The information, specification, procedures, methods and recommendations herein are presented in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may exist or occur. No representation, guarantee or warranty is made as to the accuracy, reliability or completeness of said information, specifications, procedures, methods and recommendations or that the application or use of any of the same will avoid hazards, accidents, losses, damages or injury of any kind to persons or property or that the same will not infringe patents of others or give desired results. Readers are cautioned to satisfy themselves as to the suitability of said information, specifications, procedures, methods and recommendations for the purposes intended prior to use.
The CEFIC (European Chemical Industry Council) Responsible Care Program requires that Chemical Companies demonstrate their commitment to continuously improve all aspects of Performance which relate to Protection of Health, Safety and the Environment.

An overview of the Key Elements of CEFIC’s Distribution Responsible Care Program is contained in Appendix 1.

These Guidelines have been prepared by a Task Force under the direction of the CEFIC Propylene Oxide Sector Group as their execution program with regard to the application of Responsible Care in the distribution of Propylene Oxide. They are consistent with the CEFIC Recommendations on Safe Management Practices in Distribution and establish appropriately high standards of safety for the distribution of Propylene Oxide. The key elements of these Management Practices are contained in Appendix 2.

Although Propylene Oxide is a hazardous material in terms of flammability, reactivity and toxicity, it can be distributed and handled safely provided that appropriate precautions are observed.

The Distribution of Propylene Oxide is already subject to regulations within most countries in Europe. In addition, the international movement of Propylene Oxide by road, rail, sea or river/canal is subject to international agreements which lay down specific requirements concerning distribution which must be observed by all parties involved. National regulations may differ from international regulations.

These Guidelines take into account the distribution of Propylene Oxide in bulk road tankers, rail tank wagons, sea tank ships, barges and tank containers. They cover all aspects of the transport activity from loading to delivery point. Reference to existing regulatory controls is only made where this is considered necessary for the purpose of clarification.

Since drum shipments are not carried out by the Sector Group Propylene Oxide manufacturers, specific distribution risk management requirements for drum shipments are not discussed in these guidelines. However, individual companies can offer advice upon request.

The CEFIC Propylene Oxide Sector Group recommends that these Guidelines are adopted by all parties who are involved in the distribution of Propylene Oxide. This includes Commercial Transactions, Swap, Toll or Trade agreements and Customer Collection Arrangements.

The Sector Group Members will review these Guidelines on a regular basis.
2 Product Information

2.1 General Data

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>EINECS Number</td>
<td>200-879-2</td>
</tr>
<tr>
<td>Index Number</td>
<td>603-055-00-4</td>
</tr>
<tr>
<td>CAS Number</td>
<td>75-56-9</td>
</tr>
<tr>
<td>Synonyms</td>
<td>1,2-Epoxypropane, Epoxypropane, Methyl Ethylene Oxide, Methyloxirane, 1,2-Propylene Oxide</td>
</tr>
<tr>
<td>Form</td>
<td>Liquid</td>
</tr>
</tbody>
</table>

HAZARDS IDENTIFICATION

Extremely flammable.
May cause cancer.
May cause heritable genetic damage.
Harmful by inhalation, in contact with skin and if swallowed.
Irritating to eyes, respiratory system and skin.

WARNING PROPERTIES

The odour of this material is inadequate to warn of excessive exposure.
## 2.2 Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar mass</td>
<td>58.08 g/mol</td>
</tr>
<tr>
<td>Melting Point (101.3 kPa)</td>
<td>-111.9°C</td>
</tr>
<tr>
<td>Boiling Point (101.3 kPa)</td>
<td>34.2°C</td>
</tr>
<tr>
<td>Flash Point (closed cup)</td>
<td>-37°C</td>
</tr>
<tr>
<td>Critical Temperature</td>
<td>209.1°C</td>
</tr>
<tr>
<td>Critical Pressure</td>
<td>4920 kPa</td>
</tr>
<tr>
<td>Critical Density</td>
<td>312 kg/m³</td>
</tr>
<tr>
<td>Critical compressibility factor</td>
<td>0.2284</td>
</tr>
<tr>
<td>Autoignition temperature in air at 101.3 kPa</td>
<td>430°C</td>
</tr>
<tr>
<td>Explosive limits in air (STP): - lower</td>
<td>1.7 vol%</td>
</tr>
<tr>
<td>- upper</td>
<td>37.0 vol%</td>
</tr>
<tr>
<td>Heat of combustion (25°C 101.3 kPa)</td>
<td>-33035 kJ/kg</td>
</tr>
<tr>
<td>Heat of polymerization</td>
<td>-1500 kJ/kg</td>
</tr>
<tr>
<td>Heat of fusion</td>
<td>112.6 kJ/kg</td>
</tr>
<tr>
<td>Heat of solution in water at 25°C</td>
<td>-45 kJ/kg</td>
</tr>
<tr>
<td>Heat of formation of the ideal gas (25°C)</td>
<td>-1600 kJ/kg</td>
</tr>
<tr>
<td>Heat of formation of liquid Propylene Oxide (25°C)</td>
<td>-2080 kJ/kg</td>
</tr>
<tr>
<td>Standard enthalpy (298.15K)</td>
<td>248 kJ/kg</td>
</tr>
<tr>
<td>Standard entropy (298.15K, 1 atm.)</td>
<td>4.94 kJ/kg-1 K-1</td>
</tr>
<tr>
<td>Free energy of formation (25°C, 101.3 kPa)</td>
<td>459 kJ/kg</td>
</tr>
<tr>
<td>Cubic expansion coefficient at 20°C</td>
<td>0.00151 1/K</td>
</tr>
<tr>
<td>Solubility of Propylene Oxide in water at 20°C</td>
<td>40.5 wt%</td>
</tr>
<tr>
<td>Solubility of water in Propylene Oxide at 20°C</td>
<td>12.8 wt%</td>
</tr>
<tr>
<td>Density gr/cm³ at 20°C</td>
<td>0.83</td>
</tr>
<tr>
<td>Relative vapour density (air=1)</td>
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</tr>
<tr>
<td>Vapour pressure (kPa at 20°C)</td>
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</tr>
<tr>
<td>Saturation concentration at 20°C</td>
<td>1360 g/m³</td>
</tr>
<tr>
<td>Minimum ignition energy</td>
<td>0.13 mJ</td>
</tr>
<tr>
<td>Flashpoint of 1% aqueous solution</td>
<td>23°C</td>
</tr>
</tbody>
</table>
2.3 **Flammability Hazards**

Propylene Oxide, a colorless highly volatile liquid with a sweet ethereal odour, is extremely flammable with a flashpoint of -37°C and a wide explosive range of 1.7-37 Vol% in air. The vapour is heavier than air and spreads at ground level, with the risk of ignition at great distance and flash back. Propylene Oxide has an ignition energy of 0.13 mJ.

2.4 **Reactivity Hazards**

Bases, acids or metal halides can cause violent polymerization. Propylene Oxide is presumed to be able to form peroxides and thus to polymerize. Do not use compressed air when filling, emptying or processing. Reacts violently with oxidants, organic and inorganic acids, organic and inorganic bases, anhydrides, chlorides of iron, aluminium and tin, chlorine, amines, ammonia and alkali metals with risk of fire and explosion. Do not use clay based absorbent materials.

2.5 **Toxicology and Occupational Health Hazards**

2.5.1 **Inhalation**

Propylene Oxide is classified as harmful by inhalation and irritating to the respiratory system.

Inhalation studies in laboratory animals suggest a “no effect level” of 150 ppm. Repeated exposure was associated with central nervous system depression and irritation of the eyes and respiratory system. Moderate damage to the nasal epithelium was seen in rats after repeated exposure to 200 - 400 ppm.

In humans, exposure to Propylene Oxide at several hundred ppm may result in headache, dizziness, drowsiness, nausea, chest discomfort and cough. Higher concentration (above 1000 ppm) may cause irritation and oedema of the respiratory tract and loss of consciousness. The odour threshold in air is 100 - 350 ppm. This is well above the occupational hygiene level, hence smell should not be used as an indicator of exposure to Propylene Oxide.
2.5 Toxicology and Occupational Health Hazards

2.5.2 Oral toxicity

Propylene Oxide is classified as harmful by ingestion.

Oral LD₅₀ values in the range of 520 - 1140 mg/kg have been reported from animal studies.

2.5.3 Skin contact

Propylene Oxide is classified as harmful and irritating after contact with skin.

The dermal LD₅₀ is in the range of 1240 - 7200 mg/kg for rabbit and guinea pig, respectively. It is moderately irritating to rabbit skin.

In an occupational setting, skin irritation following accidental contact with liquid Propylene Oxide will be minimised if the material is allowed to evaporate freely, although contact for several minutes may produce moderate to severe irritation. Aqueous solutions (10 % vol/vol or greater) are more irritating than undiluted material. Note that such conditions may arise following dissolution of Propylene Oxide in body sweat.

Prolonged or repeated skin contact will result in the development of chemical burns, blistering and swelling. There are reports that it may also produce allergic dermatitis.

2.5.4 Eye contact

Propylene Oxide is classified as irritating to the eyes.

High vapor concentrations may cause eye irritation, while liquid will produce corneal burns with permanent impairment of vision possible.
2.5 Toxicology and Occupational Health Hazards

2.5.5 Carcinogenicity

Propylene Oxide is classified as a Category 2 carcinogen (i.e. a substance which should be regarded as if it were carcinogenic to man).

The occurrence of nasal tumours in rats and mice was increased after lifetime inhalation exposure to 400 ppm, but not at 200 ppm. Shorter term (30 day) exposure to 900 ppm caused marked nasal irritation, but no increase in tumours was recorded during a 155 week follow-up period. The findings suggest a weak carcinogenic response in rodents that is confined to the principle site of contact (i.e. nasal tissue). There is no conclusive evidence of any carcinogenic effect in humans.

2.5.6 Mutagenicity

Propylene Oxide is a direct alkylating agent which combines with proteins and DNA, causing gene mutation and chromosomal aberrations in in vitro test systems. An increased frequency of micronuclei was reported in mice following intraperitoneal administration of Propylene Oxide, but not after oral treatment. The incidence of sister chromatid exchanges was unaltered in monkeys following inhalation exposure to 300 ppm Propylene Oxide over two years.

Experimental studies have also shown that Propylene Oxide may form DNA adducts in rats after repeated exposure to high atmospheric concentrations (500 ppm over four weeks). The biological relevance of these findings are unclear, however, since Propylene Oxide was inactive in a dominant lethal assay in rodents suggesting these adducts do not give produce heritable mutations in sperm. Nonetheless the findings lead to the classification of Propylene Oxide as a Category 2 mutagen (i.e a substance which should be regarded as if it were able to cause heritable mutations in man).

2.5.7 Effects on reproductive system

No effect on fertility, litter size, neonatal growth or survival was seen in male and female rats exposed to 300 ppm Propylene Oxide by inhalation over two generations. Foetotoxicity and developmental effects in laboratory animals exposed during pregnancy have been reported only after exposures that were maternally toxic.
2.6 Emissions and Degradation

Propylene Oxide is not known to occur naturally.

Occurrence of Propylene Oxide in the environment is expected to be mainly in the atmosphere due to fugitive emissions from production or further processing.

In the atmosphere, Propylene Oxide is indirectly degraded by reaction with photochemically produced hydroxyl radicals. The half-life of Propylene Oxide in the atmosphere is estimated to be 13 - 35 days. Propylene Oxide is not expected to contribute to ozone depletion.

In water, Propylene Oxide is rapidly hydrolyzed to propylene glycol with an estimated half-life of 4 - 12 days. Biodegradation under aerobic static laboratory conditions is moderate to high. According to MITI, Propylene Oxide is readily biodegradable. The chloride ion in salt water accelerates the chemical degradation with a half-life of 2 - 4 days. Furthermore, Propylene Oxide is eliminated from water by volatilisation with a half-life of 3 days for rivers and up to 18 days for lakes. Propylene Oxide toxicity to fish or daphnia is low.

Propylene Oxide rapidly evaporates from dry surfaces and is moderately volatile from wet surfaces.

Propylene Oxide is expected to be very mobile in soil. In moist soils, hydrolysis will be the most significant degradation process.

Accumulation in biological or environmental systems is not to be expected.
2.7 International Transportation Regulations

Road, rail & barge


<table>
<thead>
<tr>
<th>Proper shipping name:</th>
<th>PROPYLENE OXIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck, ADR loaded:</td>
<td>3 F1 Packing Group I Label: 3</td>
</tr>
<tr>
<td>Rail, RID loaded:</td>
<td>3 F1 Packing Group I Label: 3</td>
</tr>
<tr>
<td>UN number:</td>
<td>1280</td>
</tr>
<tr>
<td>Hazard Identification Nbr.:</td>
<td>33</td>
</tr>
<tr>
<td>Tremcard Nbr. CEFIC:</td>
<td>T-158</td>
</tr>
<tr>
<td>ERIC Nbr.:</td>
<td>3·21</td>
</tr>
</tbody>
</table>

| Barge - ADNR Loaded: | 3·2a Empty: 3·71 Label: 3 |
| Ship Type:           | C Blue cones / lights: 1 |
### 2.7 International Transportation Regulations

#### Sea (containers)


<table>
<thead>
<tr>
<th>Proper shipping name:</th>
<th>PROPYLENE OXIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMO/IMDG Class: 3</td>
<td>Packing Group: I</td>
</tr>
<tr>
<td>UN Nbr: 1280</td>
<td>Label: 3</td>
</tr>
<tr>
<td>Tank Type: UN-T11, (IMO-1)</td>
<td>Test Pressure (bar): 6.0</td>
</tr>
<tr>
<td>Marine Pollutant: NO</td>
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</tr>
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</table>

#### Sea (bulk)

<table>
<thead>
<tr>
<th>Proper shipping name: PROPYLENE OXIDE</th>
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<tbody>
<tr>
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<tr>
<td>UN Nbr: 1280</td>
</tr>
<tr>
<td>Tank Type: 2G</td>
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<tr>
<td>Marine Pollutant: YES, Pollution category: C</td>
</tr>
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</table>

#### Air

<table>
<thead>
<tr>
<th>Proper shipping name: PROPYLENE OXIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAO/IATA Class: 3</td>
</tr>
<tr>
<td>UN Nbr: 1280</td>
</tr>
<tr>
<td>Cargo: 304</td>
</tr>
</tbody>
</table>

**Remarks:**
Sample shipment not allowed by mail

See glossary for abbreviations
2.8 EEC Labelling / Special Risks

Safety Advice

Classification


<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Risk Phrase</th>
<th>Labeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>F+</td>
<td>Extremely flammable</td>
<td>R12</td>
<td></td>
</tr>
<tr>
<td>Carcinogen</td>
<td>Category 2</td>
<td>R45</td>
<td></td>
</tr>
<tr>
<td>Mutagen</td>
<td>Category 2</td>
<td>R46</td>
<td></td>
</tr>
<tr>
<td>Xn</td>
<td>Harmful by inhalation, in contact with skin and if swallowed</td>
<td>R20/21/22</td>
<td></td>
</tr>
<tr>
<td>Xi</td>
<td>Irritating to eyes, respiratory system and skin</td>
<td>R36/37/38</td>
<td></td>
</tr>
</tbody>
</table>

Labelling

F+, T

Risk Phrases

<table>
<thead>
<tr>
<th>Risk Phrase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R45</td>
<td>May cause cancer</td>
</tr>
<tr>
<td>R46</td>
<td>May cause heritable genetic damage</td>
</tr>
<tr>
<td>R12</td>
<td>Extremely flammable</td>
</tr>
<tr>
<td>R20/21/22</td>
<td>Harmful by inhalation, in contact with skin and if swallowed</td>
</tr>
<tr>
<td>R36/37/38</td>
<td>Irritating to eyes, respiratory system and skin</td>
</tr>
</tbody>
</table>

Safety Phrases

<table>
<thead>
<tr>
<th>Safety Phrase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S53</td>
<td>Avoid exposure obtain special instructions before use</td>
</tr>
<tr>
<td>S45</td>
<td>In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)</td>
</tr>
</tbody>
</table>
3.1 Loading Operations

3.1.1 The loading of any road tanker, tank container, rail tank car or barge / vessel with a dangerous substance is a potential hazard. It is therefore important that loading facilities and transport equipment are correctly designed and constructed, and properly used and maintained.

3.1.2 The design and construction of transport equipment is described in Appendices 6 to 8 of these Guidelines. Equipment that meets the requirements of the ADR, ADNR, RID and IMO Regulations is subjected to periodic inspection and testing requirements as laid down in these Regulations. These inspections and tests are carried out by the competent authorities.

3.1.3 Written operating instructions should be available for all filling points covering the loading of Propylene Oxide into bulk road tankers, tank containers, rail tank cars, barges or vessels, and personnel involved should be fully trained in their use. The instructions should recognise the specific hazards of Propylene Oxide, and ensure the correct operation of filling equipment in both normal and emergency situations.

3.1.4 All necessary protective clothing and emergency equipment should be available for loading operations. Personnel should be trained in the correct use of this clothing and equipment.
3.1.5 It is not the intention in this Section of these Guidelines to attempt to set detailed operating instructions for loading Propylene Oxide, since these, of necessity, will depend upon local situations. However, as part of the operating instructions, an inspection of the transport equipment should be carried out by the loading terminal staff before, during and after loading. This inspection does not replace nor diminish the responsibility of the owner of the road tanker, tank container, rail tank car, barge or vessel to ensure that the equipment is properly tested, maintained and fit for purpose. It is meant to ensure that the transport of Propylene Oxide is conducted as safely as possible. The inspection list detailed in Appendix 3 is recommended for use by the supplier to check the condition of the Propylene Oxide transport equipment, and this should apply to the loading operations of rail and road mode. Barges and vessels have specific checklists according to ADNR/IMO regulations.
3.2 Transport of Propylene Oxide by Road

3.2.1 The carrier is responsible for the safe transport of Propylene Oxide by road from the loading point to the discharge point. Road carriers must meet all relevant national and international regulations relating to Propylene Oxide. Road carriers should preferably have a Quality system (like ISO 9000) and participate in a SQAS scheme.

3.2.2 Routing

Propylene Oxide should only be transported on defined routes. The route to be followed must be selected carefully and should be known to both the carrier and the consignor.
As far as possible, the route should:
a. utilise motorways,
b. avoid areas of high population density.

3.2.3 Delays or accidents

All delays during transport, whether due to severe weather conditions, breakdown or other reasons must be reported to the consignor as soon as possible. Transport accidents must also be reported to the consignor as soon as possible.

3.2.4 Emergency procedure

Recommended instructions are given in the Transport Emergency Card.
3.2 Transport of Propylene Oxide by Road

3.2.5 Ferry selection

The consignor will ensure that he knows which ferry operators are being used by the road carrier and will satisfy himself of their suitability.

3.2.6 Customer collection

Customer collection should be avoided, except for co-producers. However, if such collections take place, Appendix 3 should be used.

3.2.7 Multimodal transport

Tank containers are often transported in a multimodal system. This is generally organised by the carrier. Management systems shall be in place to ensure quality and safety of operations by the carrier for the complete supply chain. This system should preferably be checked by means of a SQAS.

3.2.8 Subcontracting

Contractual arrangements between consignor and carrier should explicitly state that transport must not be subcontracted without prior approval of the consignor. The subcontractor must fulfil the same requirements as the principal carrier.
3.3 Transport of Propylene Oxide by Rail

3.3.1 The appropriate railway companies or authorities are responsible for the safe transport of Propylene Oxide by rail from despatch location to final reception facilities. The selection of route, intermediate stopping locations and delay of traffic due to severe weather conditions are matters to be decided by the railway companies and authorities.

As SQAS Rail is now available, it should progressively be used.

3.3.2 In case of multimodal transport, terminals should comply with acceptable safety standards in particular to firefighting capabilities and security systems.

3.3.3 In the event of derailment, leak or other problems involving rail tank cars with Propylene Oxide the railway companies or authorities should inform the consignor immediately.

3.3.4 The consignor will ensure that they are informed which rail-ferry operators the national railways are using.
3.4 Transport of Propylene Oxide by Sea

3.4.1 Transport of Propylene Oxide by sea may be either:
   a. by roll on/roll off ferries, or
   b. lift on/lift off shipment in tank containers
   c. bulk by seagoing vessels

3.4.2 Because of the nature of the transport, a number of different parties may be involved in the transport of Propylene Oxide from consignor to customer. These may include the shipping company, port or harbour authorities and carriers.

3.4.3 Prior to the commencement of each traffic flow, the consignor should make sure that all parties involved have adequate EH&S standards.

   Particular areas of interest are:
   a. the shipping company,
   b. loading/unloading facilities at container terminals,
   c. emergency handling within hazardous cargo yards at container terminals,
   d. emergency handling on board,

   The EH&S system should preferably be checked by means of a CDI-Marine inspection or equivalent scheme.

3.4.4 The consignor should issue specific instructions for the control of the operation to all parties involved and the actions to be taken in the event of an emergency.

3.4.5 Transport by sea and inland waterways in bulk requires a suitable ship or barge that is certified to carry Propylene Oxide. Refer to Appendix 4 for details.
3.5 Unloading Operations

3.5.1 The unloading of any road tanker, tank container, rail tank car, ship or barge of Propylene Oxide is a potential hazard. It is therefore important that unloading facilities are correctly designed and constructed, and properly used and maintained.

Couplings should be standardised as much as possible.

3.5.2 Unloading facilities should be designed and located having due regard to the potential hazards associated with Propylene Oxide. The equipment should be subject to regular and documented checks to ensure reliability.

3.5.3 Written operating instructions should be available for unloading Propylene Oxide from road tankers, tank containers, rail tank cars and ships as appropriate, and personnel involved should be fully trained in their use. The instructions should recognise the specific hazards of Propylene Oxide, and ensure the correct operation of unloading equipment in both normal and emergency situations.

3.5.4 All necessary protective clothing and emergency equipment should be available for unloading operations. Personnel should be trained in the correct use of this clothing and equipment.

3.5.5 Maintenance of transport equipment. Customers are requested to report any difficulties, which are experienced with the operation of valves, immediately to the consignor. The use of an information tag on the returning transport equipment identifying the problem can be of assistance.

3.5.6 The conditions for discharge of Propylene Oxide at a customer’s premises are the customer’s responsibility. It is good Responsible Care practice for the supplier to assess the ability of the customer to unload and store the product in a safe way.

If an EH&S visit is made, the scheme included in Appendix 5 may be used as a checklist. Normally the customer himself should evaluate whether his premises, especially his reception and storage facilities, correspond with the requirements of the scheme included in Appendix 5.
4.1 Current Operating Practices

The Propylene Oxide manufacturers use different types of equipment for the transport of Propylene Oxide for rail and road mode.

- Equipment for the bulk transport of liquids (BL).
- Equipment for the bulk transport of liquified or pressurized gases (LG).

Both types of equipment are in accordance with the regulations for the different transport modes. The key specification issues of the two types of equipment are described individually.

4.2 Design and Construction of Railcars (rail tank wagons)

Railcars for the carriage of Propylene Oxide must meet the design and construction requirements of:

a. National Regulations or Local Railway Administration Regulations, when used for national transport.
b. International Regulations, such as the International Regulations concerning the Carriage of Dangerous Goods by Rail (RID), when used for international transport.

In addition it is recommended that railcars are designed and constructed in accordance with the recommendations contained in Appendix 6.
Blockade to fix a railcar together with a spiral spring handle (in German: Federbein), which closes the valves automatically when the railcar rolls away.

Rail hook combined with a remote control, which closes the bottom valve if activated.
4.3 Design and Construction of Tank Trucks (road tankers)

Tank trucks used for the carriage of Propylene Oxide by road must meet the design and construction requirements of:

a. National Regulations, when used for national transport
b. International Regulations, such as the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), when used for international transport.

In addition to the above requirements, it is recommended that tank trucks are designed and constructed in accordance with the recommendations contained in Appendix 7.

4.4 Design and Construction of Tank Containers

Tank containers may be used for the carriage of Propylene Oxide by road, rail, and sea. They must meet the design and construction requirements of the appropriate National or International Regulations depending upon the specific transport modes which are to be utilised.

In addition to the above requirements, it is recommended that tank containers are designed and constructed in accordance with the recommendations in Appendix 7.
4.5 Design and Construction of Vessels and Barges

Vessels used for the carriage of Propylene Oxide by sea must meet the design and construction requirements of:
International Regulations such as the international Code for the construction and equipment of ships carrying dangerous chemicals in bulk as produced by the International Maritime Organisation (IMO).

Barges used for the carriage of Propylene Oxide by inland waterways must meet the design and construction requirements of National and International Regulations for the design and construction of barges such as the regulations concerning the Transport of Dangerous Substances in Barges on the River Rhine (ADNR).

In addition to the above requirements, it is recommended that the vessels and barges are designed and constructed in accordance with the recommendations contained in Appendix 8.

4.6 Design and Construction of Storage Tanks

The storage and handling of Propylene Oxide is subject to legislative controls in many countries. The design and construction of storage tanks for Propylene Oxide must therefore comply with national legislative controls. The general guidelines contained in Appendix 9 exemplify the best general practice which is followed within the Propylene Oxide manufacturing industry and should be used provided it does not conflict with any specific legal obligation.
4.7 Design and Construction of Loading and Unloading Facilities

As transport and storage equipment have their own specific design and construction requirements it is essential to ensure the correct design of equipment for loading and unloading facilities. Loading and unloading facilities should be designed and located to meet appropriate engineering standards having due regard to the hazards associated with the handling of Propylene Oxide and the transfer rates which are to be achieved. Particular attention should be given to the ergonomics of connecting transportation equipment and to the health and safety protection of operators.
5.1 Emergency Planning

5.1.1 All Propylene Oxide producers involved in transporting Propylene Oxide in Europe should have an established Emergency Plan for receiving transport incident reports and for providing expert advice by telephone and, as necessary, at the incident scene to the Emergency Services on how to minimise any danger arising from an incident on road, rail or waterway. The CEFIC document “Distribution Emergency Response - Guidelines for Use by the Chemical Industry” provides advice on setting up a Company Emergency Plan.

5.2 Measures in the Event of a Release of Propylene Oxide

5.2.1 • Shut off all potential ignition sources and leaks, if without risk
• No open flames
• Keep upwind
• Isolate area and deny entry
• Do not get into eyes
• Avoid contact with skin
• Avoid breathing vapour

5.2.2 • Dilute liquid spills with large amounts of water
• Use water spray to reduce the extent of vapour
• Avoid the use of clay-based absorbents
• Dike larger spills and recover
• Prevent entry into sewers and/or natural waters
• If substance has entered a water course or sewer, inform/advise Authorities
5.2.3  By covering a liquid spill as quickly as possible with alcohol foam, evaporation and hence the formation of a flammable gas cloud can be prevented. The released liquid must then be recovered and transferred to sealable tanks or drums. Any remaining quantities of Propylene Oxide should be absorbed into suitable materials such as sand and transported in closed drums to a suitable processing installation. The recommended method of disposal is by incineration.

5.3  Fire Fighting

5.3.1  Do not put out any fire until leak is shut off. The reason is to prevent reflash.

5.3.2  Cool containers exposed to heat / fire with water, to prevent overpressure / bursting

5.3.3  Small fires: use dry chemical or carbon dioxide (CO₂)

5.3.4  Large fires: use water spray, fog or alcohol foam

5.3.5  Massive fires:

- use unmanned hose holders or monitor nozzle
- consider to let the fire burn out
- dike liquid run-off
- prevent entry into sewers and/or natural waters
6.1 Personal Protection

6.1.1 Do not wear rings, or watches because they can entrap material and cause irritation, even a burn

6.1.2 Eye protection: use chemical goggles

6.1.3 Normal protective equipment should be worn during routine handling

6.1.4 Clothing for spill and fire:
- wear full protective clothing, PO resistant gloves under gauntlet type nitrile rubber gloves, rubber safety boots and approved positive pressure breathing apparatus
- remove contaminated clothing immediately, preferably under safety shower / fire hose spray, and wash before re-use
- destroy contaminated shoes and leather items

6.2 First Aid and Medical Treatment

Never give fluids or induce vomiting if patient is unconscious or is having convulsions.

Inhalation

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to medical facilities for immediate medical advice.
6.2 First Aid and Medical Treatment

**Skin contact**

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Seek medical attention immediately. Wash clothing before reuse. Destroy contaminated shoes. Call a physician if irritation persists.

**Eye contact**

Immediate and continuous irrigation with running water for at least 15 minutes is imperative. Prompt medical consultation is essential. Seek medical attention immediately.

**Ingestion**

If swallowed, rinse mouth and go immediately to hospital. Inducement of vomiting to be indicated only by a doctor.

**Note to physician**

Causes central nervous system depression. If burn is present, treat as any thermal burn, after decontamination. Treat symptomatically. No specific antidote. Supportive care. Treatment based on judgement of the physician in response to reactions of the patient.
Cefic and Responsible Care

1. **Responsible Care - a public commitment**

“Chemical companies shall demonstrate their commitment to continuously improve all aspects of performance which relate to protection of health, safety and the environment.”

2. **Prevention of accidents**

Within Responsible Care, prevention is a prerequisite to Emergency Response. The CEFIC-ICE (International Chemical Environment) prevention programme provides a valuable tool in reducing the number of incidents during the distribution of chemicals, from the time they leave the factory gate until their arrival at the customer’s premises.

3. The objective is to minimize the possibility for incidents to happen. Since most distribution activities are subcontracted and since compliance with regulations is a necessary but not a sufficient condition to prevent accidents, there is a need for uniform safety & quality criteria against which distribution companies are regularly assessed. Unlike ISO 9002, which concentrates on quality, at a level set by the individual distribution company, SQAS - Safety & Quality Assessment Systems - provide objective performance indicators, which allow the monitoring of continuous improvements.
Cefic and Responsible Care

4. Based on detailed questionnaires, distribution contractors can be assessed by a qualified third party. Questions relate to management, equipment and operations, split by: statutory requirements, additional chemical industry requirements and desirable items. Scoring results can be presented in different ways but it is up to each individual chemical company to evaluate the results according to its own standards.

The distribution contractors will include:
- Marine transport: Vessels and barges (Ferries)
- Road transport: Road carriers
- Storage operations: Terminals/Warehouses
- Ferry operators

5. Emergency response

Although the chemical industry has a fine record in preventing chemical transport incidents, it is committed to continuous improvement. The ICE Emergency Response scheme, a cooperative programme coordinated by CEFIC, will provide emergency response across national boundaries. It aims to build upon the best existing prevention practices, preserve proven emergency response schemes and extend the best emergency schemes to countries where none exist.

The chemical industry makes its expertise available to authorities - who are normally in charge of the emergency - at three levels of assistance.

Level 1: Remote information and general advice by telephone or fax.
Level 2: Presence of an expert who will provide advice at the scene of an incident.
Level 3: Actual help with equipment and personnel at the scene of an incident.

For detailed information on this subject consult: “the CEFIC Distribution Emergency Response Guidelines for use by the Chemical Industry”, issued in 1993.
Cefic Recommendations on Safe Management Practices in Distribution.

These recommendations (issued in 1993) conform to the principles of Responsible Care and include the following topics.

1. Safety, health and environmental policies
2. Auditing
3. Risk reduction
4. Specification of packages, tanks and other equipment
5. Incidents evaluation
6. Codes and regulations
7. Control operations
8. Training
9. Selection and monitoring of Contractors
10. Data and information
11. Emergency Response
12. Information to the public

Although these Guidelines for the distribution of Propylene Oxide are product specific, it is essential that policies, systems and procedures as described in the CEFIC recommendations on Safe Management Practices in Distribution are in place and well maintained.
Appendix 3

Inspection of Transport Equipment

1. Routine inspection of road tankers and tank containers at loading terminals

If any of the following conditions are not met, the loading operation must be stopped and the situation rectified before loading is allowed to continue.

a. Before loading
1. Does the truck have any visual defects (e.g. lights and tyres in good condition)?
2. Is there a valid ADR-certificate for Propylene Oxide?
3. Has the driver a valid ADR license for the transport of dangerous substances of Class 3?
4. For tank containers, is the tank container plate valid?
5. Are all 'dangerous goods' labels fitted (see Chapter 2.7.), are the identification numbers attached, or the national identification plate in accordance with national regulations, and is the Tremcard in all required languages on board?
6. For combined ADR/IMO transport: are the IMO ‘dangerous goods’ labels fitted? Is the UN number attached as per these regulations?
7. Does the driver have all the necessary items of protective clothing and safety equipment?
8. Is the cleaning certificate of the tank and hoses available? Are the previous cargoes known? Alternatively, is the equipment dedicated?
9. Is the tare weight in your possession?
10. Are all the valves closed upon arrival?
11. Can all valves be operated correctly?
12. Is the oxygen concentration below 2.0%?

b. Whilst loading
1. Is the maximum degree of filling not exceeded? See Chapter 2.7.

c. After loading
1. Is the maximum gross weight not exceeded?
2. Are all valves closed and blinded, with all bolts in place?
3. Are all seals in place?
Appendix 3

Inspection of Transport Equipment

2. Routine inspection of rail tank cars (RTC) at loading terminals

If any of the following conditions are not met, the loading operation must be stopped and the situation rectified before loading is allowed to continue.

a. Before loading
1. Is the RTC suitable for Propylene Oxide transport, e.g. in respect of maximum working pressure of tank? Is the inspection date not exceeded?
2. Are all ‘dangerous goods’ labels fitted and are the identification numbers attached?
3. For RTCs in combined RID/IMO transport: are the IMO labels fitted?
4. Is the tare weight in your possession?
5. Are all the valves on either side of the RTC properly closed and blinded upon arrival?
6. In case of hydraulically or mechanically operated valves: Is the emergency bolt unused and stored in a safe position on the RTC chassis? (This emergency bolt may only be used to open the bottom valves in the case of an emergency. It is strictly forbidden to start loading with the internal valve blocked by the emergency bolt.)
7. Can all valves be operated?
8. Is the oxygen concentration below 2.0%?

b. Whilst loading
1. Is the maximum degree of filling not exceeded? See Chapter 2.7.

c. After loading
1. Is the maximum gross weight not exceeded, concerning A, B, C or D class?
2. Are all valves closed and blinded, with all bolts in place on either side of the RTC?
3. Are all seals or locks in place?
Inspection of Transport Equipment

3. Unloading

The same guidelines as in Appendix 3 paragraphs 1 and 2 (relevant items) should be used for preparing a checklist for the inspections of the transport equipment before and during unloading.

The conditions of discharge at customer’s premises are the customer’s responsibility.

1. Are written operating procedures at the premises?
2. Have personnel engaged in this operation been adequately trained?
3. Has the product been positively identified as Propylene Oxide?
4. In case of multiple possibilities at the discharge point, has the correct discharge point been identified?
5. Can the receiving tank(s) take the complete load?
6. Is the driver available and within sight of his vehicle for emergency reasons?
7. Has the content of the truck, RTC, barge or vessel been included in the emergency plan?
8. Does the operating procedure contain actions if a problem develops i.e. stopping and closing the external discharge valves?
9. Does the operator use an unloading checklist?
Guide for the Marine Chartering and Handling of Propylene Oxide (PO).

Ships Complying with Bulk Chemical Codes

Inspection of all marine vessels for compliance with the Guidelines shall be made by a responsible and competent person prior to each loading to confirm a satisfactory condition of the vessels cargo system. Ships that have never been in the company's service will be inspected by a Marine Surveyor, under the CDI scheme (refer to Chemical Distribution Institute p.37) or a Company initiated scheme, to verify compliance with these guidelines and all applicable regulations prior to charter acceptance.

1. Certification

Propylene Oxide will only be loaded/carried on vessels meeting all currently applicable requirements and regulations of all applicable IMO codes and conventions, such as Bulk Gas Codes, Bulk Chemical Codes, SOLAS and MARPOL 73/78, and standards such as the U.S. Coast Guard Standard for the carriage of OXIDES. The carriage of Propylene Oxide should be permitted by the vessel’s International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk, which should be valid for the expected duration of the voyage, state the carriage conditions for Propylene Oxide and be suitably endorsed. Alternatively a letter of compliance of the U.S. Coast Guard or any other competent Flag State Authority can permit the carriage.
Guide for the Marine Chartering and Handling of Propylene Oxide (PO).

Ships Complying with Bulk Chemical Codes

2. Prior cargoes

Documentation of the previous three (3) cargoes must be provided prior to the ship's arrival at the loading berth. Propylene Oxide will not be transported in cargo systems which have contained as one of the three (3) previous cargoes any material known to catalyse the reaction of Propylene Oxide, unless adequate cleaning and inspection is possible and procedures to effect this have been issued.

(See Table No. 1 for cargoes known to catalyse polymerisation of Propylene Oxide in the U.S. Coast Guard Chemical Compatibility Chart).

3. Inspection, segregation and loading

Proper procedures for inspection, segregation of cargo and loading should be developed and used by the loader.

4. Carriage

Propylene Oxide must be maintained under Nitrogen blanketing within the ship's tank design pressure limits and the system relief valve. A copy of the carriage log recording cargo tank(s) temperature, pressure and exceptions must be available at the discharge port. The ship nitrogen supply used to pad the Propylene Oxide tanks shall contain less than 2000 ppm oxygen.
Appendix 4

Guide for the Marine Chartering and Handling of Propylene Oxide (PO).
Ships Complying with Bulk Chemical Codes

5. General information

PRIOR CARGOES OF BUTADIENE, ISOPRENE and STYRENE containing the polymerisation inhibitor tertiary butyl catechol (TBC) are known to have resulted in contamination of Propylene Oxide cargoes.

A thorough methanol wash followed by a water wash has been shown to be effective in removing polymerisation inhibitor residues from some vessel tanks and cargo systems. Cargo tanks with extensive internal structural members or heavy rust accumulations will be extremely difficult to clean. A water wash will not effectively remove TBC residues.

Completion (balance) cargoes
Completion cargoes are cargoes shipped concurrent with Propylene Oxide. Compounds which are reactive with or that catalyse the self-reaction of Propylene Oxide are not desirable completion cargoes. Compatible cargoes are acceptable. (See U.S. Coast Guard Compatibility Chart).

<table>
<thead>
<tr>
<th>Acids</th>
<th>Alkalis</th>
<th>Amines</th>
<th>Oxidising Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric</td>
<td>Caustic</td>
<td>Ammonia</td>
<td></td>
</tr>
<tr>
<td>Phosphoric</td>
<td>Sodium Hydroxide</td>
<td>Ethylamines</td>
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<tr>
<td>Nitric</td>
<td>Potassium Hydroxide</td>
<td>Propylamines</td>
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<tr>
<td>Acetic</td>
<td>and other metal</td>
<td>Ethyleneamines</td>
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<tr>
<td>Sulphuric</td>
<td>hydroxides and</td>
<td>Methylenamines</td>
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<tr>
<td>and other acids</td>
<td>solutions</td>
<td>and other Amines</td>
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<td></td>
<td>and solutions</td>
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</tbody>
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TABLE NO. 1: Products known to catalyse polymerisation of Propylene Oxide.

Adjacent cargo tanks that share a common bulkhead should not be heated above 30° C.
(Note: the vapour pressure of Propylene Oxide is 760 mm Hg at 34.48° C.)
Guide for the Marine Chartering and Handling of Propylene Oxide (PO).

Ships Complying with Bulk Chemical Codes

Properties
Physical properties and other useful safety and health information relating to Propylene Oxide are contained in the Safety Data Sheets.

Propylene Oxide vapours are highly soluble in water. This property is useful for control of a vapour leak and for cleaning systems of Propylene Oxide. However, the introduction of water in a tank containing oxide vapour, through a spray system or cleaning machines could result in a collapse of the tank. The owner or master of the ship should be cautioned to exercise care in cleaning and washing tank to avoid creating a vacuum within the cargo tank. Use of an inert gas system is an acceptable method of purging tanks for cleaning.

Chemical distribution institute (CDI)
This is a system that provides objective information on the quality of shipping.

CDI is an independent system to select and monitor contractors involved in shipping. The system emphasises safety performance, environmental protection, regulatory compliance, maintenance and training. A regular review of the above mentioned performance and necessary improvements are part of the system.

CDI accreditates inspectors and facilitates the distribution of assessment results. Chemical companies or consignors can initiate an assessment and/or request the assessment results from the shipowner.
A Safety Scheme for the Reception and Storage Facilities at Propylene Oxide Customers

1. Purpose

The checklist should be used for self-auditing by the customer. It can also be used as a guideline for the safety service of the supplying company.

2. Scope

2.1. This scheme shall apply to the reception of Propylene Oxide by road and rail at all customers.

2.2. The principal objective is to ensure that the transfer of Propylene Oxide from the delivering vehicle to the storage tank can be carried out safely. However, because the storage system and procedures may affect the safety of the unloading operation, these also need to be considered.

2.3. The scheme should also be used to:
   a. Assess and record any changes in policy, attitude or equipment since the previous check.
   b. Obtain customer’s comments on the transport operation and equipment being used.
Propylene Oxide Unloading / Storage Checklists

1. The unloading area

1.1 Ease of access
1.2 Housekeeping
1.3 Separation from other activities
1.4 Ability to mobilise and remove road tanker/RTC in case of emergency
1.5 Facilities to isolate area and restrict access
1.6 Fire water / foam systems
1.7 Electrical classification
1.8 Minimum safety distances according to national regulations between the offloading point and:
   - Storage
   - Ignition source
   - Boundary fence/or other facilities
1.9 Adjacent offloading points
1.10 Hoses/loading arms
1.11 Earthing Point
1.12 Pipe damage protection
1.13 Other vehicles/fork lift truck movements
1.14 Communication systems
1.15 Shutdown systems
Appendix 5

Propylene Oxide Unloading / Storage Checklists

2. Unloading

2.1 Personnel and equipment
2.2 The presence of customer’s operator
2.3 Operator’s competence
2.4 Deputy availability
2.5 Hose testing and renewal policy
2.6 Fixed loading arm testing and maintenance
2.7 Availability of suitable safety equipment
2.8 Unloading lines should be properly labelled as Propylene Oxide

Operations

2.9 Written procedures
2.10 Hose purging and leak testing
2.11 Sampling procedure
2.12 Atmospheric/personal Propylene Oxide exposure monitoring
2.13 Method of unloading:
   ● Nitrogen Pressure
   ● Pump
2.14 Use of rail hook (for LG equipment)
2.15 Safeguards for pump
2.16 Emergency response

3. Nitrogen supply

3.1 Source of nitrogen
3.2 Protection of nitrogen purity
Appendix 5

Propylene Oxide Unloading / Storage Checklists

4. **Storage tank**

4.1 Location
- Bunded area
- Shared
- If shared, with what? Are they compatible?
- Separation distances
- Emergency disposal facilities

4.2 Construction
- Insulated
- Uninsulated
- Refrigerated
- Fire water / foam availability
- Earthed
- Maximum pressure rating
- Maximum allowed working pressure
- Date and type of last test/inspection
- Dip inlet pipe

4.3 Relief valves
- Separate
- Combined with interlock
- Size
- Venting to:
  - Stack
  - Scrubber
  - Other
- Flame traps
- Nitrogen purged vents
Propylene Oxide Unloading / Storage Checklists

4. Storage tank

4.4 Instrumentation
Nitrogen padding pressure
Control points:
- Temperature
- Pressure
- Level
Alarm settings:
- Temperature
- Pressure
- Level

Are control systems, and alarm systems independent?

4.5 Monitoring of storage
Temperature
Pressure
Available ullage (available space) in the tank

5. Storage tank to process

Precaution to prevent backflow from plant streams contaminating storage vessels. Measures to prevent contamination via the vent gas system.

6. Procedures

There should be written procedures available for the following:
- Unloading Propylene Oxide
- Esting, inspection and maintenance of equipment
- Emergency

7. Comments
Guidance Notes for Propylene Oxide
Unloading / Storage Checklists

1. The unloading area

1.1 There should be sufficient space for easy vehicular access.

1.4 Unless it is connected to the unloading facilities, it should be possible for the vehicle to be removed from the unloading area in the case of an emergency. If it is connected to the unloading facilities, then the emergency arrangements should take account of the contents of the vehicle.

1.5 Barriers, warning notices (e.g. no access; no smoking) are required. Special consideration may need to be given to prevent shunting close to the unloading area.

1.6 There should be a fire fighting system. Preferably this should be a permanent installation over/around the unloading area. Strategically placed fire hoses/monitors ready for use are acceptable.

1.7 The electrical classification shall be EX D2 G4; Division 1/Class C or equivalent.

1.9 All unloading points must be clearly labelled. If compatible substances are unloaded in the Propylene Oxide area. Procedures and/or engineering controls should be in place to avoid unloading of Propylene Oxide into wrong tanks.

1.10 Hoses or unloading arms should preferably be of stainless steel. They should be dedicated to Propylene Oxide, have suitable gaskets (spirally wound PTFE or equivalent) and stored in such a way so as to prevent contamination.

1.11 The earthing point should be checked on a regular basis.
Appendix 5

Guidance Notes for Propylene Oxide Unloading / Storage Checklists

2. The unloading

2.1 The driver should be available during offloading and within sight of his vehicle for emergency reasons. He should not be in the cabin of his truck.

2.2 The customer’s operator must be present during off-loading.

2.3 & 2.4 There should be at least two trained deputies to provide cover for illness and holidays.

2.5 The test pressure of the hoses should not be less than 1.3 times the maximum design working pressure. The frequency of testing is recommended as at least every 12 months. Hoses must be purged with nitrogen and leak tested before commencing the discharge.

2.7 Air breathing sets with eye coverage. Protective suits, boots and gloves of suitable material (butyl rubber has been found to give the best degree of protection. Neoprene or natural rubber may also be considered for protective clothing, but may not remain as vapour-tight as butyl rubber, particularly after continued use. PVC offers only very limited resistance). A safety shower and eye fountain should be sited adjacent to the unloading area.

2.13 If unloading is by pump, a dedicated vapour return system (balance line) should be used.

2.14 Railhook only in connection with LG equipment (see chapter 4.1).

3. Nitrogen

3.1 The purity of the nitrogen must be maintained.

3.2 The nitrogen should preferably be supplied by a separate and independent dedicated supply system. The Propylene Oxide nitrogen supply system must not be shared with supplies to amines, acids or other catalysts for Propylene Oxide polymerization.

3.3 Ideally the supplies for storage and the plant should be taken from two completely independent sources. If this is not possible or the system is shared, the integrity of the nitrogen supply system must be protected.

3.4 All nitrogen lines to storage and to process must be fitted with back flow protection for instance such as double block and bleed systems activated by a low positive pressure difference across the valves.
Guidance Notes for Propylene Oxide Unloading / Storage Checklists

4. **The storage tank**

Some of this section falls outside the unloading safety checking procedure. However, the information is useful both from safety and quality viewpoints. It also provides information on the customer’s competence and attitudes to safety.

4.2 Storage tanks are either pressure tanks or temperature controlled. Insulation is normally not required. However in case it has been installed, procedures shall be in place to detect and control under-insulation corrosion (e.g., wall thickness test or visual inspection). Especially in hot climates, refrigeration and/or closed cell structure insulation should be considered.

4.3 Relief valves should be large enough to meet local regulatory requirements e.g., the requirements for fire engulfment.

4.4 Level alarms are required. Procedures must be present which prevent tanks overfilling.

4.5 The temperature and pressure of the storage tank should be monitored regularly.

5. **Storage tank to process**

Back flow and contamination prevention is essential. Similar equipment to that used for maintaining the nitrogen integrity should be used.
Appendix 6

Design and Construction of Rail tank cars

It is recommended that the company’s technical rail tank car experts will use the following list of key rail tank car specifications in the contractual agreement with the different rail tank car lessors.

General recommendations

1. Tanks are generally constructed of carbon steel. Baffles may need to be fitted to meet the requirements of transport regulations. However, the number of baffle plates should be kept to a minimum as they may hinder professional cleaning operations.

2. Top or bottom loading/unloading facilities are used, depending on customer requirements.

3. Sloped bottom to outlet to provide complete unloading.

4. In case of top loading/unloading facilities:
   - Maintenance platform around top nozzles and manhole with galvanised anti-slip grating and a kick plate. The holes in the grating must be sufficient to allow access for flange bolting.
   - The top valves shall be designed in the longitudinal direction to allow operation of fixed liquid and vapour arms.
   - One ladder with access to the platform shall be provided.
   - Internal ladders are not recommended, as they will hinder the use of professional cleaning equipment.

5. Earthing connections shall be provided at both sides of each bottom outlet nozzle or in the centre of the chassis at both sides. Preferably a stainless steel strip to provide good contact with the earthing clamp.

6. All valves shall be of a leak-tight design and have a blindflange permanently attached to the valve by means of a chain with welded shackles. Alternative can be realised with a dry-disconnect coupling + cover plate.

7. Insulation is not required, however if installed, verify protection/inspection of carbon steel corrosion under the insulation.

8. The right front side of the rail tank car shall be provided with a ladder and handgrips for the shunter.

9. Gaskets: PTFE, PTFE spiral wound or other PO compatible material.
Design and Construction of Rail tank cars

Special recommendations
for LG rail tank cars (see chapter 4.1)

10. Design pressure is 6.5 bar. Hydraulic test pressure is 10 bar.

11. Valves/flanges should be made of ductile steel.
Valve size: liquid phase: 3 inch/NW 80
gas phase: 2 inch./NW 50

12. Manhole >= 500 mm. Made of ductile steel, bolted and hinged.
Design and Construction of Tank Trucks and Tank Containers

It is recommended that the company's technical tank truck / tank container experts, will use the following list in the contractual agreement with the different road carriers.

General recommendations

1. Stainless steel tank material is preferred, in order to facilitate cleaning operations.
2. Baffles may need to be fitted to meet the requirements of transport regulations. However, the number of baffle plates should be kept to a minimum, as they may hinder professional cleaning operations.
3. Bottom loaders / unloaders are preferred, they prevent working on top of the truck / container.
4. Top loading/unloading facilities are acceptable: At least one walkway of anti-slip grating shall be provided on top of the tank to give access to the top nozzles and manway. The walkway on tank trucks should be fitted with a collapsible handrail, and be reached by an open rung access ladder.
5. All valves shall be of leak tight design.
6. Designed earthing connections shall be provided to prevent dangerous differences in electrical potential arising between the carrying tank, the body of the vehicle, the piping and the ground during the loading or unloading of the vehicle. These connections shall not be painted.

Special recommendations for LG road tankers and tank containers (see chapter 4.1)

7. Gaskets: PTFE, PTFE spiral wound or other PO compatible material.
8. Design pressure is 6.5 bar. Hydraulic test pressure is 10 bar.
9. Valve size: liquid phase: 3 inch/NW 80 vapour phase: 2 inch/NW 50
10. Design standard to IMO 5 is recommended for tank containers.
Design and Construction of Vessels and Barges

1. **Vessels**

Detailed Requirements for Marine movements of Propylene Oxide in gravity Vessels are contained in the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, under Chapter 15: Special Requirements. The 30 Topics list include requirements on design, inspection on cleaning quality prior to initial loading, cargo segregation, loading/unloading operations, refrigeration and nitrogen padding. The key requirements for Chartering and Handling are described in Appendix 4.

2. **Barges**

The product specific requirements mentioned for vessels are also recommended for barge movements. In general these detailed requirements can best be met by using LPG Type Barges. It is recommended to consider using this Barge type in case it is available.

3. **Vessels and barges**

Special attention shall be given to:
- Ship-Store safeguarding systems
- Leak tight flanges of dome covers
- In line-sample systems
General Guidelines for Design and Construction of Propylene Oxide Storage Tanks

1. Location of storage tanks

1.1. The arrangement and lay out of storage tanks should take into account:
   a) Normal operation
   b) Emergency operation
   c) Fire fighting activities

1.2. The design of the tank farm should take account of the likely consequences of any accidental spillage or fire. Products that react chemically with Propylene Oxide, such as oxidants, acids, anhydrides, chlorine, and ammonia, should be kept in total segregated storage.

1.3. Storage tanks shall be located away from potential sources of ignition, and in a position so as to minimise the effect of radiation from any fire which could possibly occur in an adjacent area.

1.4. Storage tanks shall be discharged by pump. Tanks should not be elevated to allow gravity discharge, because of the difficulties of stopping gravity flow in the event of a fire.

1.5. Every tank shall be sited on an impervious base and should be surrounded by a bund wall capable of containing 110% of its contents in the event of spill or leak. The walls and floor of the bund should be impervious to liquid and designed to withstand a full hydrostatic head. Bund walls should be designed to ensure adequate natural ventilation of the bunded areas, ready access for fire fighting, and good means of escape in any emergency situation.

1.6. Intermediate lower bund walls are recommended to divide tanks into groups to contain any accidental leakage and to minimise the surface area of any spillage. If tanks share a common diked area, products within the area should be chemically compatible.

1.7. The floor of the bund shall be sloped to prevent minor spillages remaining below any tank. Provisions should be made for the removal or drainage of surface water from the area within the bund. Preferably, surface water should be pumped out of the bund with an appropriate pump. If bund drains are used, they shall be provided with valves outside the bund wall, with procedures in force to ensure these valves remain closed, except when draining is being removed.

1.8. No combustible materials, equipment, etc. shall be stored in the bund or against the bund wall.
Appendix 9

General Guidelines for Design and Construction of Propylene Oxide Storage Tanks

2. Tank construction

2.1. The tank shall be of adequate strength and capacity for the proposed duty. The tank and its supports shall be designed and constructed in accordance with an appropriate nationally recognised standard of good engineering practice.

2.2. Copper and copper containing alloys shall not be used in Propylene Oxide service.

2.3. Storage tanks should be compatible with shipping and/or receiving requirements.

2.4. Vapour control systems shall meet local and/or governmental regulations. The vent system discharge should be preferably into a closed system or an atmospheric discharge at a safe distance from possible ignition sources.

2.5. Carbon steel storage tanks are generally the most economical for Propylene Oxide. Vertical storage tanks are often used for large volume storage. Horizontal tanks are also satisfactory for bulk storage, but these are generally used for small installations.

2.6. Tank filling shall be either from the bottom or with a vertical pipe extended to a designed distance from the tank bottom. It will ensure that Propylene Oxide can not fall freely through the vapour space with the hazard of electric discharges.

2.7. Insulation is normally not required, however in case it has been installed, inspection procedures shall be in place to detect and control corrosion. Closed cell structure insulation is recommended, as it does not lower the self-ignition temperature of Propylene Oxide in case of leakage.

2.8. In hot climate, large tanks with low throughput shall be protected against direct sun heating by using reflecting paint, a sun protection roof, or equivalent. In case of extreme high temperatures, insulation and a separate cooling-unit are recommended.
2. **Tank construction**

2.9. An accessible manhole of minimum 500 mm diameter shall be provided on all tanks to allow for internal inspection and cleaning.

2.10. Design of new storage tanks shall be based on full draining concept, sloped to outlet with no trapped areas. Eliminate “dead spots” of liquid and vapour phase in the system.

2.11. It is normal practice to fit tanks, which are storing highly flammable liquids, with a pressure relief valve (PRV) to protect the tank against overpressure. The design shall be according to good engineering practice. For new tanks a rupture disc under the safety valve may be considered. This design eliminates the need for vent purging.

2.12. Each tank shall have a designed earthing system. Resistance to earth to be checked at least annually.
3. Storage tank engineering controls

Level, pressure and temperature measurement, nitrogen padding system

3.1. Storage tanks shall be provided with a suitable means of determining the liquid level, the pressure and the temperature in the tank.

3.2. Audible high level alarms, which automatically shut down the unloading process in the event of overfill, are strongly recommended. High/low pressure and high temperature alarms shall be fitted.

3.3. All storage tanks should contain local temperature and pressure indicators and temperature sensors for remote readings. It is recommended that level, pressure, and temperature recording equipment is provided in the control room.

3.4. A separate and preferably independent, dedicated nitrogen padding system shall be installed. The system design must prevent backflow. If the prevention of a vacuum cannot be guaranteed, the tank should also be protected against vacuum with a vacuum-breaking valve.

3.5. It is desired to install either a low pressure snuffing steam system or nitrogen purge to all safety valve discharges. It will allow for dilution of potential Propylene Oxide vapours, especially during lightning. Design snuffing steam systems on freezing weather conditions.
Appendix 9

General Guidelines for Design and Construction of Propylene Oxide Storage Tanks

4. Pipelines

4.1. All pipelines shall be adequately grounded, to discharge static electricity safely.

4.2. The tank discharge line shall be designed with an emergency block valve (EBV) which will shut off the tank contents in case of an emergency.

4.3. It is recommended that all gaskets used in the handling of Propylene Oxide are made of PTFE, stainless steel spiral wound with external gression, or equivalent.

4.4. Wherever possible, continuous welded pipelines should be used. However where pipelines have to be disconnected for maintenance or inspection, flange joints should be fitted. Screwed fittings should not be used except for stainless steel instrumentation lines.

4.5. Pipelines should be routed to ensure that flanges are not located over doorways, windows or close to possible sources of ignition and to minimise the possibility of accidental damage.

4.6. Fixed dedicated loading/unloading arms are recommended. If hoses are used for loading/unloading operations, they should be stainless steel or equivalent. Hoses shall be inspected and pressure tested on a regular basis. Records of inspection data and results shall be retained.

4.7. All tanks and pipeline connections must be clearly product identified.

4.8. It is recommended to install a closed sample system for Propylene Oxide samples, to minimise emissions.

4.9. Valves should be fitted as close as feasible to the tank. Unused outlets should be blanked off.
Appendix 9

General Guidelines for Design and Construction of Propylene Oxide Storage Tanks

5. Pumps

5.1. Pumps should be located outside tank bunds, on an impervious base, in an open space, and not in walled or confined spaces.

5.2. Centrifugal pumps with enclosed impellers and mechanical seals or canned motor pumps are most widely used in Propylene Oxide service.

5.3. Pumps should be constructed of ductile steel, or stainless steel.

5.4. Electrical pump motors shall be of ex-proof design.

5.5. If pumps are remotely controlled then stop buttons shall be provided at the pump and at the remote control centre.

5.6. Pumps should be process controlled, e.g., by flow metering.

5.7. It should be noted that if centrifugal pumps are used, flow under gravity might occur when the pump is stopped.

6. Electrical considerations

6.1. The selection, installation and maintenance of electrical equipment for use in hazardous areas should be according to national regulations.

6.2. Pumps, tanks, electrical motors, pipelines, and all parts of the system must be effectively earthed to prevent the accumulation of static electrical charges. A compliance program shall be in place.

6.3. Working areas, i.e. tank stairs, platforms, loading/unloading facilities should be adequately illuminated for emergency response and security reasons.
General Guidelines for Design and Construction of Propylene Oxide Storage Tanks

7. Fire fighting considerations

7.1. A contingency plan shall be in place and tested in practice on a regular basis, at least once per year.

7.2. It is recommended to install sprinkler water at tanks and pumps, preferably triggered by an automatic gas detection system.

8. Systems for gas detection and monitoring

Depending on the storage volume, the storage area, the transfer pump area, gas detection and/or gas monitoring systems should be considered with audible, visible and remote alarms.

9. Measures to prevent contamination of storage tanks

A particularly high safety standard is necessary to provide protection against products that react with Propylene Oxide or products that are able to catalyse reactions.

9.1. Two redundant and quick shut-off valves to prevent backflow from the production plant should be installed. This equipment must be very reliable.

9.2. Measures to prevent contamination via the nitrogen system (see Customer checklist).

9.3. Measures to prevent contamination via the vent gas.
### Member Companies of the Propylene Oxide / Propylene Glycols Sector Group

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASF</td>
<td>Germany</td>
</tr>
<tr>
<td>BP KÖLN</td>
<td>Germany</td>
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<tr>
<td>DOW EUROPE</td>
<td>Switzerland</td>
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<td>Italy</td>
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<tr>
<td>LYONDELL CHEMICAL</td>
<td>United Kingdom</td>
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<tr>
<td>REPSOL YPF QUIMICA</td>
<td>Spain</td>
</tr>
<tr>
<td>SHELL CHEMICALS EUROPE</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
## Glossary of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADR</td>
<td>Accord européen relatif au transport des marchandises dangereuses par route. European agreement concerning the international carriage of dangerous goods by road.</td>
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<tr>
<td>ADN</td>
<td>Accord européen relatif au transport des marchandises dangereuses par voie de navigation intérieure. Regulations concerning the transport of dangerous substances in barges on inland waterways.</td>
</tr>
<tr>
<td>ADNR</td>
<td>See ADN: R for Rhine</td>
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<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>BL</td>
<td>Bulk liquid</td>
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<tr>
<td>CAS</td>
<td>Chemical Abstract System</td>
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<tr>
<td>CDI</td>
<td>Chemical Distribution Institute</td>
</tr>
<tr>
<td>CEFIC</td>
<td>Conseil Européen de L’Industrie Chimique</td>
</tr>
<tr>
<td>DIN</td>
<td>German Industry Standard (Deutsche Industrie Norm)</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
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<tr>
<td>EEC</td>
<td>European Economic Community</td>
</tr>
<tr>
<td>EINECS</td>
<td>European Inventory of Existing Commercial Chemical Substances.</td>
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<tr>
<td>Ems</td>
<td>Emergency procedures of ships carrying dangerous goods</td>
</tr>
<tr>
<td>IARC</td>
<td>International Agency for Research on Cancer</td>
</tr>
<tr>
<td>IATA</td>
<td>International Air transport Association</td>
</tr>
<tr>
<td>IBC</td>
<td>Intermediate Bulk Container</td>
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<tr>
<td>IBC Code</td>
<td>International code for the Construction and equipment of ships carrying dangerous chemicals in bulk.</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<tr>
<td>ICE</td>
<td>International Chemical Environment (CEFIC)</td>
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<tr>
<td>IMDG Code</td>
<td>International Maritime Dangerous Goods Code</td>
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<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
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<tr>
<td>ISO</td>
<td>International Standard Organization.</td>
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<tr>
<td>JSA</td>
<td>Job Safety Analysis</td>
</tr>
<tr>
<td>LC₅₀</td>
<td>Lethal Concentration (50%)</td>
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<tr>
<td>LD₅₀</td>
<td>Lethal Dosis (50%)</td>
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<tr>
<td>LG</td>
<td>Liquified Gas</td>
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## Glossary of Abbreviations

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<tbody>
<tr>
<td>MAC</td>
<td>Maximum Acceptable Concentration</td>
</tr>
<tr>
<td>MARPOL</td>
<td>Marine Polution Act</td>
</tr>
<tr>
<td>MFAG</td>
<td>Medical First Aid Guide for use in accidents involving dangerous goods at sea.</td>
</tr>
<tr>
<td>N.A.</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration (USA)</td>
</tr>
<tr>
<td>PTFE</td>
<td>Polytetrafluorethylene</td>
</tr>
<tr>
<td>RID</td>
<td>Règlement International concernant le transport de marchandises dangereuses par chemin de fer. Regulations concerning the international carriage of dangerous goods by rail.</td>
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<td>RTC</td>
<td>Rail Tank Car</td>
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<tr>
<td>RTECS</td>
<td>Registry of Toxic Effects of Chemical Substances</td>
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<tr>
<td>SOLAS</td>
<td>Safety of Life at Sea</td>
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<tr>
<td>SQAS</td>
<td>Safety and Quality Assessment System (CEFIC)</td>
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<tr>
<td>STEL</td>
<td>Short Term Exposure Limit</td>
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<tr>
<td>Tremcard</td>
<td>Transport Emergency Card (ADR)</td>
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<tr>
<td>TLV</td>
<td>Threshold Limit Value</td>
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<tr>
<td>TWA</td>
<td>Time Weight Average</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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