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Advancing Possible

Propylene Oxide

Product Safety Bulletin

Foreword

Lyondell Chemical Company and Lyondell Chemie Nederland BV ("Lyondell"), LyondellBasell companies, are dedicated to continuous improvement in product, health, safety and environmental performance. Included in this effort is a commitment to support our customers by providing guidance and information on the safe use of our products. For Lyondell, environmentally sound operations, like environmentally sound products, make good business sense.

Lyondell Product Safety Bulletins are prepared by our Product Stewardship Team. The data reflect the best information available from public and industry sources. This document is provided to support the safe handling, use, storage, transportation and ultimate disposal of our chemical products.

This Product Safety Bulletin should be evaluated to determine applicability of your specific requirements. The government regulations, industry standards cited in this bulletin are primarily applicable within the United States. Please make sure you review the corresponding government regulations, industry standards and guidelines for your specific country or region as that might have an impact on your operations.

Lyondell's ready to support our customers' safe use of our products. For additional information and assistance, please contact your Lyondell customer representative.

Telephone numbers for transport emergencies:

CHEMTREC 1-800-424-9300
International (call collect) 202-483-7616

CANUTEC (in Canada) 1-613-996-6666

SETIQ (in the Mexican Republic) 01-800-00-214-00
(Calls originating in Mexico City or the Metropolitan Area) +5-559-1588
(Calls originating elsewhere) +52-555-559-1588
TCSB (in Taiwan) +886-2-2325-7399 ext. 55111

LyondellBasell TDI (Transportation Distribution Incident) reporting Hotline

1-800-245-4532 (North America)
+32-3-575-1235 (Europe)
+886-933-635-556 (Asia)

Contact information for additional product information:

LyondellBasell Customer Service
+1-888-777-0232 (North America)
+31-10-275-5500 (Europe)
+886-933-635-556 (Asia)
or visit www.lyb.com

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Contents

1. General Information

1.1 Product Identification

Chemical Name:	2-Methyloxirane
Chemical Family:	Alkyl Epoxide
Common Names:	Propylene oxide 1,2- Propylene oxide 1,2-Epoxypropane Propene epoxide Propene oxide
CAS Number:	75-56-9
Formula:	C_3H_6O

1.1.1 Chemistry

Lyondell Chemical Company uses proprietary technology to manufacture propylene oxide. In one process, ethylbenzene is reacted with oxygen to form ethylbenzene hydroperoxide. The ethylbenzene hydroperoxide is subsequently used to epoxidize propylene to yield propylene oxide and methyl benzyl alcohol. In an alternative process, isobutane is substituted for ethylbenzene and, through analogous chemistry, tertiary butyl alcohol is the co-product. Methyl benzyl alcohol and tertiary butyl alcohol can then be dehydrated to styrene monomer and isobutylene, respectively.

1.1.2 Applications

The polyurethane industry is the largest consumer of propylene oxide. It utilizes polyether polyols made by reacting propylene oxide alone or in combination with other alkylene oxides. The most common initiators are polyols or polyamines such as glycerine, glycols, pentaerythritol, ethylenediamine, toluenediamine, sucrose, sorbitol, trialkanol amines, and trimethylolpropane. Polyether polyols are reacted with various diisocyanates to form polyurethane foams and resins.

The second largest use of propylene oxide is the production of propylene glycol and lesser amounts of coproduced dipropylene glycol and higher propylene glycols. These glycols are used in the manufacture of unsaturated polyester resins, solvents, antifreeze, humectants and plasticizers.

Propylene oxide is also used to manufacture functional fluids by reaction of propylene oxide or mixtures of propylene oxide and ethylene oxide with glycols, glycerine, alcohols and phenols. The types of functional fluids produced include heat transfer fluids, hydraulic fluids and lubricants.

Other propylene oxide derivatives include block copolymers of propylene oxide and ethylene oxide which have been found to be efficient and versatile surfactants. Propylene oxide-based surfactants can also be produced by the propoxylation of various alcohols. The water solubility of propylene glycols below a molecular weight of 800 makes propylene oxide especially useful in these applications.

Propylene oxide is also used as a reactant to produce alkanol amines from ammonia or amines and as an intermediate in the production of allyl alcohol. It can also be homopolymerized to produce polypropylene oxide.

1. General Information

1.2 Physical Properties

Table 1-1 Propylene Oxide Physical Properties	
Property	**Value**
Physical State	Liquid
Color	Colorless
Boiling Point	34.2°C (93.6°F)
Molecular Weight	58.08
Freezing Point	–112°C (–169.6°F)
Density @ 25°C (77°F)	0.823 g/cc (6.87 lb/gal)
Density of Saturated Liquid	See Figure 1-1 See Table 1-2
Vapor Density	See Figure 1-2
Vapor Pressure	See Table 1-3
Refraction Index @ 25°C (77°F)	1.3632
Coefficient of Cubical Expansion @ 20°C (68°F)	0.00151/°C (0.00084/°F)
Critical Temperature	209.1°C (408.4°F)
Critical Pressure	4.92 MPa
Critical Volume	3.2025 cc/g (0.0513 ft^3/lb)
Critical Compression	0.228
Acentric Factor	0.2683
Heat of Combustion, Liquid @ 25°C (77°F)	-458.28 Kcal/mol
Heat of Formation, Vapor @ 25°C (77°F)	-22.17 Kcal/mol
Heat of Formation, Liquid @ 25°C (77°F)	-28.84 Kcal/mol
Heat of Fusion @ -112°C (-170°F)	1560.9 cal/mol (2809.6 BTU/lbmol)
Flash Point (TCC)	-37°C (-35°F)
Auto Ignition	464°C (867°F)
Upper Explosive Limit	37%
Lower Explosive Limit	1.7%
Solubility at 20°C (68°F)	39.5% PO in water 12.5% water in PO Alcohol: ∞ Ether: ∞
Saturation Concentration in Air @ 25°C (77°F)	82.6 wt % (70.32 mol %)
Dipole Moment	6.70 x 10^{-30} x m
Electrical Conductivity	2.4 x 10^{-8} mhos/cm

1. General Information

Figure 1-1

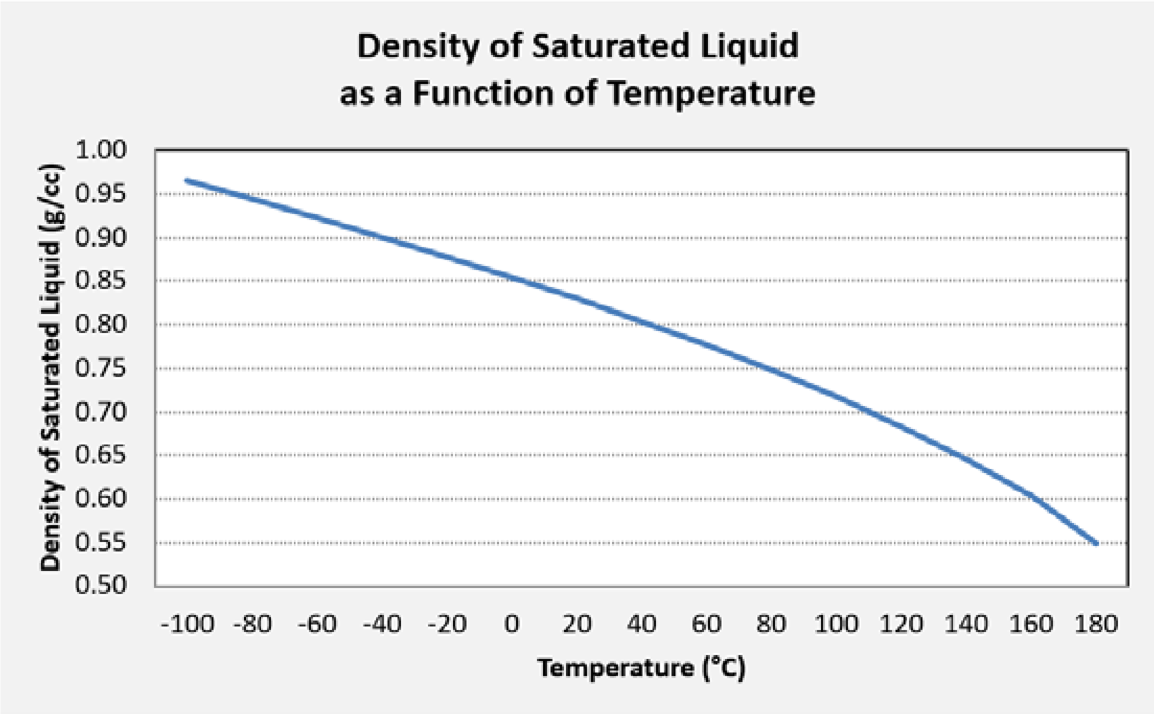
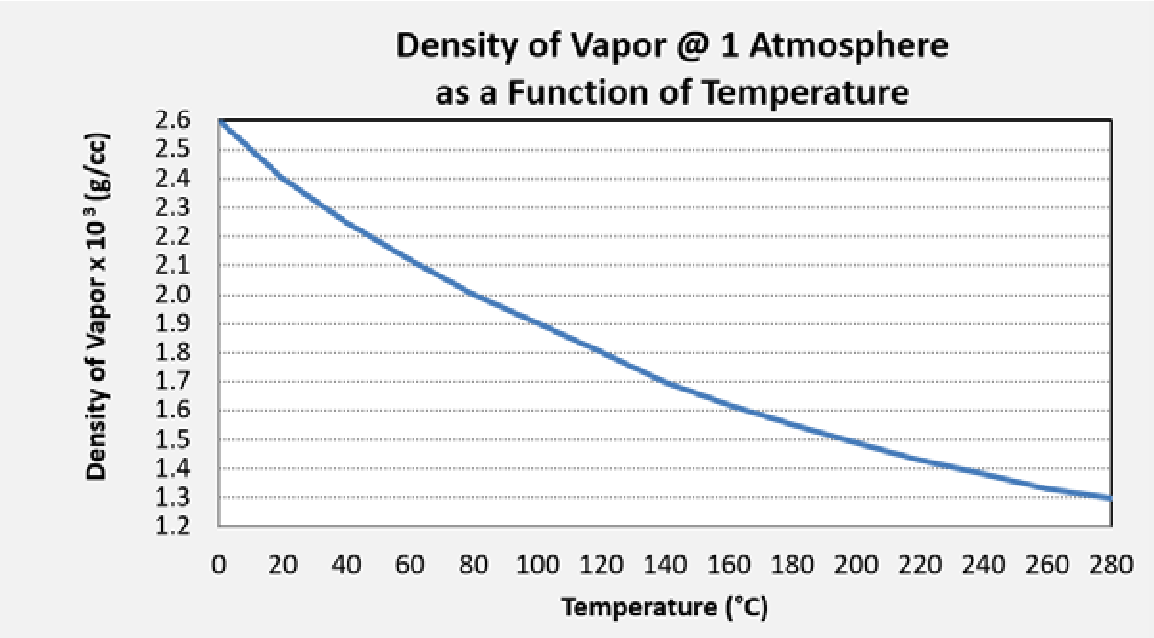


Figure 1-2



1. General Information

Table 1-2 Propylene Oxide Density as a Function of Temperature

Temperature °C	Temperature °F	Pounds Per US Gallon	Sp. Gravity to 60°C	Temperature °C	Temperature °F	Pounds Per US Gallon	Sp. Gravity to 60°C
4.4	41	7.083	1.0164	21.7	71	6.905	0.9908
5.0	41	7.077	1.0156	22.2	72	6.899	0.9900
5.6	42	7.072	1.0148	22.8	73	6.893	0.9891
6.1	43	7.066	1.0140	23.3	74	6.887	0.9883
6.7	44	7.060	1.0131	23.9	75	6.881	0.9875
7.2	45	7.055	1.0123	24.4	76	6.875	0.9866
7.8	46	7.049	1.0115	25.0	77	6.870	0.9958
8.3	47	7.043	1.0107	25.6	78	6.864	0.9849
8.9	48	7.038	1.0099	26.1	79	6.858	0.9841
9.4	49	7.032	1.0091	26.7	80	6.852	0.9832
10.0	50	7.026	1.0082	27.2	81	6.846	0.9824
10.6	51	7.021	1.0074	27.8	82	6.840	0.9815
11.1	52	7.015	1.0066	28.3	83	6.834	0.9807
11.7	53	7.009	1.0068	28.9	84	6.828	0.9798
12.2	54	7.003	1.0050	29.4	85	6.822	0.9790
12.8	55	6.998	1.0041	30.0	86	6.816	0.9781
13.3	56	6.992	1.0033	30.6	87	6.810	0.9772
13.9	57	6.986	1.0025	31.1	88	6.804	0.9764
14.4	58	6.980	1.0017	31.7	89	6.798	0.9755
15.0	59	6.975	1.0008	32.2	90	6.792	0.9747
15.6	60	6.969	1.0000	32.8	91	6.786	0.9738
16.1	61	6.963	0.9992	33.3	92	6.780	0.9729
16.7	62	6.957	0.9983	33.9	93	6.774	0.9721
17.2	63	6.951	0.9975	34.4	94	6.768	0.9712
17.8	64	6.946	0.9967	35.0	95	6.762	0.9703
18.3	65	6.940	0.9958	35.5	96	6.756	0.9695
18.9	66	6.934	0.9950	36.1	97	6.750	0.9686
19.4	67	6.928	0.9942	36.7	98	6.744	0.9677
20.0	68	6.922	0.9933	37.2	99	6.738	0.9669
20.6	69	6.917	0.9925	37.8	100	6.732	0.9660
21.1	70	6.911	0.9917				

1. General Information

Table 1-3 Propylene Oxide Vapor Pressure as a Function of Temperature									
Temperature		Vapor Pressure			Temperature		Vapor Pressure		
°C	°F	mm Hg	psia	psig	°C	°F	mm Hg	psia	psig
-28.00	-18.40	40.20	0.78		14.00	57.20	343.04	6.63	
-26.00	-14.80	45.43	0.88		16.00	60.80	372.96	7.21	
-24.00	-11.20	51.21	0.99		18.00	64.40	404.93	7.83	
-22.00	-7.60	57.60	1.11		20.00	68.00	439.05	8.49	
-20.00	-4.00	64.65	1.25		22.00	71.60	475.42	9.19	
-18.00	-0.40	72.39	1.40		24.00	75.20	514.16	9.94	
-16.00	3.20	80.89	1.56		26.00	78.80	555.35	10.74	
-14.00	6.80	90.20	1.74		28.00	82.40	599.13	11.59	
-12.00	10.40	100.38	1.94		30.00	86.00	645.59	12.48	
-10.00	14.00	111.50	2.16		32.00	89.60	694.85	13.44	
-8.00	17.60	123.60	2.39		34.00	93.20	747.02	14.45	
-6.00	21.20	136.76	2.64		34.48	94.06	760.00	14.70	0.00
-4.00	24.80	151.06	2.92		35.00	95.00	774.24	14.97	0.28
-2.00	28.40	166.55	3.22		40.00	104.00	922.24	17.83	3.14
0.00	32.00	183.31	3.54		45.00	113.00	1091.51	21.11	6.41
2.00	35.60	201.42	3.89		50.00	122.00	1284.06	24.83	10.13
4.00	39.20	220.97	4.27		55.00	131.00	1502.00	29.04	14.35
6.00	42.80	242.02	4.68		60.00	140.00	1747.51	33.79	19.10
8.00	46.40	264.66	5.12		65.00	149.00	2022.85	39.12	24.42
10.00	50.00	288.99	5.59		70.00	158.00	2330.38	45.06	30.37
12.00	53.60	315.08	6.09		75.00	167.00	2672.54	51.68	36.98

1.3 Instability Hazards

Propylene oxide is a stable material that will not decompose under normal conditions of temperature and pressure.

1.4 Reactivity Hazards

Propylene oxide may react vigorously with oxidizing materials, anhydrous metal chlorides, acids, bases, clay-based adsorbent materials, and peroxides. Propylene oxide mixed with ammonium hydroxide, chlorosulfonic acid, hydrochloric acid, hydrofluoric acid, nitric acid, oleum (fuming sulfuric acid), or sulfuric acid causes violent reactions. Propylene oxide reacts slowly in neutral water. However, the presence of acids or bases in water will catalyze the hydrolysis of propylene oxide, and a vigorous reaction may occur.

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2.1 Hazard Assessment

The primary route of exposure to propylene oxide is through inhalation of fugitive emissions in the workplace. Propylene oxide is likely to be readily absorbed through the respiratory tract and metabolized by conjugation with glutathione or hydrolyzed to 1,2–propane diol (propylene glycol). Acutely, propylene oxide is a severe skin, eye and respiratory irritant.

Long-term studies in animals have clearly shown that high exposure levels of propylene oxide can induce malignant tumors and should be considered a possible human carcinogen (see Section 2.1.6).

2.1.1 Acute Effects of Overexposure

Single exposures to liquid propylene oxide can cause severe skin and eye irritation, including corneal burns. There are reports in the literature which indicate that propylene oxide may induce dermal sensitization in workers. Exposure to high vapor concentrations can cause irritation of the eyes and respiratory tract as well as central nervous system effects such as general depression.

Confinement of propylene oxide in liquid form under clothing or in shoes prevents evaporation and may result in skin irritation. Acute contact with even dilute solutions of propylene oxide (10%) cause hyperemia and edema, while higher exposures result in scar formation.

Single oral doses of propylene oxide, ranging from 382 mg/kg to 1140 mg/kg, have been reported to be lethal to various animal species. Inhalation exposure to 9500 mg/m3 (approximately 4000 ppm) for four hours has been reported to be lethal in rats. The data indicates that propylene oxide is slightly toxic in single exposure scenarios.

2.1.2 Repeated Exposures

In short-term, repeated animal exposure studies, concentration of propylene oxide at or above ~1000 mg/m3 (457 ppm) were irritating to the eyes and respiratory tract, caused lung edema (fluid in the lungs) and central nervous system depression.

2.1.3 Reproductive and Developmental Toxicity

Propylene oxide has been reported to have only minimal reproductive effects in male and female rats at exposure levels up to 300 ppm. There were no significant variations from control animals in any of the reproductive indices measured. At 500 ppm, propylene oxide induced only minimal body weight changes in pregnant rats and a slight skeletal variation in the offspring. Propylene oxide is not considered to be a reproductive hazard in animals.

2.1.4 Genetic Toxicology

Propylene oxide is a direct alkylating agent and has induced genetic mutation in several in vitro test systems, with and without metabolic activation. However, in whole animal studies, propylene oxide did not appear to be active as a mutagen.

2.1.5 Chronic Effects of Overexposure

While there is limited epidemiologic data available concerning the effects of long-term, repeated exposures of humans to propylene oxide, there is sufficient evidence from animal studies that exposure to this reactive chemical can induce cancerous lesions and should be considered a possible human carcinogen.

2.1.6 Carcinogenicity

In two separate inhalation studies in rodents, propylene oxide induced tumors in the nasal passages at approximately 400 ppm. In another inhalation study, at 300 ppm propylene oxide, hyperplasia of the nasal epithelium of rats was reported.

The National Institute for Occupational Safety and Health (NIOSH), the International Agency on Research for Cancer (IARC), Environmental Protection Agency (EPA) and the National Toxicity Program (NTP) consider propylene oxide to be a possible, potential or probable human carcinogen.

2.2 Occupational Exposure Limits

Please consult your local safety data sheet (SDS) for an overview of current occupational exposure limits.

2.2.1 Warning Properties

Propylene oxide has a sweet, ether-like odor that is readily perceived at elevated concentrations. It is not certain if olfactory fatigue occurs promptly as with other similar compounds.

2.3 First Aid

When an emergency arises, approach the incident with caution. Understand emergency procedures and become familiar with the location of rescue equipment and emergency contact numbers before the need arises.

Caution should be used to prevent responder exposure to propylene oxide from victim. Personnel aiding a victim should be cautious not to contaminate themselves by touching the victim's clothing unless wearing appropriate protective apparel. The removal of clothing from the victim is important to minimize continued skin contact, and to prevent continued off-gassing of propylene oxide during transport to an emergency care facility. Emergency transport services should be equipped to provide continual flushing of the skin and eyes, especially when the victim is complaining of burning or irritation.

2.3.1 Eye Contact

Flush eyes immediately with copious amounts of cool water for at least 15 minutes, periodically lifting the lower and upper lids

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to enhance flushing. Individuals splashed with propylene oxide may require assistance in locating emergency eyewash stations and flushing the eyes. Medical attention should be provided as soon as possible, and an ophthalmologist should be available for consultation.

2.3.2 Skin Contact

Flush eyes immediately with copious amounts of cool water for at least 15 minutes, periodically lifting the lower and upper lids to enhance flushing. Individuals splashed with propylene oxide may require assistance in locating emergency eyewash stations and flushing the eyes. Medical attention should be provided as soon as possible, and an ophthalmologist should be available for consultation.

2.3.3 Inhalation

If overcome from inhalation of propylene oxide, victim should be moved from contaminated atmosphere into fresh air at once by persons properly equipped with appropriate personal protective equipment (PPE). Treat for shock if necessary. If victim has stopped breathing, administer cardiopulmonary resuscitation (CPR) immediately. First aid trained individuals, or equivalent, should administer CPR. Caution should be used to prevent responder exposure to propylene oxide from the victim. Once revived, keep the victim warm and calm. Seek prompt medical attention.

2.3.4 Ingestion

In the unlikely event of propylene oxide ingestion, give the patient, if conscious, a pint of lukewarm water. Do not induce vomiting. Seek prompt medical attention.

2.4 Medical Management

Victims who have been acutely exposed to propylene oxide and have received the initial first aid procedures outlined above may require additional medical treatment. This may include assessment of the extent and severity of tissue injury by appropriate diagnostic studies and procedures. Advanced life support should be provided by medical staff to all victims with evidence of respiratory injury or extensive skin burns.

Employers should be prepared to handle potential medical emergencies resulting from propylene oxide exposure. Each facility should have at least one person trained and certified in first aid. If medical personnel are not present at the work site, a local physician and hospital emergency room should be contacted and informed of potential medical emergencies and their treatment.

Medical personnel should be informed of the proper precautions to take when confronted with a propylene oxide emergency. Copies of the propylene oxide safety data sheet (SDS) or this Product Safety Bulletin should be provided and reviewed with medical personnel.

2.4.1 Initial Medical Screening

Prospective employees who will work with or around propylene oxide should be medically evaluated to determine pre-existing conditions that may be aggravated by exposure to propylene oxide.

The individual could find it stressful to wear personal protective equipment, which may include respiratory protection and chemical protective clothing. Some workers are claustrophobic when placed in full facemask respiratory protection, full containment suits, or when entering confined spaces. Workers required to wear respiratory protection should be evaluated and approved for work by a medical professional. The medical decision is based upon the practitioner's judgment, but commonly involves a targeted medical history and physical with particular reference to the cardiorespiratory system.

Because propylene oxide may cause dermatitis, persons with pre-existing skin disorders may be more susceptible to the effects of this chemical. For individuals with impaired pulmonary function, especially those with obstructive airway diseases, breathing propylene oxide may exacerbate symptoms.

While propylene oxide is not known as a liver toxin in humans, the importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function. Similarly, propylene oxide is not known as a kidney toxin. However, due to the importance of this organ in the elimination of toxic substances, special consideration should be given to those with impaired renal function.

A specific protocol for initial medical examination should be developed by an occupational health physician before hiring individuals who may be exposed to propylene oxide.

2.4.2 Periodic Screening

Workers that are potentially exposed to propylene oxide should receive routine medical evaluations that essentially duplicate the initial evaluation for comparative purposes. Regular medical screening is an effective tool for the identification and prevention of occupational disease.

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3.1 Site Facilities

If a potential for contact with propylene oxide liquid exists in work areas where it is handled or stored, quick drenching facilities and equipment should be provided. This should include deluge showers and eyewash stations. These items should be installed, tested and maintained in accordance with established industry standards. Workers should be familiar with the location and operation of this safety equipment.

If contaminated clothing is laundered, appropriate facilities should be provided. Propylene oxide will evaporate from clothing potentially increasing the risk of fire, explosion and worker exposure. Site facilities should include closed containers for clothing storage and engineering controls to limit worker exposure. Personnel who will be handling contaminated clothing should be trained and fully aware of the methods available to protect themselves, including the use of personal protective equipment and methods to determine vapor concentrations.

Shower facilities should be available for use at the end of the shift by workers working with propylene oxide. It is strongly recommended that a clean room arrangement is established in locker/shower facilities.

3.2 Hygiene Practices

Proper personal hygiene practices should be used when working with and around propylene oxide. Workers should be familiar with good work practices to avoid direct contact with propylene oxide. They should also be familiar with decontamination procedures for equipment. Propylene oxide should not be handled or stored in areas where personnel take breaks, such as lunch rooms, or in areas that are not designed for chemical storage.

Hygiene practices that should be enforced for employees working with propylene oxide include prohibiting the consumption and storage of food, use and storage of tobacco products and application and storage of cosmetics. After handling propylene oxide and prior to eating, smoking, drinking, applying cosmetics or using toilet facilities, personnel should thoroughly wash their hands and faces with lukewarm water and mild soap or detergent.

Protective clothing used during the handling of propylene oxide, including gloves, aprons, protective suits and respirators, should be properly decontaminated using mild soap/detergent and water. Non-impervious clothing should be sealed in containers to prevent vapors from escaping into the air until laundered or disposed. Clothing may be laundered, provided that personnel handling these materials are aware of the hazards of propylene oxide. Articles such as wallets, belts and shoes constructed of leather, and other items that cannot be effectively decontaminated should be disposed of properly as contaminated waste (see Section 7.2).

3.3 Respiratory Protection

Good industrial hygiene practice requires that engineering controls be used to reduce workplace airborne concentrations of propylene oxide to below the established Occupational Exposure Limits. However, if engineering controls are not technically feasible; are currently being installed; or fail to control exposure and need to be supplemented, respiratory protection may be provided for worker protection. Respirators may also be needed for non-routine operations such as confined space entry and in emergency situations arising from spills/leaks and fire/explosions involving propylene oxide.

If respirators are used, a complete respiratory protection program should be implemented which includes training, fit testing, inspection, medical surveillance, cleaning and maintenance. Respiratory protection programs should meet the requirements set forth in the national Respiratory Protection Standards.

Approved respirators should be used when worker exposure exceeds established limits. Since propylene oxide is very irritating to the eyes, full face respirators with an organic vapor cartridge are considered the minimum level of respiratory protection. Supplied air or self-contained breathing apparatus (SCBA) with a full-face mask operated in positive pressure mode must be used when the exposure can exceed 400 ppm (IDLH level). Due to the poor warning properties of propylene oxide (high odor and eye irritation thresholds), air-purifying respirators should not be used.

For emergency escape purposes, a full-face respirator (gas mask) may be used. Table 3-1 provides for the selection of respiratory protection.

Respirators contaminated with propylene oxide can be decontaminated using lukewarm water with mild soap or detergent. Propylene oxide may permeate through and degrade the elastomeric materials of the respirators. Therefore, precautions must be taken to prevent direct contact with liquid propylene oxide. Degraded respirators must be discarded.

National Institute for Occupational Safety and Health and Mine Safety and Health Administration (NIOSH/MSHA)-approved airline respirator or self-contained breathing apparatus (SCBA) with a full facemask operated in a positive pressure mode may be used during routine and nonroutine work activities. Where the exposure can exceed 400

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ppm (IDLH level) or when an oxygen deficient atmosphere exists, air line respirators must be equipped with an auxiliary SCBA escape pack operated in the positive pressure mode.

Table 3-1 Propylene Oxide Respiratory Protection Selection Guide

Condition	Minimum Respiratory Protection*
400 ppm OR LESS	• Any airline respirator with a full facemask, helmet or hood • Any SCBA with a full facemask
GREATER THAN 400 ppm OR ENTRY INTO UNKNOWN CONCENTRATIONS	• SCBA with a full facemask operated in pressure-demand or other positive pressure mode • A combination respirator which includes a supplied-air respirator with a full facemask operated in pressure demand or other positive pressure or continuous-flow mode and an auxiliary SCBA operated in pressure-demand or other positive pressure mode
FIRE-FIGHTING	• SCBA with a full facemask operated in pressure-demand or other positive pressure mode
ESCAPE	• Any gas mask providing protection against organic vapors • Any escape SCBA

*Only NIOSH approved and MSHA certified equipment should be used.

Work locations where the potential for spills and leaks of propylene oxide exists should have escape respirators conspicuously displayed. For emergency escape purposes only, a full facemask air-purifying respirator (gas mask) may be used. Respirators designed for escape purposes are never to be used for entry into an environment contaminated with propylene oxide above the established exposure limits. Table 3-1 provides for the selection of respiratory protection.

Respirators contaminated with propylene oxide can be decontaminated using lukewarm water with mild soap or detergent. Propylene oxide may permeate through and degrade the elastomeric materials of the respirators. Therefore, precautions must be taken to prevent direct contact with the liquid propylene Oxide. Degraded respirators should be discarded.

3.4 Chemical Protective Clothing

Personal protective equipment (PPE) should be provided to personnel during routine and non-routine handling, spill cleanup, and fire-fighting involving propylene oxide. PPE is necessary to prevent exposure to vapor or liquid during both routine and nonroutine work activities. Select PPE according to the working conditions and the potential for contact with liquid or vapor.

PPE ensembles range from safety glasses, hard hats and safety shoes to chemical protective suits with an air supply. Materials must be selected giving consideration to the chemical properties of propylene oxide. Factors that should be considered include the chemical resistance, durability, flexibility, thermal limits, cleanability and lifetime of the material.

3.4.1 Eye Protection

Chemical safety goggles, cup-type plastic of gas-tight design, equipped with impact-resistant lenses, should be worn whenever the potential for exposure to vapor or liquid is present. A face shield may be worn to provide added splash protection. These eye protective measures should meet ANSI Z87.1 specifications.

Individuals wearing contact lenses while working with or around propylene oxide should wear chemical safety goggles at all times. The potential for increase in eye injury of contact lens wearers exposed to chemicals has not been determined. A conservative approach in PPE selection is warranted.

3.4.2 Head Protection

Hard hats should be worn where there is danger from falling objects or overhead leaks and spills. Hard hats should meet the requirements of ANSI Z89.1 specifications for protection. Manufacturers have adapted hard hats so that ear protection and face shields may be easily attached. If, due to the specific circumstances, a hard hat is not required, a hood made of chemically impervious material may be worn.

3.4.3 Foot Protection

Heavy rubber overboots should be provided and worn over leather shoes or boots to protect the leather from contamination. Leather items absorb propylene oxide, thereby increasing the risk of dermal (skin) exposure and cannot be effectively decontaminated. Rubber boots should be worn under pant legs to prevent propylene oxide from entering the boot.

3.4.4 Skin Protection

Impervious protective clothing suitable for a particular work activity should be worn. Clothing can range from gloves and an apron to a full-containment suit.

Propylene oxide was tested against a variety of chemical protective clothing (CPC) materials. Protective clothing and gloves made of butyl rubber or Teflon® should provide protection from contact with liquid for at least 2 hours. However, the quality and thickness of the CPC may vary between manufacturers. Therefore, manufacturer specific propylene oxide permeation data should be obtained and evaluated before selection.

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Where the potential for exposure to propylene oxide liquid exists, workers should wear a liquid-tight containment suit or slicker suit. These suits are designed to protect employees from skin contact with propylene oxide. All suits should be routinely inspected to identify any damage or wear. If tears are observed, exit the contaminated area and replace the clothing.

Protective clothing used in a contaminated environment should be properly decontaminated prior to handling by unprotected individuals and reuse. To decontaminate the protective clothing wash with a mild soap/detergent and water.

3.5 Direct Reading Instruments

Propylene oxide is readily analyzed by a variety of direct reading instruments. The advantage of using direct reading instruments is that real-time analysis and instantaneous air concentrations can be determined by trained personnel. The value of a real-time analysis, in terms of prevention of injury and illness, is considerable.

Direct reading instruments that have been successfully used to measure propylene oxide are combustible gas indicators, infrared spectrophotometers, flame ionization detectors, photoionization detectors and colorometric detector tubes. Limits of detection vary between these instruments and should be evaluated to ensure proper use. The proper selection, calibration, use and interpretation of direct reading instruments requires the services of a professional industrial hygienist or other knowledgeable person. The output from these instruments may require interpretation depending on the presence of other chemicals.

3.6 Air Sampling and Analysis

When assessing worker exposure to propylene oxide, an extended sampling period is desirable. The most common method of air sampling is collection on a sorbent media over an extended period of time. Air is drawn at a predetermined rate by a sampling pump into a charcoal tube. This can be substituted with the use of passive samplers, which use the diffusion characteristics of the material instead of an active sampling pump. These methods have been extensively developed and evaluated for use with propylene oxide.

The National Institute for Occupational Safety and Health (NIOSH) has developed Method Number 1612 for sampling and analysis of propylene oxide. The method recommends sampling with standard sized coconut charcoal tubes and analysis by gas chromatography. In addition, Lyondell has funded the development and validation of a passive diffusion badge method. This method recommends sampling with the 3M 3520 passive sampler and analysis by gas chromatography. Contract Lyondell for additional information.

These methods for air sampling and analysis are the primary means to determine worker exposures over extended periods. When considering the use of these methods for determination of employee exposure, it is important that a monitoring program is developed by professional industrial hygienists. This program should include the sampling strategy, quality assurance and statistical analysis of results.

4. Engineering

This section is included for use as a guideline. It is not intended to be a design handbook and does not relieve the user from exercising competent engineering judgment or using qualified professional personnel to meet the specific requirements. The information contained is only applicable to the specific chemical compound identified in Section 1 General Information, 1.1 Product Identification. Mixtures or compounds using propylene oxide will require additional engineering studies to determine the applicability of the enclosed information.

4.1 Bulk Storage

The construction of low pressure propylene oxide storage tanks should be in accordance with American Petroleum Institute (API) 620, 650 and National Fire Protection Association (NFPA) 30 and 30H. Higher pressure storage vessels should comply with American Society of Mechanical Engineers (ASME) Code, Section VIII, Division 1. Carbon steel is acceptable but should be clean and rust free. Liquid propylene oxide should enter through the bottom of the tank. Incoming liquid should be prevented from free falling through the tank vapor space (see Section 8).

4.2 Piping

Piping and piping components should comply with the latest applicable national standards. The minimum grade acceptable is 304 stainless steel if iron contamination is a concern. Carbon steel is also acceptable. Welded or flanged connections are preferred; the use of threaded connections should be avoided. Flanged connections should be kept to a minimum.

4.3 Electrical Area Classification

All electrical equipment should conform to applicable national regulations.

4.4 Pump Specifications

Centrifugal: Any stainless steel ASME B73.1/2 type, or any carbon or stainless steel API 610 type, designed with dual mechanical seals and Grafoil®, Kalrez® 6375/6380/7275/0090, Teflon®, or Chemraz® 505/605 secondary sealing elements.

Rotary: Any API rotary type constructed of carbon or stainless steel for hydrocarbon service designed with dual mechanical seals and Grafoil®, Kalrez® 6375/6380/7275/0090, Teflon®, or Chemraz® 505/605 secondary sealing elements. This type of pump should be checked regularly for gear/screw wear.

Reciprocating: Any API diaphragm type constructed of stainless steel for hydrocarbon service designed with Grafoil®, Kalrez® 6375/6380/7275/0090, Teflon®, or Chemraz® 505/605 secondary sealing elements. Construction is hydraulically-driven dual-diaphragm with inter-diaphragm leak detection and stainless steel or Teflon® diaphragms.

4.5 Instrumentation

Independent and redundant high-level alarms and/or shutdowns should be provided to avoid overflow of propylene oxide storage vessels. Additional guidance can be found in API 2350 Tank Overfill Protection. Storage tanks should be equipped with temperature sensors.

4.6 Relief Requirements

The requirements of API 2000 should be followed for low pressure vertical storage tanks. Pressure relieving systems for pressure vessels are defined in API 520 parts 1 and 2. Flame arresters, when required, should follow the requirements of API 2028 and 2210, Underwriters Laboratory (UL) 525 and NFPA 30 and 30H.

4.7 Leak Detection Devices

Secondary containment areas in confined spaces should be monitored with instrumentation able to detect the lower flammability limit of propylene oxide in air.

Instruments that have been successfully used to measure propylene oxide are combustible gas indicators, infrared spectrophotometers, flame ionization detectors and photoionization detectors (see Section 3.5).

4.8 Material Requirements

All equipment (including but not limited to piping, pressure vessels, storage tanks, pumps, gaskets, etc.) should follow recognized industry codes and standards and the requirements of local jurisdictions. These codes include but are not limited to:

- ASME Boiler and Pressure Vessel Code
- ASME B31.3 “Process Piping”
- API 650 “Welded Storage Tanks for Oil”

4. Engineering

4.8.1 Equipment (Piping, Tanks, Vessels, etc.)

- Carbon Steel
- 304L and 316L Stainless Steels are also acceptable

4.8.2 Gaskets

- Flat Ring (sheet): Grafoil® GHE, dimensions per ANSI B16.21.
- Spiral Wound: Flexitallic CG, 100 percent graphite-filled, dimensions per ASME B 16.20.

4.8.3 O-rings

- Teflon®, Chemraz® 505 or equivalent
- PO (pure, no water) – Kalrez® 7275, 6375 or 6380
- Aqueous PO – Kalrez® 7275 or 0090.

4.8.4 Pipe Thread Sealant

- PTFE-based paste or tape, however, the use of threaded pipe connections is generally discouraged. Continuity should be checked across connections or other means must be provided to ensure proper bonding and grounding of piping components

4.8.5 Pumps

- Casings: see section 4.8.1 above.
- Gaskets: see section 4.8.2 above.
- Elastomers: see section 4.8.3 above.
- Seals: Double mechanical seals (such as plan 52, 53, 72 or 74) are recommended.
- Component materials for mechanical seals should include:
- Stationary Faces: tungsten carbide or silicon carbide.
- Rotation Faces: carbon.

4.8.6 Valves

- Body and Bonnet: see section 4.8.1 above
- Bonnet Gaskets: see section 4.8.2 above or welded bonnet valves may be used
- Packing: Graphite-based die-formed rings or bellows sealed
- Isolation valves should be “fire safe” per API 607
- Additional information can be found in API RP 615 Valve Selection Guide

4.8.7 Hoses

- Stainless steel corrugated core with stainless steel outer braid
- User must follow hose manufacturer’s recommendations regarding temperature/pressure ratings, minimum bending radius, support requirements, etc.

4.9 Vapor Containment System

The requirements of API 2000 should be followed for low pressure vertical storage tanks. Vapor containment systems for pressure vessels are defined in API 520 parts 1 and 2. Flame arresters, when required, should follow the requirements of API 2028 and 2210, UL 525 and NFPA 30.

4.10 Chemical Compatibility

Propylene oxide is incompatible with oxidizing materials, anhydrous metal chlorides, acids, bases, clay-based adsorbent materials, peroxides, inorganic chlorides and any acetylide-forming metals, such as aluminum, copper and copper alloys, including brass and bronze.

5. Fire Safety

5.1 Fire and Explosion Hazard

Propylene oxide is an extremely flammable liquid and vapor (H224) that is classified by the following organizations:

Organization	Classification	
OSHA 29 CFR 1910.106	Class 1A flammable liquid	
NFPA 30 and 30H	Class 1A flammable liquid	
NEC-NFPA 70	Class 1, Group B* flammable liquid	
NFPA 704	Health	3
	Fire	4
	Reactivity	2

Vapors of propylene oxide at concentrations between 1.8% and 37% in air can explode if an ignition source is present. Propylene oxide vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. All precaution necessary for the safe handling and storage of a volatile flammable liquid or vapor should be strictly observed with propylene oxide. Aqueous mixtures as low as 0.75% propylene oxide may be flammable.

Storage areas should be designed to prevent exposure of propylene oxide containers to fire (see Section 8.1). Section 9 provides recommendations for the safe unloading and transfer of propylene oxide which are necessary to minimize the fire and explosion hazard while performing these operations.

If this material is involved in a fire, prevent unauthorized individuals from entering the area, and evacuate the area downwind from the fire. Fires should be fought from a safe distance upwind. Thermal decomposition products, such as carbon dioxide, carbon monoxide and perhaps other toxic gases and vapors, may be generated. Propylene oxide, when involved in a fire, burns rapidly with tremendous heat. Figure 5-1 on the following page provides propylene oxide flammability limits in air.

Heat may build pressure and cause rupture of closed containers. A water fog may be used to cool the containers. Water may be ineffective as an extinguishing agent. Prevent liquid from entering water sources and sewers by building dikes as necessary to contain flow.

5.2 Fire Prevention

Propylene oxide, when ignited, burns rapidly with high heat. Due to the high vapor pressure of propylene oxide, it is capable of readily forming explosive mixtures. Sources of ignition, including heat, sparks, flames and static electricity, must be avoided. Compliance with this basic rule requires continual oversight and management. Meeting this rule should typically include the following combination of work practices and mechanical controls:

- a strong “no smoking” policy in areas where propylene oxide is used
- the use of non-sparking tools while working with or near propylene oxide-containing equipment
- grounding of metallic containers/vessels in which the material is stored
- bonding and grounding of metallic receiving containers
- stringent welding, cutting and burning permit systems
- implementation of inside and outside storage methods that comply with legal requirements and good industry practice.

5.2.1 Static Electricity

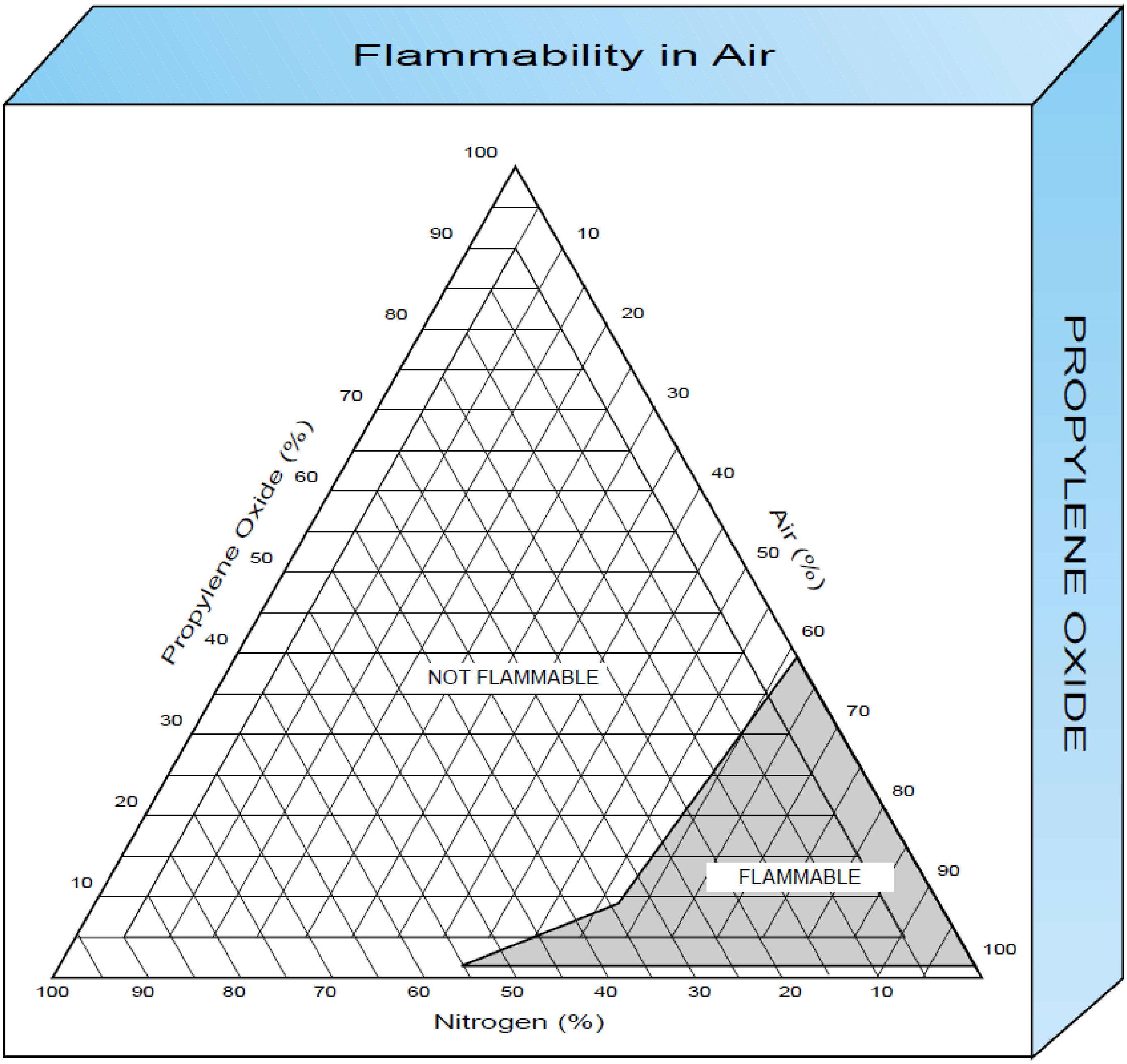
As with other flammable liquids, the transfer of propylene oxide can create static electricity charges, which can act as an ignition source of the flammable vapors. The charge can develop when the liquid flows or is poured through air. To reduce or eliminate this, bonding and grounding is required by federal regulations, OSHA 29 CFR 1910.107, building and fire codes and industry practice (NFPA 70, NFPA 77, NFPA 30 and 30H).

Bonding provides a low resistance path to current flow between two surfaces which are physically separated or become separated. Maximum resistance to ground of 1 megaohm is acceptable (NFPA 77), but generally much lower values are possible.

Grounding connects the containment vessels, pipes, etc. to a grounding electrode (ground) in the earth by means of conductors welded/attached to both the equipment and the ground. A 10-ohm maximum is the recommended value for the resistance of the cable and ground.

5. Fire Safety

Figure 5-1



To determine if a mixture of propylene oxide is flammable, find the concentration of propylene oxide and the air or nitrogen concentration. Follow both lines until they intersect. If they intersect within the shaded area, the mixture is flammable.

5. Fire Safety

5.3 Fire Suppression

Propylene Oxide is a flammable liquid with an high vapor pressure and low flash point that requires firefighting agents to suppress vapors and/or extinguish fires involving propylene oxide. Both film forming foams and fluorine free foams have proven successful at extinguishing and suppressing propylene oxide vapors and extinguishing fires involving propylene oxide. The foam manufacturer should be contacted to verify their foams' effectiveness in suppressing propylene oxide vapors and extinguishing fires involving propylene oxide. A fire risk assessment should be conducted to develop contingency plans for spills and fires involving propylene oxide to include emergency response plans and fire protection and/or extinguishment systems.

Fire protection and extinguishing systems should be designed to all relevant NFPA codes with special considerations given to NFPA 11 and 16. Foam application rates should follow NFPA 11 and 16 recommendations and be verified with foam vendor to ensure the foams effectiveness at the prescribed rates and discharge time.

Propylene oxide is soluble in water and the resulting solution requires substantial dilution to minimize the rate of vaporization. In confined spaces, such as sumps or sewers, a dilution greater than 150 to 1, or less than 0.75% propylene oxide, maybe necessary to prevent PO vapor concentrations above 20% LEL.

Portable fire extinguishers should be placed in the vicinity where propylene oxide is handled or stored and in areas where the potential for spills or leaks exists. Class B dry chemical or foam extinguishers should be used when fighting small propylene oxide fires. Guidelines for the correct selection, use, distribution, inspection, maintenance, and recharging of portable fire extinguishers should be referred to when designing a work area (NFPA 10).

5.4 Fire Fighting

If a facility relies on community fire companies for fire response, information regarding propylene oxide operations and storage should be provided. Information should include facility layouts indicating the storage locations and quantities of propylene oxide. Drills should be conducted periodically with the fire company and facility information updated on a regular basis.

If a facility chooses the option of an internal fire brigade for structural firefighting, then compliance with the OSHA Fire Brigade Standard is required. These requirements as defined in 29 CFR 1910.156 include the organization of a fire brigade, the personal firefighting equipment and training requirements.

Fire fighters should use full protective clothing and equipment, including National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA)-approved self-contained breathing apparatus (SCBA) with full facemask operated in the pressure demand mode (see Sections 3.3 and 3.4). Water spray can be used to disperse vapors to protect the fire fighters who may be attempting to stop a leak.

If a fire is controllable or propylene oxide containers are not exposed to direct flame, an evacuation zone with a minimum radius of 1,500 feet may be needed. If the fire becomes uncontrollable or propylene oxide containers are exposed to direct flame, an evacuation zone with a minimum radius of 5,000 feet may be required.

In some instances, depending on specific facility hazards, it may be prudent to allow a propylene oxide fire to burn itself out. A qualified fire-fighting expert should make this decision.

After a fire has been extinguished, residual propylene oxide contamination may occur. This may require a cleanup of the liquid. Individuals who engage in such a cleanup should be thoroughly trained in proper techniques and have received training in accordance with the OSHA Hazardous Waste Operations and Emergency Response (HazWOpER) standard, 29 CFR 1910.120 (see Section 7).

6. Hazard Communication

6.1 Hazard Communication

Under hazard communication and national and local worker right-to-know laws, workers should be informed of the potential hazards of chemicals in the workplace. Such laws require that employers who use hazardous chemicals in their workplace, including propylene oxide, develop written programs and train employees on the potential hazards and protective measures.

6.1.1 Worker Training

As a user of propylene oxide, an employer should provide information and training to employees on its hazards, the methods for detecting releases and methods of protection from exposure. This information should be included in your Hazard Communication Training Program. To assist you in this effort, the following summary information is provided.

6.1.1.1 Hazards

Propylene oxide is a flammable liquid with a low boiling point and a high vapor pressure. Propylene oxide vapors are heavier than air and may travel long distances along the ground. These vapors are flammable and will burn or explode.

Exposure to propylene oxide can occur through any route of exposure but most commonly occurs through inhalation, skin or eye contact. If inhaled, short-term exposure to propylene oxide in high concentrations will cause pulmonary edema (fluid in the lungs) and may cause narcotic effects.

Skin contact with propylene oxide can result in irritation or chemical burns, depending on the concentration of the liquid and the duration of skin contact.

Eye contact with liquid propylene oxide may result in chemical burns. High vapor concentrations may cause eye irritation.

The National Institute for Occupational Safety and Health (NIOSH), the International Agency on Research for Cancer (IARC), Environmental Protection Agency (EPA) and the National Toxicity Program (NTP) consider propylene oxide to be a possible, potential or probable human carcinogen.

For a complete discussion of the health effects of propylene oxide see Section 2.

6.1.1.2 Methods of Detection

Propylene oxide cannot be detected by odor or irritation response at concentrations below 200 ppm and is, therefore, considered to have poor warning properties. Above 200 ppm propylene oxide has a sweet ether-like odor. In the event of sensory detection of propylene oxide, recommended exposure guidelines may have been exceeded.

To determine propylene oxide concentrations in air, measurements can be made using air sampling equipment. A variety of instruments are available to provide instantaneous or continuous monitoring of propylene oxide concentrations in air.

Direct reading instruments including combustible gas indicators, infrared spectrophotometer, flame and photoionization detectors, and colorometric detector tubes (see Section 3.5) can be used to monitor for propylene oxide. When assessing worker exposure to propylene oxide, personal breathing zone samples should be collected to determine compliance with the established exposure limits (see Section 3.6).

6.1.1.3 Methods of Protection

Hazard Communication Training should include information on methods of protection that can be used by workers handling propylene oxide. This should include the engineering and administrative controls employed, as well as the personal protective clothing and equipment (PPE) to be worn (see Sections 3.3 and 3.4).

6.1.2 Labeling

All incoming containers of this product are accompanied by a product label providing health and safety information. The product label is a primary source of information for safe handling of this material. Lyondell product labels contain the material identification, principal hazards, and Lyondell's name, address and telephone number.

6.1.3 Safety Data Sheets

The Lyondell safety data sheet (SDS) is provided to customers with the first order of the new year and with the first order after any major change or revision to the SDS. SDS are the primary means of providing information regarding the safe storage, handling, use and ultimate disposal of Lyondell products. While he product SDS is an invaluable source of health and safety information, it may not supply information specific to the actual uses of the product.

Lyondell SDS are available in several languages and formats on the Lyondell website. While the additional downstream sales of this product, or materials containing this product, are the responsibility of the distributor, Lyondell will support your hazard communication efforts.

6. Hazard Communication

6.2 SARA Title III (U.S. only)

The Emergency Planning and Community Right to Know Act of 1986, also referred to as the Superfund Amendment and Reauthorization Act or SARA Title III, requires facilities which use or store propylene oxide to notify their state emergency response commissions and work with local authorities to develop emergency response plans. Users of propylene oxide should read the SARA Title III regulations and familiarize themselves with its requirements.

Since propylene oxide is a potentially hazardous chemical, facilities should submit to their local emergency planning committee (LEPC) a copy of the SDS or their chemical inventory list. If a facility uses or stores more than the threshold planning quantity (TPQ) of 10,000 pounds of propylene oxide in a year, the facility should submit an annual Tier I or Tier II Report to state and local agencies. This inventory listing should include all mixtures of propylene oxide in excess of 0.1% concentration.

6.3 State Regulations

State or local regulations, while patterned after the federal legislation, may have different or contain more stringent requirements. Specific state regulations should be reviewed in order to assess the applicability of these regulations to the use of propylene oxide.

7. Environmental

Aqueous solutions of propylene oxide degrade and convert to propylene glycol with an average half-life of 13 days, through hydrolysis in fresh water, and to chloropropanol in sea water in only 2 days. The length of time for propylene oxide degradation will vary based on the conditions of the aquatic medium. Aquatic organisms metabolize propylene glycol. Both propylene glycol and chloropropanol are readily biodegraded.

Propylene oxide may contaminate the soil from accidental spills and uncontrolled process runoff. Degradation in wet soil occurs through hydrolysis, as discussed previously. In dry soil propylene oxide will evaporate into the air. Propylene oxide tends to be very mobile in the soil.

Studies indicate that propylene oxide, based on its water solubility and conversion to propylene glycol and chloropropanol, will not accumulate in aquatic or terrestrial life forms.

7.1 Spills and Leaks

Facilities involved in the storage and/or handling of propylene oxide should be designed to contain and/or control spills from process areas and loading and unloading operations. Soil and groundwater contamination from an accidental spill of propylene oxide can be minimized by installation of curbs, sumps and impervious containment areas.

Concrete curbing with a minimum one percent slope or earth diking with a minimum two percent slope from the point of the potential spill to a collection basin or sump should be used to retain propylene oxide within the containment area, thus minimizing worker exposure and overall environmental impact. The total volume of the containment area should be adequate to handle a worst-case release of propylene oxide. For storage tanks the capacity of the containment area is generally the volume of the largest storage tank in the diked area. Design of the diking or curbing should also provide an allowance for accumulated rainfall.

Pumps, piping and equipment, designed to operate within potential spill areas, should be compatible with propylene oxide (see Section 4) and free of potential ignition sources.

If possible, all pumps and ancillary equipment should be located outside the primary containment area and should be provided with curbing to collect drips, leaks and minor spills. Drain valves may be installed at the low point of the containment area or sump. During normal operations all drain valves should be in a closed position.

To minimize soil and ground water contamination in the event of a propylene oxide spill, the containment areas should be designed and constructed of impermeable materials such as concrete, synthetic liners or compacted clay. Since concrete is not totally impervious, other measures should be taken to prevent soil and groundwater contamination. Use only compatible sealants on cracks and concrete joints because propylene oxide may degrade certain epoxy resins.

In the event of a propylene oxide release to the environment, local or national regulations should be consulted to ensure compliance with reportable quantities.

Any accidental discharge of propylene oxide or waste containing propylene oxide into the municipal sewer system should be reported immediately to local authorities.

In the event of a spill of propylene oxide, all nonessential personnel should be evacuated. All ignition sources must be extinguished immediately. After donning the appropriate personal protective equipment (see Section 3), the spill should be covered with Alcoseal® FFFP foam or equivalent (see Section 5.3) to minimize potential fire hazard from vaporization of the propylene oxide. Depending on the volume and location of the spill, it can be recovered by vacuum truck or absorbed with solid sorbent (see Section 4.10) and placed in drums for disposal. Residual propylene oxide in the containment area should be flushed with water into a sump or collection area for subsequent treatment or disposal.

7. Environmental

7.2 Waste Disposal

Propylene oxide is an extremely flammable liquid and is hazardous when discharged to the environment. In areas where propylene oxide may be released or handled, access should be limited to required personnel only. Waste disposal should be conducted in accordance with local regulations.

Aqueous solutions, containing low concentrations of propylene oxide, can be treated biologically in a waste treatment plant. Biological treatment can also be considered for disposal of minor spills provided that the system is acclimated to propylene oxide and propylene glycol, and the treatment system has obtained any required permit approvals. Process waste streams should be characterized to determine the proper regulatory classification.

Discharge of aqueous solutions of propylene oxide from minor spills into a municipal treatment system must be approved by the regulating authority prior to discharge.

If propylene oxide process waste is treated biologically at a POTW, the local authority should be consulted to determine appropriate requirements. If propylene oxide is biologically treated onsite and then discharged to surface waters, the treatment plan effluent should comply with federal and state discharge permit provisions.

Soil contaminated with propylene oxide should be excavated and disposed of in compliance with all requirements of hazardous waste regulations.

Discarded, off-specification commercial product may be considered a hazardous waste. The material should be disposed of in accordance with the local regulations. Waste, off-specification propylene oxide product, containers that have not been cleaned and spill clean-up materials may be subject to land disposal restrictions.

7.3 Container Disposal

Any shipping container or drum which has been used to ship propylene oxide and has not been satisfactorily cleaned should be considered a potential fire/explosion risk and should not be cut, burned, soldered or welded. These materials may also be considered a listed hazardous waste and should be disposed of in accordance with applicable regulations.

8. Product Storage

Among the considerations in the design and construction of propylene oxide storage and handling facilities are flammability, toxicity, potential effects in the environment, and worker exposure. The specific design requirements for facilities receiving and storing propylene oxide depend upon several factors, including volumes stored and handled, container type, mode of transportation, processes utilized at the facility and proximity to other hazardous materials. The proper design and construction of storage and handling facilities requires consultation with competent professional engineers.

Additional requirements may be imposed by the U.S. Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA). EPA's Risk Management Plan (RMP) for Accidental Releases, 40 Code of Federal Regulations (CFR) 68.130 applies to facilities that process or store regulated substances that exceed the threshold quantities as established by the EPA. The RMP threshold quantity for propylene oxide is 10,000 pounds or more. OSHA's standard for Process Safety Management of Highly Hazardous Chemicals, 29 CFR 1910.119 applies to processes that involve flammable liquids, including propylene oxide, in one location, in quantities of 10,000 pounds or more.

Facilities must review the RMP regulations and the PSM standard prior to designing or modifying existing facilities. Though Lyondell does not assume the responsibility of deeming management plans as appropriate or effective, Lyondell will require that facilities provide evidence of compliance with these regulations, including, but not limited to, providing copies of the management plans to Lyondell prior to delivery of bulk quantities. Additionally, U.S. Department of Transportation (DOT) regulations, as codified at 49 CFR 172.800, will require facilities to establish or update a written transportation security plan to account for the transportation, storage, and handling of any quantity of propylene oxide.

8.1 Storage Tanks

Requirements for atmospheric tank storage, including secondary containment, are presented in NFPA 30 and 30H. This code requires that storage of propylene oxide in an unprotected facility should be situated at least 3 times the distances from a property line presented in Table 8-1 below. A protected storage facility should be at least 1-½ times the distances presented in the table.

Considerations in site selection and tank spacing include proximity to other flammable material storage facilities, nearby ignition sources, fire-fighting accessibility, and impact of a vapor cloud explosion on nearby areas. Installations should comply with applicable national standards such as NFPA 30 and 30H and NFPA 70 in the US. Note that according to NFPA and OSHA, propylene oxide is a Class 1A flammable liquid.

Propylene oxide tanks should be designed and constructed at twice the absolute vapor pressure of propylene oxide at the planned operating temperature. Atmospheric propylene oxide storage tanks (see Figure 8-1) should be designed and constructed in accordance with NFPA 30 and 30H as it applies to Class 1A liquids. This standard is intended to ensure that tanks possess sufficient structural strength and pressure relief systems to prevent catastrophic loss of contents in either normal service or under fire conditions (see Section 4).

American Petroleum Institute (API) Standard 620, Recommended Rules for Design and Construction of Large, Low-Pressure Storage Tanks should be applied to the design and construction of propylene oxide storage tanks at low pressures. A typical pressure storage tank (ASME Pressure Vessel) for propylene oxide can be seen in Figure 8-2.

Storage tanks should be situated within containment systems capable of providing detection and control of an accidental release of propylene oxide. Containment system design and operation should conform with NFPA 30 and 30H. Tank venting systems should comply with API 2000, Venting Atmospheric and Low-Pressure Storage Tanks. These standards require, at a minimum, that instrumentation at the loading station warns the operator of the potential for overfilling and that a totally independent device shuts off flow whenever overfill is imminent. Neither device is to be used as a regular operating tool for determining tank level.

Bulk storage tanks should be vented to a containment device which eliminates discharges of propylene oxide vapors to the atmosphere. The containment device should be designed to prevent the passage of a flame from one container to another.

Refrigeration units may be used to keep storage temperature below 70°F to minimize polypropylene oxide formation.

The National Electric Code (NFPA 70) outlines electrical requirements for the handling, transport, and storage of propylene oxide and other Class 1, Group B* flammable liquids. It also requires that whenever flammable liquids are stored or transferred, their containers should be effectively bonded and grounded to prevent static electricity.

8. Product Storage

8.2 Unloading Stations

The installation for unloading tank cars and tank trucks of propylene oxide should be designed, maintained and operated to meet current standards for fire protection, worker safety and environmental protection.

Loading racks should be located at least 150 feet from all equipment and tanks. Electrical wiring and devices should comply with the requirements of NFPA 70. Piping throughout the installation should comply with NFPA 30 or with American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI) B31.3.

Table 8-1

Capacity Tank Gallons	Minimum Distance in Feet from Property Line which is or can be Built Upon Including Opposite Side of Public Way	Minimum Distance in Feet from Nearest Side of any Public Way or from Nearest Important Building on same Property
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

Collection systems should be large enough to contain the worst credible accidental release of propylene oxide, plus an additional volume for flush water and rain water. The unloading area should be curbed to divert spillage into the drainage system and prevent run-off into the surrounding areas. Adjacent unloading areas should be segregated by curbing. At a minimum, the surface of the unloading area under and around the bulk transport vessel should be constructed of concrete or ballast installed over a synthetic impermeable barrier suitable for the retention of propylene oxide. The drainage surfaces should be pitched towards a collection basin or sump.

The sump or catch-basin should have fire seals and be equipped with instruments that will detect liquid levels and the presence of propylene oxide vapor. Rain water and spilled liquids trapped inside the containment area are to be disposed of through the sump or catch-basin. Discharge valves from the collection area should be closed under normal conditions. Accumulated liquids should be disposed of by a trained operator, after determining the liquid's composition.

Lighting adequate for night-time unloading operations should be provided, unless all unloading is to be performed during daylight hours.

A suitable method of discharging container contents should be provided. Acceptable methods include pumping from the top via a dip pipe or pressurization with nitrogen. If nitrogen pressure is used, the installation should be designed to avoid over-pressurization of the vessel. Furthermore, a means of collection and environmentally acceptable treatment of the displaced vapor from the storage tank should be provided (e.g., flaring or scrubbing). Vapor containment systems should be designed to remove or recover vapor (see Section 4).

8.3 Workplace Location

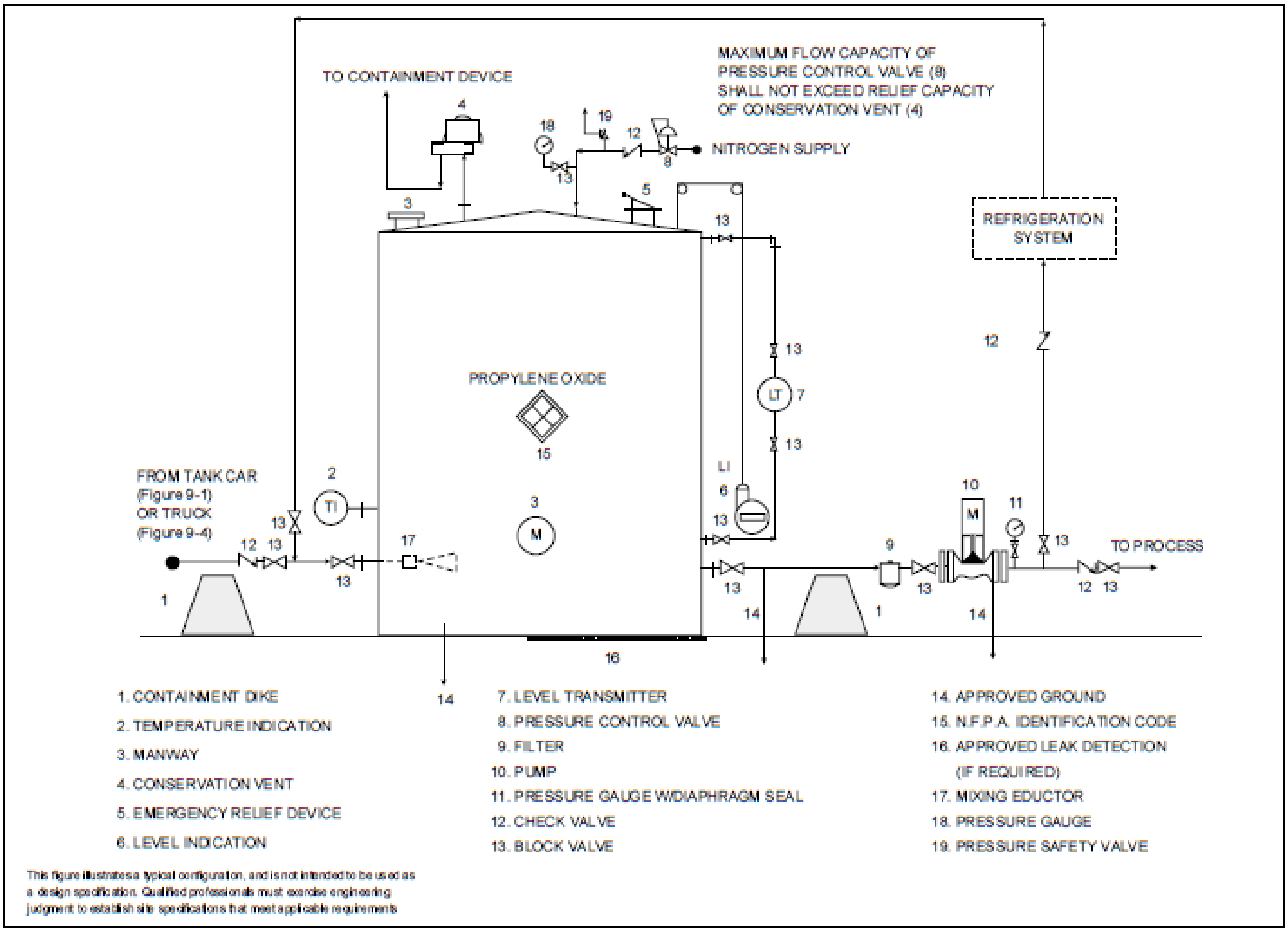
When planning for the handling, storage and use of propylene oxide, the workplace location is of primary importance. When properly located, worker and community exposure can be reduced and controlled. Processing operations utilizing propylene oxide should be located and operated to minimize the potential risk of fire and explosion.

Break rooms and locker/shower facilities should be separated from areas handling propylene oxide and they should have isolated air handling systems (HVAC). Workers should remove contaminated work clothes before entering break rooms. Workers that handle propylene oxide on a routine basis should be advised to shower and change into fresh clothes at the end of their shift.

Community exposure to fugitive emissions or possible spill or release should be evaluated prior to site selection. The impact of the site on existing facilities should also be taken into consideration. Additional factors to consider are the location's proximity to access roads, surface waters and other drinking water sources, and emergency services, such as medical, fire department and mutual aid facilities.

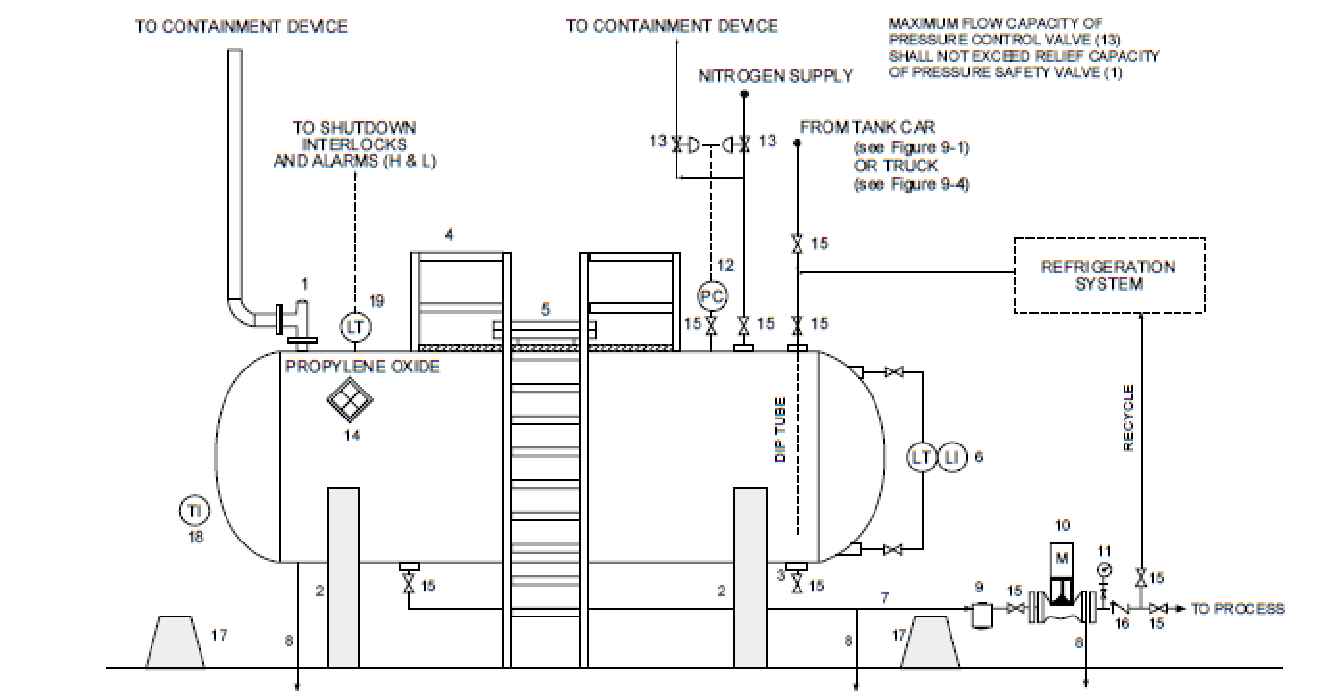
8. Product Storage

Figure 8-1 Typical Atmoshperic Storage Tank Configuration



8. Product Storage

Figure 8-2 Typical Pressure Storage Tank Configuration



1. PRESSURE SAFETY VALVE
2. TANK SUPPORT
3. TANK DRAIN
4. SAFETY RAILING
5. MANWAY
6. LEVEL TRANSMITTER W/OUTPUT GAUGE
7. OUTLET LINE
8. APPROVED GROUND
9. FILTER
10. PUMP
11. PRESSURE GAUGE W/DIAPHRAGM SEAL
12. PRESSURE CONTROLLER (SPLIT RANGE)
13. PRESSURE CONTROL VALVE
14. N.F.P.A. IDENTIFICATION CODE
15. BLOCK VALVE
16. CHECK VALVE
17. CONTAINMENT DIKE
18. TEMPERATURE INDICATION
19. LEVEL TRANSMITTER

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

9. Transfer Operations

Propylene oxide should be transferred and handled following written operating procedures developed for the specific facility. This section provides guidelines used by Lyondell in our handling of propylene oxide. Operating procedures should include the hazards associated with this product (see Section 6) and the selection of personal protective clothing and equipment (see Section 3). Only workers properly trained in these operating procedures should handle propylene oxide.

9.1 Seal Procedure

Lyondell seals all tank cars, tank trucks and intermodal tanks with cable seals. The consignee should verify the seal numbers on the bulk vessel with the seal numbers provided in the accompanying paperwork. If the seals are missing, evidence of tampering is present, or the seal numbers do not match, please contact Lyondell.

When preparing the bulk vessel for return, the consignee should the seal originally sealed openings that were broken with cable seals and record the seal numbers on the return paperwork.

9.2 Tank Cars

Lyondell ships propylene oxide in DOT 105J300 tank cars. The unloading valve is located at the top of the tank car. A typical tank car configuration is shown in Figure 9-1.

During unloading, the tank car should be connected to a vapor balance or equalizing system or blanketed with an inert gas (e.g., nitrogen) depending on the unloading system design.

Piping systems and track rails should be connected to a common earth ground. The tank car should be bonded to the discharge system. Continuity of ground should be checked prior to unloading.

An automatic deluge sprinkler system should protect the unloading facility and dome area of the tank car. It should provide for both cooling and dilution of the propylene oxide. A fire water monitor should be located near the tank car dome with an unobstructed path to the target. A dry-powder fire extinguisher should also be present.

There should be emergency block valves or shut-off switches in the liquid and vapor line permanent piping that can be operated locally and remotely. If a pump is used, there should be a switch at a remote location to shut the pump down. Workers should identify all piping so that proper alignment can be made.

Tank cars should be unloaded in accordance with 49 CFR 174 Subpart C.

9.2.1 Work Preparation

The following procedures have been developed to assist in the safe unloading of propylene oxide. A suggested unloading checklist is provided in Figure 9-2.

1. Center the tank car with the unloading station.

2. Set brakes and chock wheels on tank car.

3. Connect ground cable to car and check for continuity of connections.

4. Be sure blue flag and derailer are in place.

5. Locate metal caution signs in front of and/or behind the tank car. An additional sign should be located at the rail siding switch. These signs should read “STOP—TANK CAR CONNECTED.”

6. Remove the housing cover pin and lift dome cover. This will expose all valves and fittings which are required for unloading. The typical tank car dome configuration is shown in Figure 9-3.

7. Inspect for leakage around valves and fittings in the dome area by pouring soapy water on the connections only and checking for bubbles. If leaks are detected, stop work and make repairs.

8. Determine the available storage tank capacity and the liquid level in the tank car before transfer.

9. Transfer Operations

9.2.2 Unloading Procedures

1. Attach nitrogen line to the vapor valve. Attach hoses to the liquid unloading valves. Stainless steel braided hoses with two-way shutoff quick-disconnect couplings are recommended. If dry disconnect couplings are not used, purge all lines and connections with nitrogen before transferring propylene oxide.

2. Pressure tank car to 60 psig and hold for one minute. If pressure cannot be maintained, use a soap and water solution to identify leak. After the leak has been corrected, proceed to Step 4.

3. Open vapor valve and use a regulator to adjust the nitrogen pressure to equalize that of the tank car. This will force liquid propylene oxide into the pump and keep the vapor phase of the tank car out of the flammable limits.

CAUTION: Do not let nitrogen pressure exceed 90% of the rated relief valve pressure.

4. Open the liquid unloading valve and allow propylene oxide to fill the pump. This valve must be opened slowly to avoid activating the excess flow valve. Start pump and begin pumping propylene oxide to the storage tank.

CAUTION: A positive pressure should be maintained on the tank car to keep the pump from pulling a vacuum on the car; monitor closely.

5. Monitor liquid level on storage tank to identify when the transfer is complete. A density gauge or a bull's eye in the transfer line can also be used.

6. When the tank car is empty, shut down the pump. Clear transfer line using nitrogen. Close the unloading line valve to the storage tank and the storage tank vent. Close the tank car vapor valve and the tank car liquid unloading valve. Vent transfer line of pressure. Pressurize tank car to 15 psig with nitrogen for return trip. Disconnect transfer, nitrogen and storage tank vent lines.

7. Test for leaks by pouring soapy water over the valves. If no bubbles are detected, close and secure dome cover. If bubbles are detected, retighten all valves and retest. If leaks are still detected, stop work and make repairs.

8. Disconnect the ground cable. Remove the wheel chocks, derailer, blue flag and caution signs.

9. Leave the tank car brakes engaged for the railroad crews to release.

10. If there are any mechanical problems with the tank car, advise Lyondell Customer Service before releasing the tank car for return to Lyondell.

9.3 Tank Trucks

Lyondell ships propylene oxide in Department of Transportation-specified cargo tank motor vehicles with a nitrogen pad. The unloading valve is located at the rear of the trailer. A typical tank truck configuration is shown in Figure 9-4.

The tank truck unloading facility should be in a relatively remote, level location distant from general activity and ignition sources. Use of road barriers and warning lights is recommended to restrict traffic or other operations from the unloading area.

Workers who are properly trained should use only non-sparking tools during unloading of the tank truck. The tank truck should be grounded. All electrical equipment, including telephone and intercom systems, should be Class 1, Group B*.

Workers should use either steel pipe and swing joints for truck liquid and vent connections or flexible stainless steel braided hoses to connect the unit's fixed piping to the truck connections. Since these hoses are probably the most vulnerable part of the unloading process, workers should inspect, and pressure test them frequently and store them in a protected location.

There should be emergency block valves in the liquid and vapor line permanent piping that can be operated locally and remotely. If a pump is used, there should be a switch at a remote location to shut the pump down. Workers should identify all pipelines so that proper alignment can be made.

9. Transfer Operations

9.3.1 Work Preparation

The following procedures have been developed to assist in the safe unloading of propylene oxide. A suggested unloading checklist is provided in Figure 9-5.

1. Chock both sides of one tank truck wheel; set brakes.

2. Connect ground cable and check for continuity.

3. Check bill of lading and verify sample to confirm contents.

4. To prevent truck movement during unloading, the driver is not to remain in the cab.

5. Inspect hoses, pump and valves for cleanliness, leaks and other defects.

9.3.2 Unloading Procedures

1. Connect storage tank vapor recovery line to tank truck.

2. Connect transfer line to liquid unloading valve and nitrogen line to vapor valve. Flexible stainless steel braided hoses with two-way shutoff quick-disconnect couplings are recommended. If dry-disconnect couplings are not used, purge all lines and connections with nitrogen before transferring propylene oxide.

3. Pressure tank truck to 25 psig and hold for one minute. If pressure cannot be maintained, use a soap and water solution to identify leak. After the leak has been corrected, proceed to Step 4.

4. Confirm that the vent-back and liquid inlet valves at the storage tank are open. Slowly equalize the pressure on the truck and the storage tank. Maintain nitrogen pressure below 20 psig on tank truck.

5. Nitrogen pressure and/or a pump may be used to unload tank truck.

6. The unloading valve must be opened slowly to avoid activating the excess flow valve.

CAUTION: A positive pressure of at least 10 psig should be maintained on the tank truck to keep from pulling a vacuum on the truck; monitor this closely.

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

8. Shut down the pump when the tank truck is empty. Blow transfer lines clear of propylene oxide by using an inert gas. Close all valves and vents. Vent transfer lines of pressure by blowing back into truck with nitrogen. Disconnect transfer, nitrogen and storage tank vent lines.

9. Check to ensure placards meet DOT requirements.

10. Disconnect ground cable and remove wheel chocks.

9.4 Intermodal Tanks

Propylene oxide is shipped in intermodal bulk transport tanks meeting the T15 portable tank specifications. The unloading valve is located at the rear of the tank. The work preparation and unloading procedures are the same as the tank truck procedures located in Section 9.3. A typical intermodal tank configuration is shown in Figure 9-6.

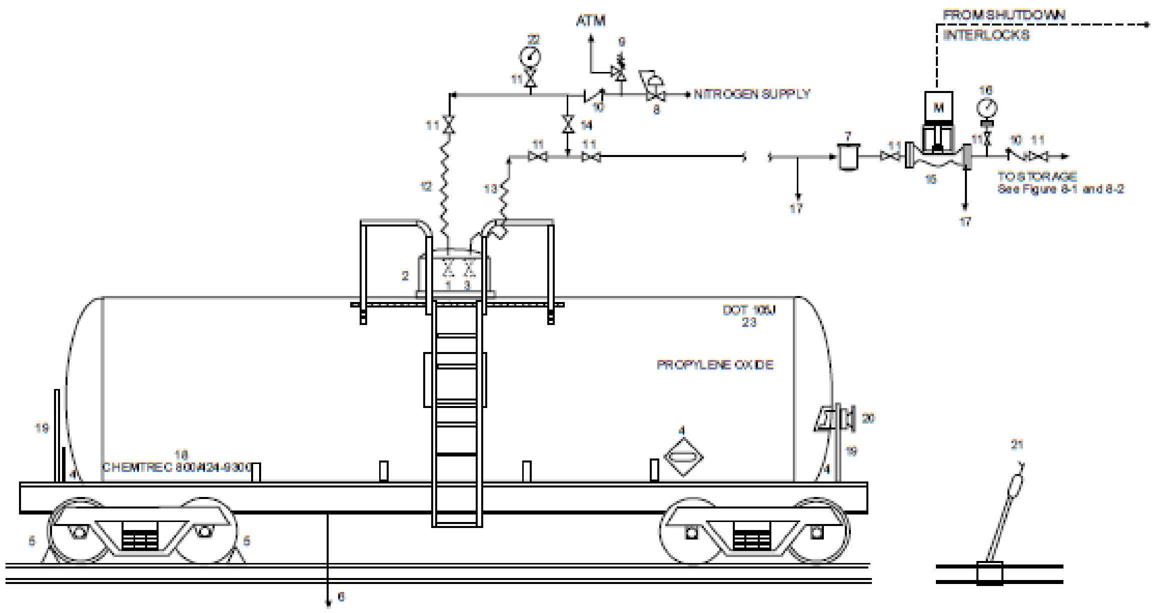
9.5 Dry-Disconnect Fittings and Hoses

Lyondell recommends the use of dry-disconnect fittings and flexible stainless steel braided hoses for the transfer of propylene oxide from all transportation equipment. The dripless fittings are designed to minimize worker exposure and environmental release during transfer operations.

Customers should implement preventative maintenance programs for both the fittings and hoses. Lyondell replaces dry-disconnect fittings and hoses on annual basis. Customers should determine appropriate maintenance schedules based on their practices. Fittings and hoses should always be inspected prior to each use.

9. Transfer Operations

Figure 9-1 Typical Tank Car Configuration



1. VAPOR VALVE
2. MANWAY (see Figure 9-3)
3. LIQUID VALVE
4. PLACARD (Figure 11-2 & 11-3) (ALL 4 SIDES)
5. WHEEL CHOCKS
6. APPROVED GROUND CLAMP
7. FILTER
8. PRESSURE CONTROL VALVE
9. PRESSURE SAFETY VALVE (N_2)
10. CHECK VALVE
11. BLOCK VALVE
12. FLEX. HOSE ASSEMBLY W/2" NPT CONN.
13. DRY DISCONNECT & FLEX. HOSE ASSEMBLY W/2" NPT CONNECTIONS
14. NITROGEN HIGH POINT PURGE W/BLOCK VALVE
15. PUMP
16. PRESSURE GAUGE W/DIAPHRAGM SEAL
17. APPROVED GROUND
18. CHEMTREC EMERGENCY NUMBER 800/424-9300
19. HANDRAIL
20. HAND BRAKE WHEEL
21. DERAILER
22. PRESSURE GAUGE
23. DOT CLASSIFICATION NO.

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

9. Transfer Operations

Figure 9-2 Tank Car Unloading Checklist

Propylene Oxide
Tank Car Unloading Checklist

Tank Car Number: ____________________ Date: ____________________

Operator: ____________________ Time: ____________________

Prior to Unloading Tank Car	YES	NO
Wheels chocked and hand brakes engaged		
Blue flag and derailer device in place		
Metal caution signs located in front of and behind tank car		
Eyebath and safety shower flushed and ready		
Ground cable connected to car and checked for continuity		
Pressure dome inspected for leakage around valves and fittings		
Bill-of-lading and seal numbers checked		
Certificate of Analysis and placards checked		
Storage tank capacity and tank car liquid level determined before transfer		
Load and back-vent lines connected, purged and checked for leaks		
Proper piping alignment made and checked		
Open transfer lines and monitor liquid level		
Qualified operator in attendance during transfer		
Qualified operator wearing all required PPE		

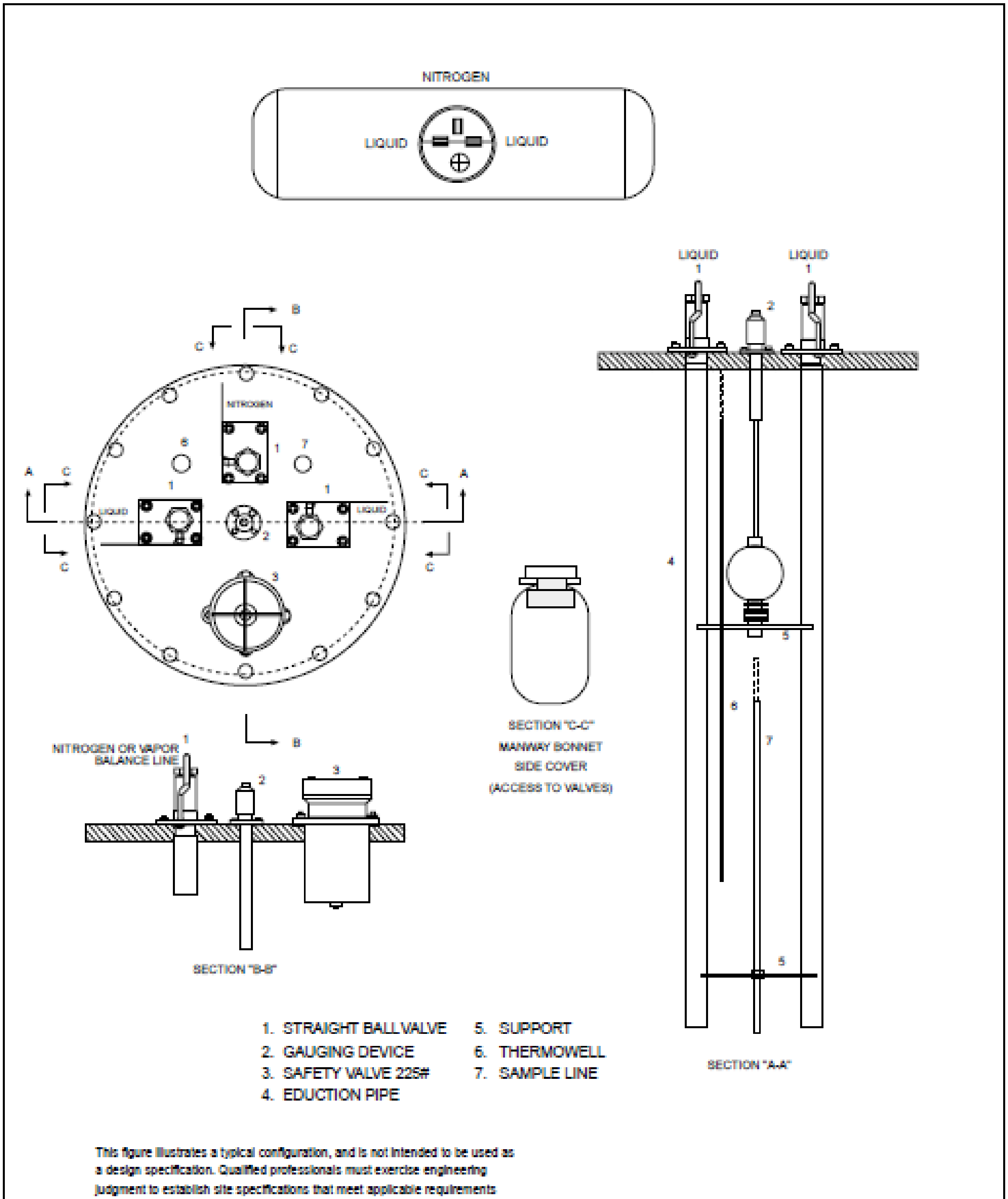
After Unloading Tank Car	YES	NO
When tank car is empty, shut down the pump		
Transfer line blown clear of propylene oxide		
Unloading line valve closed to the storage tank and the storage tank vent		
Tank car vapor valve and liquid unloading valve closed		
Transfer line vented of pressure		
Tank car pressured (slightly) with nitrogen for return trip		
Transfer, nitrogen and storage tank lines disconnected		
Inspected for leakage around valves and fittings and dome cover secured		
Ground cable disconnected		
Check tank car placards and reseal		
Blue flag and derailer device removed		
Wheel chocks removed		

In the event of an emergency – 1-800-245-4532

Advise Lyondell of any mechanical problems – 1-888-777-0232

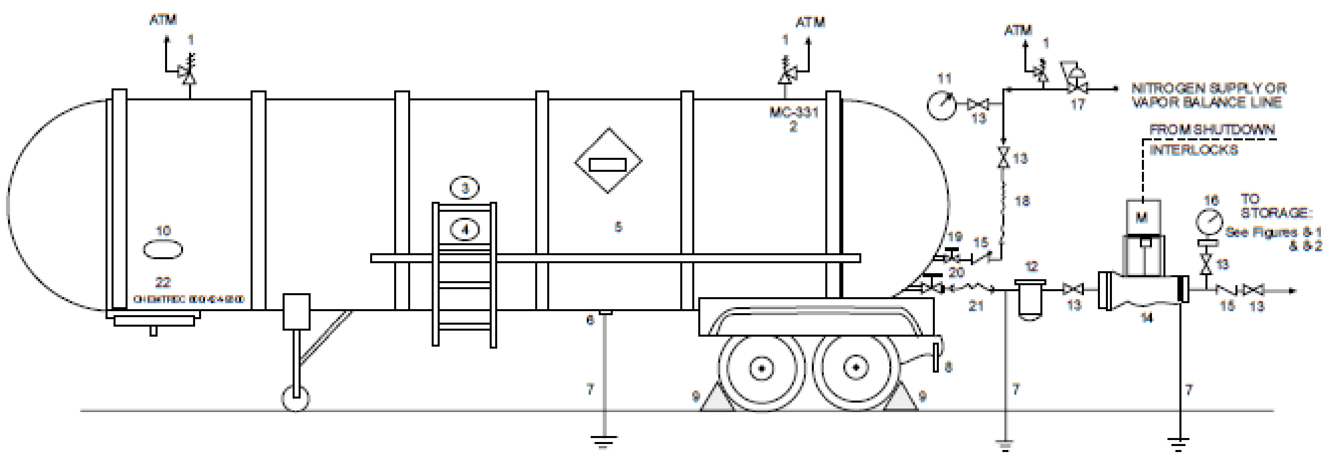
9. Transfer Operations

Figure 9-3 Typical Tank Car Dome Configuration



9. Transfer Operations

Figure 9-4 Typical Tank Truck Configuration



1. PRESSURE RELIEF VALVE
2. DOT CLASSIFICATION NO.
3. ROTARY GAUGE (LIQUID LEVEL)
4. THERMOMETER AND PRESSURE GAUGE
5. PLACARD (Figure 11-4, 11-5, 11-6) (ALL 4 SIDES)
6. APPROVED GROUND CLAMP
7. GROUND WIRE
8. REAR END PROTECTION
9. WHEEL CHOCKS
10. CERTIFICATION DATE
11. PRESSURE GAUGE
12. FILTER
13. BLOCK VALVE
14. PUMP
15. CHECK VALVE
16. PRESSURE GAUGE W/DIAPHRAGM SEAL
17. PRESSURE CONTROL VALVE
18. FLEX. HOSE ASSEMBLY
19. GLOBE VALVE
20. GLOBE VALVE
21. FLEX. HOSE ASSEMBLY
22. CHEMTREC EMERGENCY NUMBER 800/424-9300

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

9. Transfer Operations

Figure 9-5 Tank Truck Unloading Checklist

Propylene Oxide
Tank Truck Unloading Checklist

Tank Truck Number: ____________________ Date: ____________________

Operator: ____________________ Time: ____________________

Prior to Unloading Tank Truck	YES	NO
Wheels chocked and hand brakes engaged		
Ground cable connected to truck and checked for continuity		
Bill-of-lading and seal numbers checked		
Eyebath and safety shower flushed and ready		
Placard placed on windshield		
Inspected for leakage around valves and fittings		
Certificate of Analysis and placards checked		
Storage tank capacity and tank truck liquid level determined before transfer		
Load and back-vent lines connected, purged and checked for leaks		
Proper piping alignment made and checked		
Open transter lines and monitor liquid level		
Qualified operator in attendance during transfer		
Qualified operator wearing all required PPE		

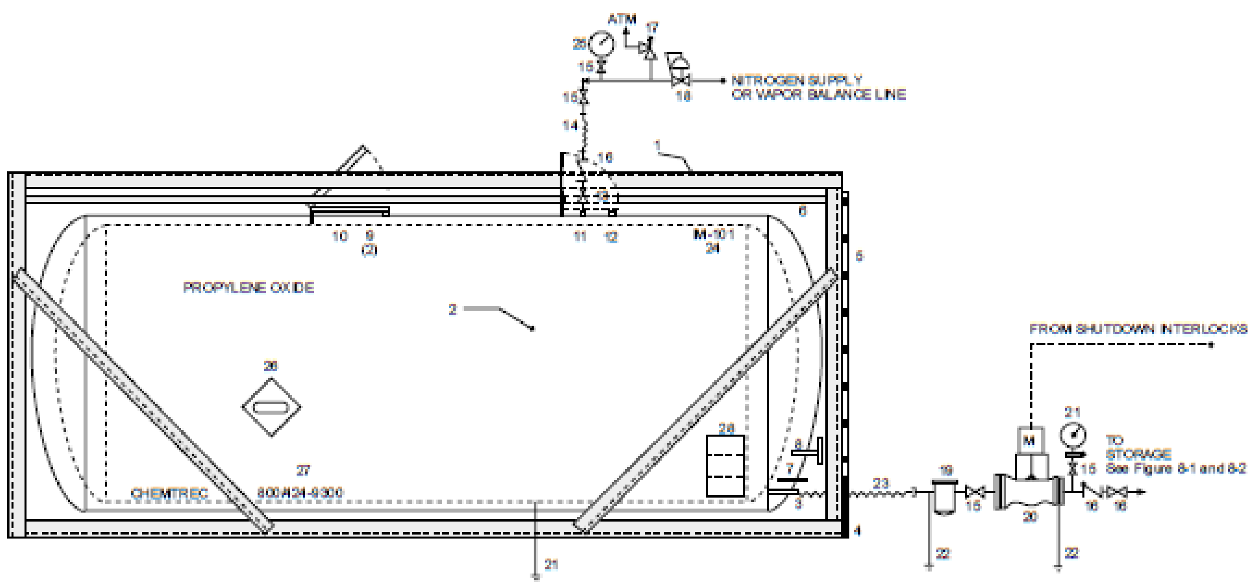
After Unloading Tank Truck	YES	NO
When tank truck is empty, shut down the pump		
Transfer line blown clear of propylene oxide		
Unloading line valve closed to the storage tank and the storage tank vent		
Tank truck vapor valve and liquid unloading valve closed		
Transfer line vented of pressure		
Tank truck pressured (slightly) with nitrogen for return trip		
Transfer, nitrogen and storage tank lines disconnected		
Inspected for leakage around valves and fittings		
Ground cable disconnected		
Check tank truck placards and reseal		
Placard removed from windshield		
Wheel chocks removed		

In the event of an emergency – 1-800-245-4532

Advise Lyondell of any mechanical problems – 1-888-777-0232

9. Transfer Operations

Figure 9-6 Typical IMO Tank Configuration



1. TANK FRAME
2. TANK SHELL IN STAINLESS STEEL WITH INSULATION AND ALUMINUM CLADDING PROTECTION
3. MALE BOTTOM DISCHARGE
4. DATA PLATE
5. LADDER
6. WALKWAY
7. STEAM HEATING (NOT USED FOR P.O. SERVICE)
8. THERMOMETER
9. SAFETY RELIEF VALVES (2) W/TANK
10. MANHOLE
11. NITROGEN INLET
12. PROVISION FOR FILLING/DRAIN SYSTEM
13. BALL VALVE
14. FLEX HOSE ASSEMBLY
15. BLOCK VALVE
16. CHECK VALVE
17. PRESSURE RELIEF VALVE
18. PRESSURE CONTROL VALVE
19. FILTER
20. PUMP
21. PRESSURE GAUGE W/DIAPHRAGM SEAL
22. GROUND WIRE
23. FLEXIBLE HOSE ASSEMBLY
24. DOT CLASSIFICATION NO.
25. PRESSURE GAUGE
26. DOT PLACARD (Figure 11-2) ALL 4 SIDES
27. CHEMTREC EMERGENCY NUMBER 800/424-9300
28. CARRIER'S NAME CONTAINER OWNER/LESSOR'S NAME CERTIFICATION DECALS

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

10. Tank Cleaning & Equipment Repair

10.1 Work Preparation

The proper preparation for tank cleaning and equipment repair is necessary to prevent exposure to hazardous chemicals. Preparation should include a clear definition of the tasks to be performed, an identification of hazardous materials and related hazardous conditions. A hazardous work permit system should be used to identify the job-related hazards and plan for the safe completion of this work. Worker protection should include the use of engineering controls and the selection of personal protective equipment (PPE) (see Section 3).

Tanks and equipment that contained propylene oxide vapor or liquid should be cleared of residual material before starting cleaning and/or repair. Liquids should be removed from a low point. Residual liquid and vapor should be either flushed with water or another suitable material, and vapor should be purged with nitrogen. The tank vapor space should be tested for propylene oxide prior to opening the tank to atmosphere.

Only workers properly trained should be involved in the cleaning and repair of tanks and equipment that have previously held propylene oxide.

Eyewash and safety showers should be located near the work operation. Appropriate fire extinguishing equipment should be present (see Section 5.3).

10.2 Control of Hazardous Energy

A facility must have procedures for the control of hazardous energy that comply with the requirements of OSHA 29 CFR1910.147. The procedures are to prevent accidental contact with hazardous chemicals and pressurized and energized equipment, and to prevent the accidental start-up of the equipment. After the system is purged, ensure that all potential sources of propylene oxide or hazardous energy are physically tagged and/or locked out, and affected persons notified.

10.3 Confined Space Entry

OSHA 29 CFR 1910.146 establishes requirements for entry into confined spaces. For confined spaces that typically contain propylene oxide, a lower flammability limit of 1.7 volume percent should be used to determine permit requirements. Appropriate respiratory protection for propylene oxide vapor exposures may also be required (see Section 3.3).

10.4 Equipment Cleanout

If a new tank is to be put into service, it is critical that it be clean of all rust, dirt, grease and water. Soap or detergents and water should be used to remove grease and oils. The cleaned surface should be rinsed with water until a neutral pH is obtained. All rinse water must be drained from low points in the tank and piping. Residual water in the equipment can react with propylene oxide to form propylene glycol and evolve heat.

Iron oxide is a catalyst for propylene oxide polymerization. To eliminate loose rust (iron oxide) and scale from inside a tank, a high pressure fresh water blast is effective. Acidic or basic cleaning or pickling systems should be avoided because their residues can cause vigorous reaction of propylene oxide. No solvents containing organic or inorganic chlorides should be used. After this step, the tank walls should be dried, and the bottom cleaned of all solids and water. The tank should then be purged with nitrogen gas down to 2% concentration of residual oxygen (see Figure 5-1). This concentration will provide a measure of protection in case any air pockets remain during purging. After out-of-service equipment has been padded with nitrogen gas, the manways should be marked as follows: "DANGER DO NOT ENTER — PADDED WITH N_2."

10.5 Maintenance and Inspection

Preventive maintenance and inspection of containers, hoses, pumps, fittings, fire protection equipment and refrigeration units used for propylene oxide should be conducted. An adequate supply of spare parts for refrigeration units should be maintained. Overpressure and overfill detectors and combustible gas detectors should be maintained and calibrated regularly.

Inspection programs should include daily inspection of equipment, storage areas, and monitoring of ventilation systems.

Preventive maintenance schedules should be developed for critical equipment such as fire-fighting equipment, combustible gas detectors, pumps, safety relief valves, gaskets and emission control equipment.

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(ii) film, overwrap and/or product packaging that is considered a part or component of one of the aforementioned medical devices;
(iii) packaging in direct contact with a pharmaceutical active ingredient and/or dosage form that is intended for inhalation, injection, intravenous, nasal, ophthalmic (eye), digestive, or topical (skin) administration;
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