treatment
Immediately flush eyes with water; remove contact lenses, if present, after the first 5 minutes, then continue flushing eyes for at least 15 minutes. Obtain medical attention without delay, preferably from an ophthalmologist.

Ingestion (Swallowing)

Health Hazards and Preventive Measures
Swallowing may result in gastrointestinal irritation or ulceration. Food should not be prepared or consumed where TDI is handled or stored. In the event of accidental ingestion, personnel should be prepared to give emergency first aid.

First Aid/Medical Treatment
Do not induce vomiting. Give one cup (8 ounces or 240 ml) of water or milk if available and transport to a medical facility. Do not give anything by mouth unless the person is fully conscious.

Note to physician: Due to irritant properties, swallowing may result in burns/ulceration of mouth, stomach and lower gastrointestinal tract with subsequent stricture. Aspiration of vomitus may cause lung injury. Endotracheal/esophageal control is recommended if lavage is done.

Chronic Toxicity
Both the National Toxicology Program (NTP) and the International Agency for Research on Cancer (IARC) have designated TDI as a potential carcinogen. Both agencies based their conclusions primarily on the results of an NTP study that reports increased tumors in rats and mice dosed orally with TDI. The agencies accept this as a valid animal study. However, a number of deficiencies have been cited that may compromise its validity. In addition, results of a chronic inhalation study are deemed more relevant to the exposures experienced in occupational settings. This inhalation study, contracted by the International Isocyanate Institute, reports no increase in tumors in rats and mice exposed to TDI vapors for their lifetime. At this time, we do not believe that TDI represents a significant cancer hazard when atmospheric levels are maintained below the recommended exposure guidelines.
**CAUTION:** First aid is emergency treatment only, and medical attention from a qualified physician should be provided as soon as possible. Toluene diisocyanate (TDI) is a highly reactive and potentially hazardous material that can adversely affect or injure the eyes, the skin, and both the respiratory and digestive tracts. Treatment should be based on the judgment of the physician and individual patient response. For additional emergency medical information, you can call The Dow Chemical Company using the appropriate regional SDS to locate the correct emergency number (United States 989-636-4400 – This number may also be accessible from other world regions (with appropriate international prefix to the number as necessary) in addition to the regional specific number provided in the SDS).
Part Two –
Shipment, Handling and Storage

NOTICE: The information and recommendations that follow are presented in good faith. However, since this information and the recommendations are provided without charge, and since use conditions are not within Dow’s control, Dow does not guarantee any results from the use of the information or the recommendations; no warranty, express or implied, is given. It is the Customer’s responsibility to determine that its workplace and practices comply with law and applicable safety standards. Information provided in this section, in many cases, reflects United States practices – Please contact Dow’s CIG (contact numbers on page 52) for specifics pertinent to other world regions.

General Unloading Procedures and Specifications
VORANATE™ T-80 TDI is shipped in tank trucks and tank cars designed to meet regional regulatory requirements. For specifics on regional transportation classifications, refer to the relevant current jurisdictional SDS. Table 3 and Figures 2 and 3 provide some examples of specifications for vehicles used by Dow for the bulk shipment of TDI.
### Table 3: Typical North American Specifications (Tank Trucks and Tank Cars)

*Note: Truck and tank car designs may be different in different regions by design or to meet regulatory requirements e.g. ISOPA guidance in Europe. Contact Dow’s CIG for more information (phone numbers on page 52).*

<table>
<thead>
<tr>
<th>Details</th>
<th>Tank Trucks</th>
<th>Tank Cars</th>
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</thead>
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</table>

<sup>1</sup> Quick Connect  
<sup>2</sup> National Pipe Thread  
<sup>3</sup> Male Pip Thread; can be reduced to 2 inches with adapters
Tank Trucks

The following is based on use of tank trucks meeting the aforementioned general specifications for tank trucks.

VORANATE™ T-80 TDI is shipped in pressurized and insulated stainless steel tank trucks, equipped for bottom unloading only. It is important to use tank trucks that meet regional/national requirements specified by transportation regulatory agencies such as Accord Dangereux Routier (ADR - European regulations concerning the international transport of dangerous goods by road) or United States Department of Transportation (DOT). Only properly trained and equipped personnel should be permitted to unload tank trucks. Operators should wear an approved respiratory protective device, and impervious clothing, footwear, gloves and goggles.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

1. Before using the following procedure, operators should be thoroughly familiar with the potential hazards associated with the handling and storage of TDI.
2. Position the trailer as level as possible and block the wheels.
3. Check the storage tank to be certain that it contains TDI. Also, check the storage tank’s gauge to be sure that there is sufficient room to receive the entire contents of the tank truck.
4. Check all “product identification” or “bulk” tags (usually attached to product outlets, valves or seals) to be certain that the product being unloaded is TDI.
5. Check the temperature of the contents. The temperature must be above 16°C (60°F) when the trailer is unloaded.
6. If heating is required, attach a 15- to 25-psi steam supply to the heating coil inlet connection. For better control of the heating process, use a steam pressure of 15 psi. Attach a steam trap, designed for the steam pressure available, to the heating coil outlet connection. Internal coils are not advised because of severe effects due to possible water contamination of the product. Allow the contents to warm until the temperature is at least 20°C (68°F). When the temperature reaches 20°C (68°F), turn off the steam and disconnect the lines. To prevent heating coils from freezing during cold weather, be sure to drain them or blow them out. Do not allow the temperature to rise above 40°C (104°F). (See “Temperature Control,” page 10.)
7. Attach the unloading line. It should be a clean, dry hose preferably made using Teflon fluorocarbon, Viton fluoroelastomer or stainless steel that can safely withstand unloading pressures.

8. Connect the dry purge gas (preferably nitrogen) line to the tank truck. This line should have a pressure gauge, a safety valve set at 30 psig and a pressure regulator set at 25 psig.

9. Draw off a sample of the contents for analysis by connecting stainless steel tubing to the sample connection. Flush the sample connection by drawing off at least one gallon of product into a clean, dry container. The sample may now be drawn off into another clean, dry container of whatever size is necessary for testing.

**WARNING:** Do not breathe vapors. Wear proper protective equipment, including an approved respiratory protective device.

10a. If the contents are to be unloaded by purge gas pressure alone, the storage tank should be fitted with a vent scrubber. This will prevent vapors from being vented into the atmosphere during unloading.

**CAUTION:** Do not exceed 25 psig (1.7 bar) purge gas pressure to unload the tank truck.
When the tank truck is empty, the pressure gauge will show a drop in pressure. Close the valve at the storage tank connection first. Then close the truck unloading valve.

10b. If the contents are to be unloaded by pump, one of the options is to use a vapor line connecting the storage tank vent to the tank truck under Nitrogen padding (closed loop). Another option is to use a low-pressure, replenishable gas pad placed on the tank truck. If a gas pad is used, install a vent scrubber or a carbon bed filter (with pressure safety device in the filter) on the storage tank vent. These precautions will not only prevent isocyanate vapors from being vented to the atmosphere, but will prevent a vacuum from being pulled on the tank truck during unloading.

**CAUTION:** Do not use a closed-loop system unless the dead air space in the storage tank is free of moisture (e.g., -40°C [-40°F] dew point). Also, connection hoses should be purged with dry air or nitrogen before hookup. When the trailer is empty, allow the unloading hose to vent down to the storage tank. Close the valve at the storage tank connection first. Then close the tank truck unloading valve.

11. Shut off the purge gas to the tank truck. Close the tank truck purge gas valve and disconnect the purge gas line. If a closed-loop system was used in conjunction with pump unloading, close the tank truck connection valve and the tank vent valve. Then disconnect the hose connecting the two. All connection hoses should now be capped for storage.
**CAUTION:** Unloading must be closely monitored, particularly if there is no automatic cutoff in the unloading line. For example, if gas flow is allowed to continue after unloading, the gas flowing into the storage tank could rapidly increase internal pressure. This could cause serious structural damage to the storage vessel. The cleaning and inspection of the tank truck should be handled by the shipper only under carefully controlled conditions designed to safeguard personnel and equipment.

**WARNING:** Under no circumstances should personnel enter any empty tank.

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**Figure 2: Typical Tank Truck (North America)**

![Diagram of a typical tank truck](image)

- A — ⅜" Steam Inlet
- B — 35# Safety Valve and Pressure Gauge
- C — Manhole
- D — ⅜" Dry Air Nitrogen Connection
- E — 3" Unloading Connection
- F — ½" Sample Valve
- G — Steam Outline
- H — Air Drier
- I — 2" Lossing Line
- J — 2" Vent Line

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**Figure 3: Typical Tank Car (North America)**

**Note:** On some 17,000-gallon DOWX series cars there is a variation in the dome valving configuration. The diagram above shows the normal configuration. However, in some cars the positions of A (the gauging device) and C (the 75# safety valve) are reversed.

**Tank Cars**

The following is based on the use of tank cars meeting the aforementioned general specifications for tank cars.

VORANATE™ T-80 TDI is shipped in insulated, baked phenolic-lined tank cars, equipped with external heating coils and a pressure relief device set at 75 psi. Tank cars from Dow can be unloaded from the top only. Also, only properly trained and equipped personnel should be permitted to unload tank cars. Operators should wear an approved respiratory protection device, and impervious clothing, footwear, gloves and goggles.

*Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.*
1. Before using the following procedure, operators should be thoroughly familiar with the potential hazards associated with the handling and storage of TDI.

2. Verify that the proper car is being unloaded. Check the car number, product identification and commodity stenciling against the bill of lading or other appropriate document. (Product identification and information tags are attached to the metal seal.) Also, sample the contents to be sure that the material is TDI.

3. Position the car on the selected siding, then set the brakes and block the wheels.

4. Position caution signs on the track or car to provide adequate warning to persons approaching the car from the open ends of the siding.

   **CAUTION:** The signs should not be removed until the car has been unloaded and disconnected from the discharge connection.


   *The signs must be of metal or other comparable material, at least 12 inches high by 15 inches wide in size, and bear the words, STOP – TANK CAR CONNECTED, or STOP – MEN AT WORK, the word “STOP” being in letters at least 4 inches high and the other words in letters at least 2 inches high. The letters must be white on a blue background.*

   In addition to these mandatory U.S. regulations, Dow recommends that the switches on the open ends of the siding be provided with locks, or that derails be placed on the track at least 50 feet from the ends of the car. This should effectively prevent entry of other cars into the siding where TDI is being unloaded.

   **CAUTION:** In the event derails are used, be sure to attach a signal flag to the track to indicate that the derail is in position. Also, attach a signal light to the flag at night.

5. Safely climb to the platform area on top of the car. All unloading apparatus on Dow tank cars is located in the manway bonnet in the center of the platform. Remove the seal from the latch pin and open the bonnet dome. When the cover is open, check to see that all valves are in the closed position with plugs in place.

6. Check the temperature of the tank car by removing the 3/4-inch cap from the thermowell and inserting a thermometer approximately 48 inches for 15 to 20 minutes. The temperature of the contents must be above 16°C (60°F) when the car is unloaded.
7. If heating is necessary, remove the cover from the magnetic gauge and raise the gauge rod to where the magnet in the end of the rod engages the magnet on the float. The rod is calibrated in 1/4-inch increments and should read between 4 and 7 inches. Next, attach a steam hose to the steam inlet connection located on the bottom of the car. Attach a steam trap, designed for the steam pressure available, to the heating coil outlet connection. For greater control of the heating process (to avoid hot spots and product deterioration), use a steam pressure of 25 pounds or less. Also, monitor the outage to be sure that expansion does not fill the car “liquid full” and cause it to “pressure relieve” through the safety valve. If this happens, ensure that the pressure relief device is subsequently properly cleaned and inspected before re-use. Finally, monitor the pressure on the tank car during heating. Do not allow pressure to go beyond 30 psig.

8. Allow the contents to warm until the temperature reaches 20°C (68°F), then turn off the steam, disconnect the lines and allow the heater coils to drain. Do not allow the temperature to rise above 40°C (104°F). (See “Temperature Control,” page 10.)

9. Connect vents or vapor lines, and equip the vent or vapor line connection with a pressure gauge. Regulate pad gas to a maximum pressure of 30 psig.

10. If desired, a sample of the contents may be drawn off through the sample valve – a 1/4-inch needle valve equipped with standard pipe threads. If a sample is desired from an unpressured car, use 3 to 4 pounds of purge gas pressure.

11. Attach the unloading line. It should be a clean, dry hose preferably made of flexible metal or Teflon fluorocarbon or Viton fluoroelastomer that can safely withstand unloading pressures to the unloading valves. After proper attachment of the unloading lines, slowly open the unloading valves until discharge lines are liquid full.

12. Pressure on the car may now be increased to discharge the product. Make certain, however, that the amount of pressure is appropriate to the unloading method used (e.g., purge gas pressure or pump). If the contents are to be unloaded by purge gas pressure alone, the storage tank should be fitted with a vent scrubber. Also, storage tank pressure should be carefully controlled and monitored during the unloading operation.
13. When the tank car is empty, the unloading lines should be blown clear of liquid and blocked in before being disconnected. There are a number of ways to determine when the tank car is empty. For example, a rapid drop in pressure on the car would indicate that the liquid is gone and that the gas is blowing out through the unloading line. The amount of product received into the storage tank should also indicate whether or not the tank car is empty.

**CAUTION:** Do not use the magnetic gauging device to determine if the car is empty. This device extends only 60 inches into the car, and the car itself is typically at least 102 inches in diameter. These devices are used only during filling.

14. Once the tank car is empty, return all valves, connections and unloading lines to their original condition:
   a. Remove the thermometer from the thermowell and replace the dust cap.
   b. Completely lower the magnetic gauging device and replace the dust cap.
   c. Close the sample valve and replace the 1/4-inch plug.

15. Blow dry the liquid unloading lines and disconnect in the following sequence:
   a. Blow the line to the storage tank and close off the valve to the storage tank.
   b. Open the unloading valve on the tank car and blow any material left in the line back into the car.
   c. Determine the amount of pressure remaining in the car. If it is below 10 psig, continue flow of purge gas until pressure in the car reaches a minimum of 10 psig. Do not allow pressure to exceed 40 psig.
   d. Close the tank car valve, bleed off any pressure left in the unloading line and disconnect.

16. Replace the plug in the unloading valve.

17. Remove the purge gas line and replace the plug.

18. Close dome cover and replace latch pin. It is recommended that the pin be sealed to preclude its removal during transportation.

19. If any car defects are found, note them on the standard “Bad Order” tag and attach the tag to the dome cover latch pin.
20. If steam is used, do not replace inlet and outlet plugs on the heater coils. This will allow drainage.


When lading requiring placards or car certificates are removed from a rail car other than a tank car, each placard and car certificate must be removed by the person unloading the car.

For a tank car that contained a hazardous material, the person responsible for removing the lading must assure, in accordance with the provisions of Section 172.510(c) of this subchapter, that the tank car is properly placarded for any residue that remains in the tank car.

Section 172.514(b), “Bulk Packaging,” states, in part:

Each bulk packaging that is required to be placarded when it contains a hazardous material, must remain placarded when it is emptied, unless it is:

(1) Sufficiently cleaned of residue and purged of vapors to remove any potential hazard; or

(2) Refilled, with a material requiring different placards or no placards, to such an extent that any residue remaining in the packaging is no longer hazardous.

21. Remove warning, open derails, unlock switches, etc. Release hand brakes and remove chocks from wheels. If an unloading rack was used for entrance to the dome platform, be sure that all parts of the rack are removed and relocated far enough away from the car to conform to American Association Railroad (AAR) specified clearance for entry of the rail crew for switching operations.

22. Complete all final paperwork (e.g., “Empty Return Instructions”). After all forms have been completed and the proper carrier endorsements obtained, send the various copies to the locations designated in the instructions.
Drums

VORANATE™ T-80 TDI is shipped in Department of Transportation-specified phenolic-lined steel drums or high-density polyethylene drums that are authorized for TDI. Drums are equipped with two bungs on the top.

Carefully review and understand the following safety recommendations and precautions before handling, storing or disposing of TDI products.

- Examine each shipment for damaged drums. If damaged drums are found, they should be closely inspected for leaks or punctures. Leaking drums should be removed to a well-ventilated area and the contents transferred to other suitable containers. The empty drums should be decontaminated (see pages 14-16) and then holed or crushed to prevent reuse.

- Drums may be unloaded with conventional stainless steel drum pumps. To prevent collapse of the drum during unloading, equip the drum vent with a dry air or dry nitrogen breather. This attachment will also prevent moisture contamination of the contents. When not in use, pump lines should be protected from moisture by fitting a plug or cap into the open end. Portable pumps, lines and fittings should be carefully rinsed, dried and stored in a dry location (see "Moisture Control," page 8).

**CAUTION:** Operators engaged in handling, opening, unloading and closing drums should be properly trained and equipped with an approved respiratory protective device and impervious clothing.

Drum Storage

Whenever possible, drums containing TDI should be stored indoors. During cold weather, the temperature in storage areas should be kept above 18°C (65°F). 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.

**CAUTION:** Do not heat the contents above 40°C (104°F) or the drum wall above 79.5°C (175°F). Overheating may cause expansion of the contents, homopolymerization, and the subsequent formation of carbon dioxide, which can seriously weaken or completely rupture a drum (see "Temperature Control," page 10). During warm weather, drums may be stored outdoors. Prevent water from collecting on the tops by storing drums under a cover or by stacking them on their sides.
Segregate drums of TDI such that they are not stored along with other drums containing incompatible materials described in earlier sections. Finally, drums should be stored in such a way as to minimize the possibility of accidental damage and product contamination – especially by water. This may be accomplished by handling the drums with care and by stacking them on their sides. This will not only help protect the drums from external damage, but will prevent water from collecting on the drum tops. Before drums are stored, they should be carefully examined for damage. If damaged drums are found, they should be closely inspected for punctures or leaks. Breached drums should be removed to a dry, well-ventilated area and examined. Contact Dow concerning drums containing solid material. Do not store outside, protect from rain and temperature variations.

Bulk Storage

A properly designed bulk storage system for TDI must:

• Permit safe handling of the material
• Provide both moisture and temperature control
• Prevent contamination of the product
• Minimize the hazards of combustibility

Before attempting to construct such a system, it is essential that designers familiarize themselves with the hazards, safety recommendations and precautions associated with the handling and storage of TDI. A practical system must not only include the physical layout of the facilities and equipment, but must also include a plan for personnel safety in all areas of the operation. The establishment of safe work procedures must be an integral part of any bulk storage system. In addition, designers must consider all applicable insurance requirements, as well as governmental codes and regulations, and should consult with all appropriate local and state agencies during each stage of planning and construction.

The following equipment is suitable for bulk storage systems for TDI. However, this must not be considered a finished design. Also, similar equipment can be tested for performance and may provide equally good results.
Tanks

Tanks should be sized to meet plant and customer needs. Minimal capacity equivalent to 150 percent of normal monthly bulk receipt is suggested. Each storage vessel should be a welded, vertical or horizontal, cylindrical, stainless steel tank (A283C steel) built to API 650 Code and designed to hold the specified product safely when filled to capacity. Carbon steel tanks with an appropriate liner are acceptable.

Tanks should be equipped with the following openings:

- One 20-inch top manway
- One 20-inch shell manway 12 inches off floor
- One 3- or 4-inch roof nozzle for vent
- Three 1-1/2-inch roof nozzles for gauge
- One 2-inch shell nozzle near floor leading to a dished sump for drain
- Two 2- to 3-inch shell nozzles 12 inches above floor for inlet and outlet. Inlet and outlet are to be 90° apart
- One 1-inch, 3,000-pound coupling in shell 36 inches above floor for thermometer well

Tank vents should be passed through an activated carbon bed prior to discharging to the atmosphere ensuring that the discharge does not lead to an inhabited area exposing people and/or the environment.

Tank Design

For lined tanks, minimal radii recommended by the lining manufacturer must be observed. Full fillet interior welds should be used, and all splatter must be ground smooth. Welds must be continuous and smooth with no undercuts or porosity. The tank manufacturer should be responsible for providing the 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; then dried, sandblasted inside, and cleaned. A silica gel charge should be placed inside the tank prior to sealing it for shipment. Ensuring dryness is very critical - Moisture content should be 125 ppm maximum prior to putting the tank into service. Exterior scale should be removed and the exterior primed with one coat of red inorganic zinc primer. Silica gel charges in tanks must be removed and the system must be thoroughly cleaned, dried and purged with a dry gas pad prior to use.
**Linings**

Linings help prevent rust or iron pickup, which can cause product discoloration. Surface preparation and lining application should be conducted in strict accordance with the lining manufacturer recommendations. Only lining applicators who are licensed or approved by the lining manufacturer should be considered for application work.

Surfaces should be prepared and coated within 8 hours, during which proper temperature and humidity control should be maintained. In no case, however, should a lining application be attempted on a surface once evidence of rust has been detected. Also, if linings are applied in the shop, extra care must be exercised to prevent lining damage during transportation and erection of the tank. If any damage occurs, it should be thoroughly repaired prior to placing the tank in service. High-temperature, baked phenolic lining is satisfactory for storage of TDI, provided proper application and curing methods are employed.

Other satisfactory lining materials include: Heresite P403-L66; Bisonite 957; Plasite 3055, 3066 or 7122; Corturiet Phenguard 7436 and equivalent materials.

**Insulation**

Storage tanks located outdoors where they may be exposed to temperature extremes should be insulated with either a 1-inch or 1-1/2-inch thick polyurethane foam or 2-inch thick fibrous glass. Insulation must be sealed to prevent the collection of moisture, which could corrode the external tank wall. In addition, an effective weather cover should be used to protect the tank from rain, snow and ice.

Tanks located indoors may not need insulation. Interior storage tanks insulated with plastic foam should be covered with an effective flame barrier to minimize combustibility. To prevent lining damage, insulation and any necessary welding should be completed before the lining is installed.

**Pumps**

Steel or stainless steel standard centrifugal or positive displacement pumps equipped with mechanical seals have been found satisfactory. Sealless pumps (such as Chempump from Crane) and magnetic drive pumps (such as KONTRO and Magnatex pumps) are considered preferred. Do not use silicone greases. Also, mechanical seals should be purged with dry gas to prevent moisture from contacting the seal face, and causing urea formation and seal failure.

Depending upon preferred flow rates, two pumps for each system may be desirable. Truck unloading pumps should have a capacity of 100 to 150 gallons per minute. Lower rates, however, may be preferred for process pumps. If so, two suitably sized pumps should be used.
Pressure Relief Devices

Two types of valves are required:

- Pressure Relief Vacuum Valves (PRVV) for vents of tanks
- Relief valves for positive displacement pumps
- Pressure rupture discs

To prevent accumulation of vapors, each storage tank **must** be provided with a pressure-vacuum valve that relieves or terminates outdoors.

Also, provided that all parts and equipment are rated for a working pressure of 150 psig, each positive displacement pump should be equipped with a relief system set at a maximum of 125 psig. If parts and equipment are not rated at 150 psig, the relief should be set at 75 percent to 95 percent of the system’s lowest working pressure.

Pressure Gauges

Gauges should be provided at the pump, before and after filters, and near the process. They should be protected by a sealed diaphragm filled with a non-hydrocarbon fluid.

Sample Valves

To facilitate product sampling, 1/2-inch to 3/4-inch sample valves, which terminate in a stainless steel nipple, should be provided in each system.

Piping

Schedule 40 seamless carbon steel pipe (A53) and welded pipe joints with flanges and flanged valves work well. Threaded couplings and valves may also be used, provided that tape made of Teflon fluorocarbon fiber is used on all threaded fittings. Apply tape carefully. A liquid Teflon coating applied after the tape is recommended.

Selection of line sizes will be determined by product flow rate, system design and pump specifications. Normally, a line 2 inches in diameter is satisfactory, while for longer and more complex systems, 3 or 4 inches may be required. In any event, sizes should be established in conjunction with the pump supplier, keeping the diameter to the practical and economic minimum. Pipeline insulation and heating or cooling may be required if lines are either outdoors or in an area where normal room temperatures are not maintained.
Heating

TDI should be maintained at 21°C to 32°C (70°F to 90°F). Care should be taken to prevent the product from overheating to above 40°C (104°F). For heating uninsulated indoor storage tanks, an industrial heater may prove adequate. However, for outdoor insulated tanks, either external plate coils using steam to 25 psig or electrical tracing are recommended. If external coils are used for steam tracing, it is important to maintain appropriate conditions to avoid corrosion. To maintain suitable product temperatures, pipelines may also require insulation, tracing or both. See Figure 4 for a diagram of an isocyanate storage component system.

Heat Exchangers

Sometimes, heat exchangers are used in TDI systems. If heat exchangers are used, they should have an area 2 to 3 square feet per gallon/minute. It is important to ensure that cross contamination with water does not happen in water-based exchangers. A P&F (Plate and Frame) heat exchanger with double plates would help prevent contamination.

Figure 4: Typical Isocyanate Storage Component System
Gas Pad
Dry nitrogen is preferred. With nitrogen gas padding, it is critical to have good air circulation to prevent asphyxiation hazard as oxygen can be depleted. However, dry, oil-free air supplied by an air compressor and dryer may also be used. Either gas should have a maximum dew point of -40°C (-40°F). TDI tank atmospheres must be kept dry. If wet air is allowed to enter the tank, solid ureas will form. Over a period of time, a substantial amount of solids can accumulate.

Pressure Control Valves (PCV)
Use a low-pressure regulator to control the pressure in the isocyanate storage tank.

Temperature Indicators (TI)
The product's temperature may be accurately monitored with a dial-type thermometer inserted into a suitable thermowell. For a more accurate content temperature, be sure the thermometer is in direct contact with the thermowell.

Level Indicators (LI)
A level indicator is used to measure product level in the tank and to determine inventory. Electronic level indicators based on sonic principles are the best option. Another option is differential pressure cells (DPC). Glass/plastic tubing is not recommended due to breakage/spillage concerns which would result in exposure to TDI.

Strainers
Steel-cased, dual-line strainers with 100-mesh stainless steel reinforced wire screen baskets are recommended. Units should also be equipped with block valves that permit one side to continue in operation while the other is being serviced. It is very good to use two pressure gauges or manometers installed before and after the strainer to check appropriate strainer performance. It is strongly recommended that all unloading and process lines be equipped with either strainers or filters (e.g., use strainers on the unloading lines close to the tank and filters on the process lines close to the process).

Filters
Filters should be equipped with elements that are suitable to the product and desired flow rate. Bag-type filters are recommended, but 20-micron, cotton-wound elements with voile-covered steel mesh cores are suitable.
Meters
Use suitably sized meters. Meters should contain no aluminum, no aluminum alloys, and no synthetics other than Teflon fluorocarbon and Viton fluoroelastomer.

Valves
Cast steel, malleable iron or 316 stainless steel 150 psig valves are suitable for tank nozzles. Steel, malleable iron or iron 125 psig valves may be used on lines. Gate, ball or plug valves also may be used, provided no internal lubrication is required. Valve packing, if required, should be braided Teflon fluorocarbon fiber. Also, ball valves should have seals of Teflon.

Gaskets
Gaskets of braided Teflon fluorocarbon fiber may be used. Spiral-wound gaskets and gaskets filled with Teflon and GYLON material also work well. Re-using gaskets is not recommended.

Hoses
Hoses should be made of either Teflon fluorocarbon or Viton fluoroelastomer. For permanent and continuous service, use only flexible, seamless metal, steel or stainless steel hoses. A hose maintenance program is critical and yearly pressure tests are recommended (water contamination is a concern with pressure tests but this can be avoided by using a solvent such as perchloroethylene to clean prior to testing).

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

Foundations
Depending on load and soil conditions, reinforced concrete pads, concrete rings, reinforced concrete piers or crushed stone rings may be used. Vertical tank bottoms should be coated and, if outdoors, sealed to the foundation with asphalt. Also, if ring foundations are used, the centers should be filled with compacted, oiled sand. If oiled sand is used, consult with an environmental expert to ensure that you address any concerns to the environment.
Paint
All steel equipment used outdoors should be carefully cleaned and coated with a suitable primer.

Dual-Service Equipment
Equipment to be used for two or more TDI products should be designed so it can be drained and blown dry between products but it is important to not use the same equipment for other products as cross-contamination will occur. Manifolds should not be used. Instead, switch-hose and quick-coupler connections should be made between dual-service equipment and individual product lines.

Drains
All equipment should be provided with drains that 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 area.

Ventilation
Indoor storage systems should be housed in a separate room, equipped with exhaust fans and intakes to minimize vapor accumulation in the event of a leak or spill.

Miscellaneous
• Waste control, disposal and air pollution control measures should comply with federal, state, provincial and local laws, regulations, codes and ordinances. Proper systems and operational controls should be instituted and carefully maintained.

• All equipment and facilities, as well as their installation, should conform to the specifications and requirements of appropriate federal, state, provincial and local laws, regulations, 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 made available at all loading and unloading stations.

• All electrical equipment, such as motors and switches, as well as their installation and use, must conform to codes established by Underwriters Laboratories (UL).

• All tanks should be equipped with a low-point drain so that the tank may be completely emptied for cleaning, inspection or repair.

• All liquid bulk storage systems should be hydrostatically tested prior to lining, insulation or use.
• All systems, should have adequate waste control and disposal facilities, as well as sources of air, water, steam and electric power for operation and cleaning.

• **Isocyanate:** Equipment containing copper, zinc, tin or their alloys, including brass, bronze or galvanized materials, should not be exposed to liquid isocyanate or its vapors. Also, do not expose either rubber or synthetics – except Teflon fluorocarbon or Viton fluoroelastomer – to isocyanate liquid or vapor.

• **Silica gel charges:** Silica gel charges on tanks must be removed, and the system must be thoroughly cleaned, dried and purged with a dry gas pad prior to use. As the minimum dew point recommended is -40°C (-40°F), it should be noted that silica gel can only bring the dew point from 0-10°C (32-50°F) and this can result in undesired isocyanate reaction with water content of humid air.

**CAUTION:** Virtually all chemicals possess some degree of toxicity. Before handling a new chemical, it is essential that its toxicological properties, as well as potential hazards associated with its handling and use, be thoroughly studied and understood. Based upon this study, appropriate health and safety standards should then be established and maintained. Before working with VORANATE™ T-80 TDI, obtain a copy of the current SDS by contacting Dow’s CIG at numbers provided on page 52.
APPENDIX – Additional Resources

Printed Materials
For further information, you may want to consult literature published by the following firms and organizations:

American Chemistry Council (ACC)
1300 Wilson Blvd.
Arlington, VA 22209
(703) 741-5000
www.americanchemistry.com/dii

Center for the Polyurethanes Industry (CPI)
1300 Wilson Blvd.
Arlington, VA 22209
http://www.americanchemistry.com/polyurethane
www.polyurethane.org
703-741-5103

International Isocyanate Institute
http://www.diisocyanates.org/

ISOPA - European Diisocyanate and Polyol Producers Association
Av. E. Van Nieuwenhuys Laan 4, Box 9
B-1160 Brussels
Tel: ++32 2 676 74 75
www.isopa.org

American Conference of Governmental Industrial Hygienists (ACGIH)
1330 Kemper Meadow Drive, Suite 600
Cincinnati, OH 45240
(513) 742-2020
www.ACGIH.org
Manufacturers and Suppliers of Bulk Handling and Storage Equipment

For a list of manufacturers and suppliers of equipment that may be used for TDI bulk handling and storage, consult your local phone book, Thomas Register, Standard & Poor’s or the Dun & Bradstreet Reference Book of Manufacturers.
Manufacturers and Suppliers of Respiratory Equipment

The authority for approving or certifying respirators in the United States is held jointly by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA). (In Canada, refer to the Canadian Standards Association [CSA] standard “Selection, Care and Use of Respirators,” Z94.4.) For current information on the status of approvals of respirators, e-mail NIOSH: pubstaff@cdc.gov, or call 1-800-356-4674. Another source for information is the OSHA Respiratory Protection Standard 29CFR 1910.134.

Product Stewardship

Dow strongly encourages its customers to review both their manufacturing processes and their application of Dow products from the standpoint of human health and environmental quality. To help ensure that Dow products are not used in ways for which they are not intended or tested, Dow personnel will assist customers in dealing with ecological and product safety considerations. Dow product literature, including current Safety Data Sheets must be consulted prior to use of Dow products. Additional safety and handling information can be obtained by contacting Dow’s Customer Information Group at:

**CIG North America**
1-800-441-4DOW (4369)

**CIG Europe**
+800-3-694-6367 (International toll-free from Austria, Belgium, Denmark, Finland [prefix 990], France, Germany, Hungary, Ireland, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom)

800 783 825 (Italy toll-free national)
0800 99 5078 (South Africa toll-free national)

**CIG Pacific**
+800 7776 7776 (except Indonesia and Vietnam)

**CIG Brazil**
+55-11-5188-9222

**CIG Latin South Region (Argentina, Chile, Peru)**
+54-11-4510-8777

**CIG Latin America (General)**
+55-11-5188-9000
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