lyondellbasell

T-Hydro Tert-Butyl Hydroperoxide (TBHP)

Product Safety Bulletin

Foreword

Lyondell Chemical Company ("Lyondell"), a LyondellBasell company, is 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 Environmental, Health and Safety Department with the help of experts from our manufacturing and research facilities. 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 to your specific requirements. Please make sure you review the government regulations, industry standards and guidelines cited in this bulletin that might have an impact on your operations.

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

LyondellBasell is a member of SPI's Organic Peroxide Producers Safety Division (OPPSD).

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Contents

1. General Information

1.1 Product Identification

This document refers to the product as *T-Hydro* or TBHP-70 and the pure compound as tertiary butyl hydroperoxide, t-butyl hydroperoxide or TBHP.

T-Hydro TBHP is a clear, colorless, stable and aqueous solution of approximately 70 wt% t-butyl hydroperoxide and 30 wt% water. The active oxygen content is about 12%. It has a characteristic odor.

Chemical Name:	1,1-Dimethyl ethyl hydroperoxide
Chemical Family:	Alkyl hydroperoxide
Common Names:	Tertiary butyl hydroperoxide t-Butyl hydroperoxide 2-Hydroperoxy-2-methylpropane TBHP
CAS Number:	75-91-2
Formula:	$C_4H_{10}O_2$, 70% in H_2O

Lyondell produces *T-Hydro* TBHP by autoxidation of isobutane at commercial plants in Texas and The Netherlands. Lyondell is the largest merchant producer of TBHP-70 worldwide.

T-butyl hydroperoxide's oxygen-oxygen (-O-O-) bond contributes to its unique commercial applications as well as potential hazards.

1.2 Applications

T-Hydro TBHP provides a readily available and convenient source of active oxygen suitable for diverse oxidation technologies. Lyondell's epoxidation of propylene to propylene oxide accounts for the largest commercial application for TBHP. Producers of initiators use *T-Hydro* solution to synthesize many perester, dialkyl peroxide and perketal derivatives. The product itself serves as a free radical initiator for polymerizations, copolymerizations, graft polymerizations and curing of polymers.

T-Hydro TBHP offers advantages of versatility, regioselectivity, stereoselectivity, chemoselectivity and reactivity control with catalyst choice, mild reaction conditions and bulk availability.

T-Hydro TBHP finds use in preparing specialty chemicals required by fine chemical and performance chemical industries such as pharmaceuticals and agrochemicals. TBHP can selectively oxidize hydrocarbons, olefins and alcohols. Asymmetric epoxidation and kinetic resolution with TBHP can provide access to complex chiral intermediates.

1.3 Physical Hazards

T-Hydro TBHP is a highly reactive product. The three types of significant physical hazards are flammability, thermal and decomposition due to contamination (see Section 2 for toxicity hazards). To minimize these hazards, avoid exposure to heat, fire or any condition that will concentrate the liquid material. Store away from heat, sparks, open flames, foreign contaminants, combustibles and reducing agents. Inspect containers frequently to identify bulges or leaks.

1.3.1 Flammability Hazards

T-Hydro TBHP is highly combustible with a flash point of 43°C (109°F). Once ignited, the material burns with a flare-burning effect. During combustion, thermal decomposition may occur as well. As a peroxide, *T-Hydro* TBHP vapors can burn in the absence of oxygen.

Determination of flammability limits are affected by temperature, pressure, the volume of sample tested and type of ignition source. The lower flammability limit of *T-Hydro* solution vapors in air is 5.75 vol% TBHP at 80°C (176°F). The upper flammability limit is 100 vol% TBHP.

Because TBHP is capable of decomposing at elevated temperatures with the generation of oxygen, the flammability limits in nitrogen were also measured under the above conditions. The lower flammability limit in pure nitrogen is 42.8 mol% and the upper limit is 100%. The lower flammability limit will decrease as decomposition occurs and oxygen is generated, depending on temperature and time. Similarly, the flash point of *T-Hydro* TBHP in pure nitrogen is 74°C (165°F) and will decrease as decomposition occurs.

1.3.2 Thermal Hazards

Compared with most other hydroperoxides, *T-Hydro* TBHP has high thermal stability. The material is stable at temperatures below approximately 38°C (100°F), and unadulterated material may keep for several months without a significant loss of activity. However, at increased temperatures *T-Hydro* solution will deflagrate[1] rather than detonate with a concurrent generation of oxygen, highly flammable isobutylene and incomplete combustion products such as carbon monoxide. The thermal decomposition rate and half-life of TBHP will change dramatically depending upon specific conditions. Surface-to-volume effects as well as container material and trace contamination may change rate and temperature relationships for decomposition.

Using an accelerating rate calorimeter in which the stainless steel bomb was first passivated, the 10-hour half-life of contaminate-free *T-Hydro* TBHP is approximately 118°C (244°F). Self-accelerating decomposition becomes significant (i.e., the self-heat rate greater than 0.02°C per minute) at a temperature of approximately 110°C (230°F). Decomposition proceeds at a faster rate in an untreated stainless steel bomb. The estimated SADT for a standard 55-gallon carbon steel, polyethylene-lined drum is 77°C (171°F). The SADT for a 5-gallon steel container is estimated at 88°C.

1.3.3 Hazards Due to Contamination

Contamination with acids, bases and especially polyvalent metal ions such as those from iron can accelerate the decomposition rate. For example, addition of caustic will lead to exothermic decomposition and the generation of oxygen. Spontaneous combustion may occur if mixed with readily oxidizable organic or flammable material. Other reactive organics such as ketones may result in the formation of less stable peroxides.

1.3.4 Hazard Rating

The Organic Peroxide Producers Safety Division (OPPSD) of the Society of the Plastics Industry has developed standardized tests to determine hazard ratings for organic peroxides. They can provide details of the apparatus and methods. They categorize the results according to three hazard ratings – 1 (low hazard), 2 (intermediate hazard) and 3 (maximum hazard). The following table shows the results for *T-Hydro* TBHP:

Hazard Test Rating

Test	Rating
Self-Accelerating Decomposition Temperature (SADT)	1
Pressure Vessel Test for Heat Sensitivity	1
Rapid Heat Test for Decomposition Type	1
Impact Sensitivity Test for Susceptibility to Decomposition upon Shock	1
Modified Trauzl Block Test for Energy Released by Explosion-Caused Decomposition	1
Burning Test for Ease of and Time to Ignition; Burn Time and Flame Height	1
Hazard Class	Low

The UN Committee of Experts on the Transport of Dangerous Goods and other regulatory codes, IMDG, ADR/RID, etc. (see Section 11) classify organic peroxides from A to G according to the degree of hazards presented.

It is forbidden to transport a peroxide of Type A, the most hazardous. An organic peroxide of Type G is exempt from the regulatory code requirements as it is thermally stable, shows no effect when heated nor any explosive power. TBHP-70 is classified as a Type F organic peroxide, which is the lowest hazard group of organic peroxide to which regulatory codes apply.

1 In a deflagration, the flame's propagation velocity is between a few decimeters and meters per second, and the pressure differences between different parts of the gas are small at any time. In contrast, a detonation experiences velocities at or near the speed of sound and the pressure differences are significant.

1. General Information ...

1.4 Physical Properties

Table 1-1 *T-Hydro* Solution Physical Properties

Property	Value
Physical State	Liquid
Color	Colorless
Boiling Point[3]	96°C (205°F)
Molecular Weight[1]	90.12
Freezing Point[3]	-2.8°C (27°F)
Density[3] @ 25°C (77°F)	0.933 g/cc 7.8 lbs/gal
Density of Saturated Liquid[2]	See Figure 1-1
Vapor Density[2]	See Figure 1-2
Vapor Pressure[3]	See Figure 1-3
Viscosity of Saturated Liquid[2]	See Figure 1-4
Critical Temperature[2]	351.4°C (664.6°F)
Critical Pressure[2]	16.4 MPa (2382 psia)
Critical Volume[2]	3.18 cc/g
Heat/Combustion	-654 Kcal/mol
Liquid[1] @ 25°C (77°F)	13,000 BTU/lb
Heat/Vaporization[2]	See Figure 1-5
Heat Capacity of Saturated Liquid[2]	See Figure 1-6
Enthalpy of Saturated Liquid[2]	See Figure 1-7
Heat Capacity of Vapor[2]	See Figure 1-8
Enthalpy of Saturated Vapor[2]	See Figure 1-9
Surface Tension[2]	See Figure 1-10
Thermal Conductivity of Saturated Liquid[2]	See Figure 1-11
Flash Point (TCC)	43°C (109°F)
Auto Ignition[3]	237.8°C (460°F) Decomposes
Upper Flammable Limit[3] @ 121°C (250°F)	100 vol%
Lower Flammable Limit[3] Vapor in Air @ 80°C (176°F)	5.75 vol%
SADT (55-gal. drum)[4]	77°C (171°F)
Phase Diagram	See Figure 1-12
Half Life[3]	See Figure 1-13

1 Refers to pure tertiary butyl hydroperoxide.
2 *ASPEN* estimate for *T-Hydro* Solution.
3 Measured for *T-Hydro* Solution.
4 Estimated from accelerating rate calorimeter data.

Figure 1-1 Density of Saturated Liquid as a Function of Temperature

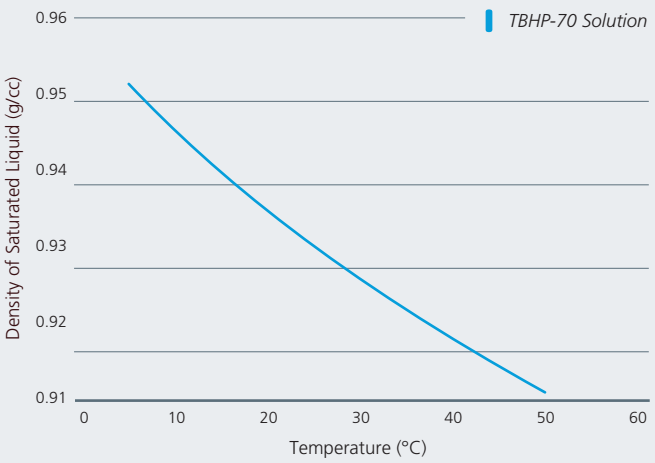


Figure 1-2 Density of Vapor @ 1 Atmosphere as a Function of Temperature

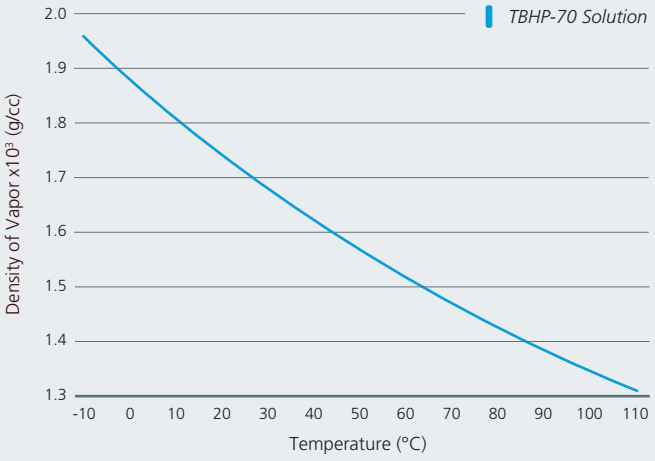


Figure 1-3 Vapor Pressure as a Function of Temperature

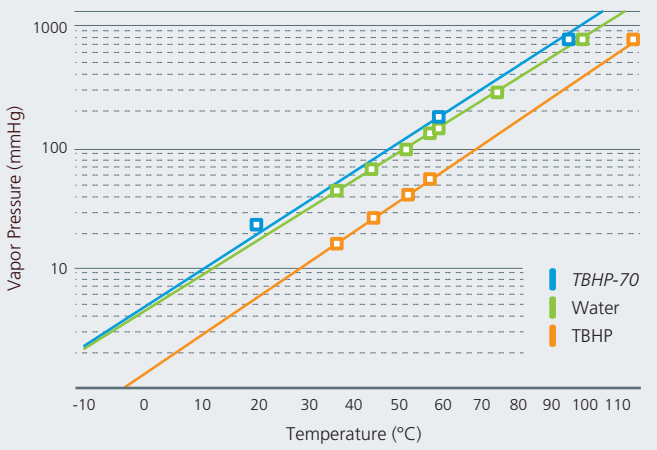


Figure 1-4 Viscosity of Saturated Liquid as a Function of Temperature

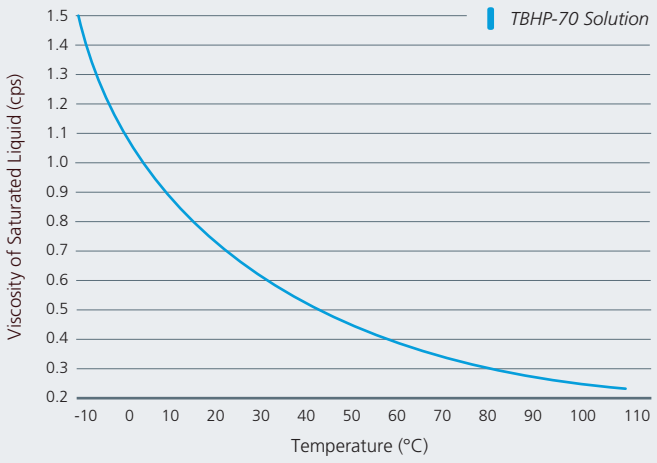


Figure 1-5 Heat of Vaporization as a Function of Temperature

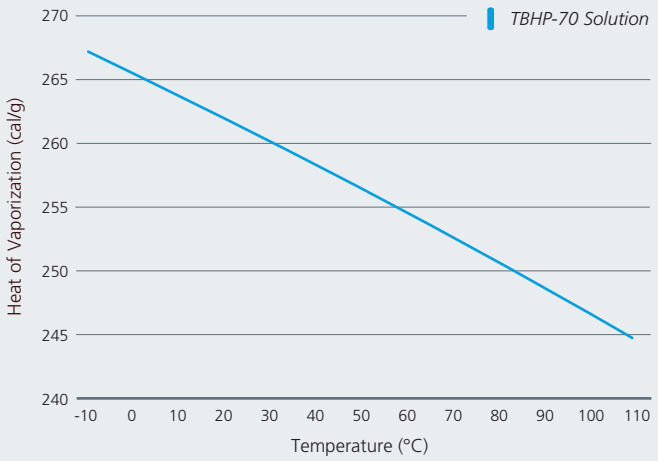
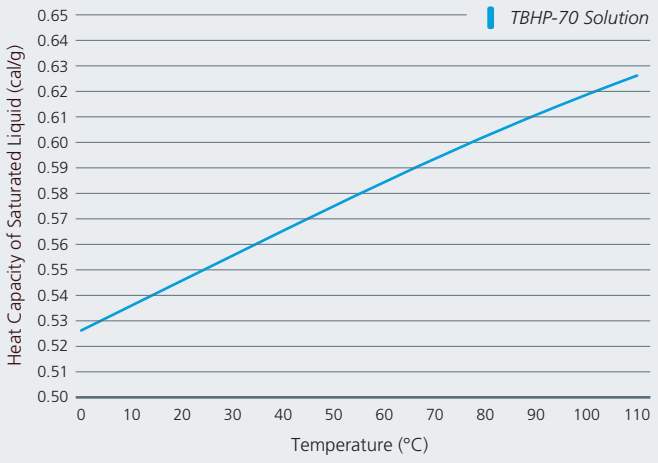


Figure 1-6 Heat Capacity of Saturated Liquid as a Function of Temperature



1. General Information ...

Figure 1-7 Enthalpy of Saturated Liquid as a Function of Temperature

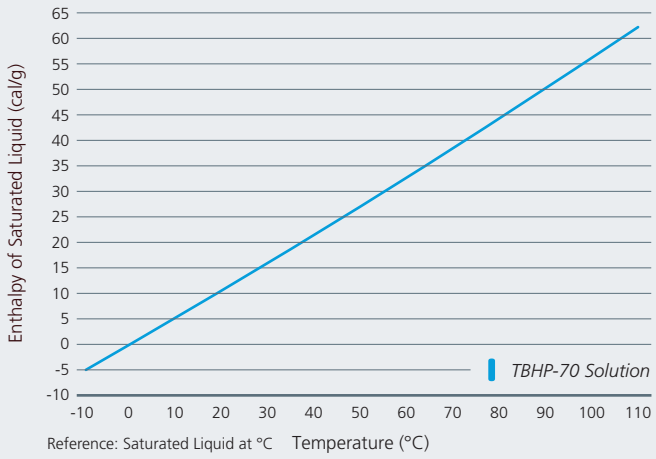


Figure 1-8 Heat Capacity of Vapor (Ideal Gas) as a Function of Temperature

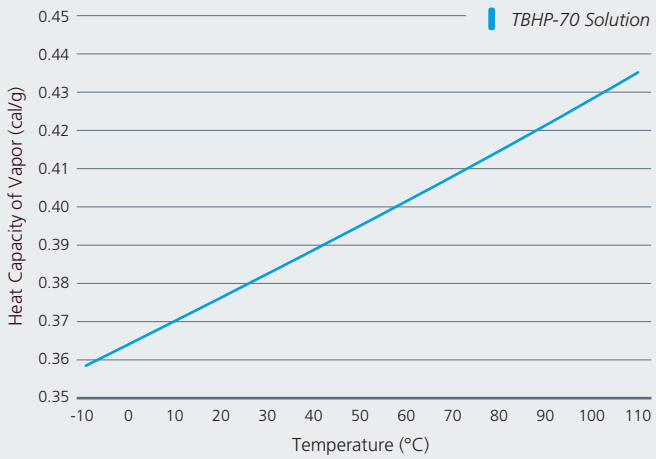


Figure 1-9 Enthalpy of Saturated Vapor as a Function of Temperature

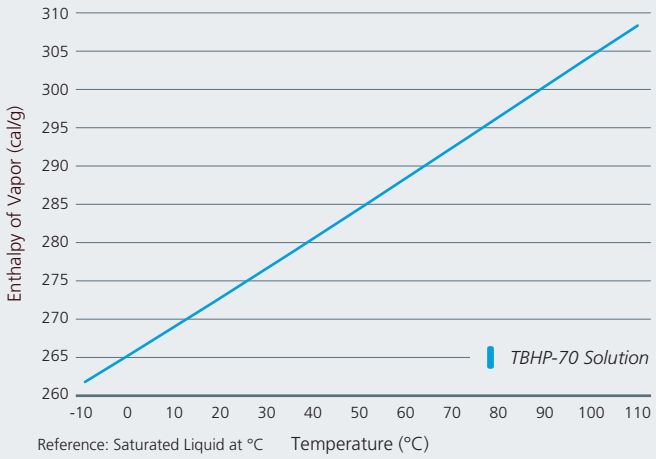


Figure 1-10 Surface Tension as a Function of Temperature

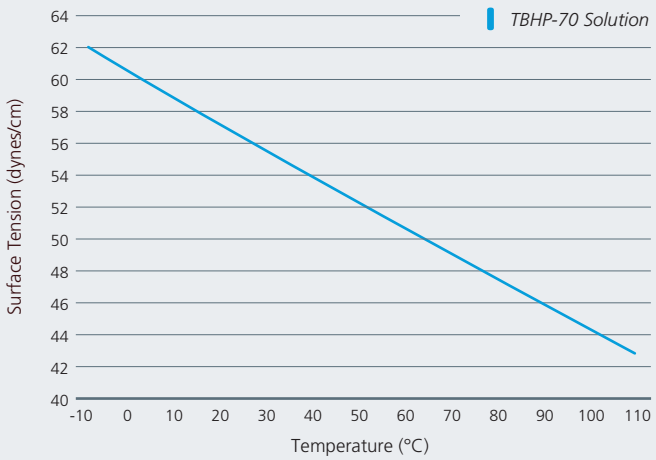


Figure 1-11 Thermal Conductivity of Saturated Liquid as a Function of Temperature

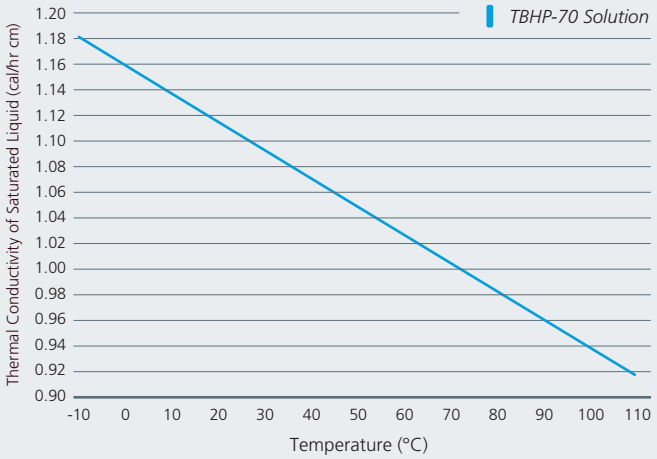


Figure 1-13 Half Life vs. Temperature TBHP-70 Decomposition in ARC™

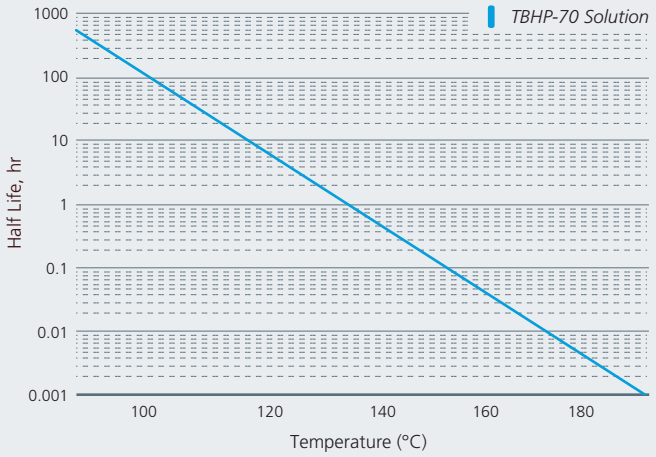
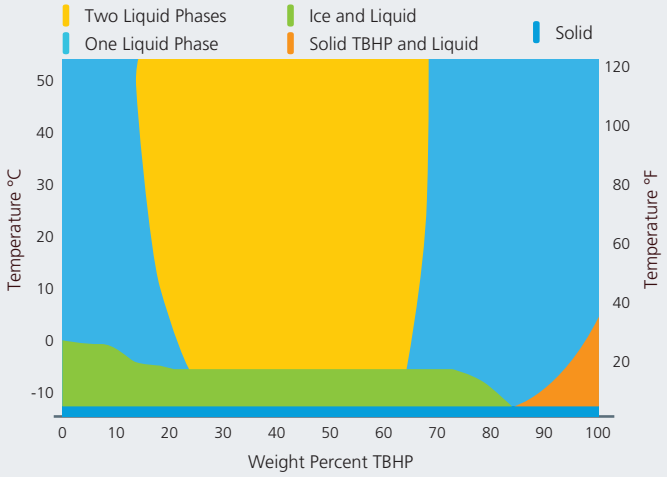


Figure 1-12 Phase Diagram for Aqueous Tertiary Butyl Hydroperoxide



2. Occupational Health

2.1 Hazard Assessment

The primary routes of exposure to TBHP-70 solution are by inhalation and dermal contact. It is considered moderately toxic acutely, is corrosive to skin and eyes, may cause respiratory irritation and is a skin absorption hazard. It is a skin sensitizer. It is mutagenic *in vitro*, but is rapidly broken down in the body and mutagenicity studies in animals are negative. Reproduction and developmental toxicity studies are also negative. Based on the limited information available, TBHP-70 is not expected to be carcinogenic.

2.1.1 Acute Effects of Overexposure

Single exposures to *T-Hydro* TBHP, even with minor contact, can cause severe skin and eye irritation that may lead to cell death if not treated promptly. Overexposure to vapor concentrations can cause irritation to the eyes and respiratory tract. It was positive in a guinea pig skin sensitization test. It is therefore expected to be a skin sensitizing agent.

T-Hydro TBHP is suspected to be readily absorbed through the skin and is acutely toxic by inhalation and with occluded dermal exposure. The dermal LD_{50} of 440 mg TBHP/kg (95% confidence limits of 391-494 mg TBHP/kg) was reported for rabbits following a 24-hour exposure. Exposure of rats to TBHP-70 aerosols for four hours produced an inhalation LC_{50} of 1.85 mg TBHP/1 (1.58-2.16 mg TBHP/1) with signs of respiratory and ocular irritation. Based on an oral LD_{50} of 560 mg TBHP/kg (476-658 mg TBHP/kg) reported for rats, TBHP-70 is considered moderately toxic by ingestion.

2.1.2 Repeated Exposures

Repeated dose studies in animals have not shown any dose-related adverse effects that can be expected in humans with controlled exposures. TBHP-70 causes local irritation-related effects following oral or inhalation exposures. In addition, specific kidney effects found in male rats occurred with repeated exposures.

In a five-day repeated oral dose screen in rats receiving 12.5 to 357 mg/kg/day TBHP-70, severe irritation and submucosal edema of the stomach were reported at and above 107 mg/kg TBHP-70. Subsequently, when 3, 10 or 30 mg/kg/day TBHP-70 was administered orally for up to 45 days, microscopic renal lesions resembling those seen in alpha-2-microglobulin nephropathy, an effect commonly reported for male rats, were seen in male rats at 10 and 30 mg/kg TBHP-70. The no observable adverse effect level (NOAEL) for female rats in this study was at least 30 mg/kg TBHP-70, but less than 107 mg/kg TBHP-70, based on the effects seen in the screen.

Rats exposed to aerosol concentrations of 10 to 100 ppm TBHP six hours per day for five days showed increased ocular and nasal secretions indicating slight irritation of mucous membranes, and decreased body weights at 75 and 100 ppm TBHP in males and at 100 ppm TBHP in females. No treatment-related effects were seen at gross necropsy, and bone marrow samples showed no evidence of chromosomal damage.

2.1.3 Reproductive and Developmental Toxicity

Tests with *T-Hydro* TBHP have not shown any harmful reproductive or developmental effects. Rats receiving up to 30 mg/kg/day TBHP-70 orally did not exhibit signs of reproductive or developmental toxicity in parental animals or their offspring. However, at 10 and 30 mg/kg/day, TBHP-70 parental males again showed microscopic renal lesions resembling those seen in alpha2-microglobulin nephropathy. Another study demonstrated no signs of embryo/fetotoxicity or developmental effects in rats receiving up to 50 mg/kg/day TBHP-70 orally, although slight maternal effects were seen at 15 mg/kg/day TBHP-70.

2.1.4 Genetic Toxicology

TBHP-70, like other reactive peroxides, is active in *in vitro* mutation assays. However, in whole animal studies, TBHP-70 was not mutagenic.

Positive responses were seen in the Ames test with tester strains TA1535, TA98 and TA100, the mouse lymphoma assay and Chinese hamster ovary test systems. Significantly, TBHP-70 did not display mutagenic potential in a whole animal system, as evaluated in the mouse dominant lethal assay and the rat bone-marrow cytogenetics assay, even after repeated exposure to toxic levels. *T-Hydro* TBHP was not positive in the C3H/10T 1/2 cell transformation assay, a test that has been interpreted as an *in vitro* estimation of carcinogenic potential.

2.1.5 Carcinogenicity

Some studies designed to evaluate specific mechanisms of cancer development have shown TBHP-70 to have indirect capabilities for tumor formation. However, other reports have indicated no clear evidence that it can cause cancer. In addition, while it is mutagenic *in vitro*, mutagenicity tests in animals are negative. Based on the available information, *T-Hydro* TBHP is not expected to be carcinogenic.

2.2 Occupational Exposure Limits

TBHP has no regulated occupational exposure limits in the United States. Lyondell has employed a provisional occupational exposure limit of 1 ppm expressed as an eight-hour time-weighted average based on available toxicologic data. European occupational exposure limits are as follows:

OEL (LT) IPRV	5 mg/m^3
OEL (LV) TWA	5 mg/m^3
OEL (RU) MAC	5 mg/m^3 Vapor

A TBHP exposure monitoring method validated by Lyondell is given in Appendix II.

2.2.1 Warning Properties

T-Hydro TBHP is a clear, colorless liquid with a pungent odor. Its odor threshold is 0.06 ppm, with a 1 ppm threshold warning concentration.

2.3 First Aid

TBHP-70 is a respiratory, mucous membrane, skin and eye irritant. When an emergency arises, approach the incident with caution. Know emergency procedures, the location of rescue equipment and emergency contact numbers before the need arises. Persons who have been acutely exposed to TBHP and have received initial first aid procedures may require additional emergency medical treatment.

Employers are required by OSHA's Medical Services and First Aid Standard, 29 CFR 1910.151 to provide for medical personnel in cases of medical emergency and/or employee illness. In the absence of a clinic or local hospital, the employer may have first aid trained staff on site. If no medical personnel are located at the facility, prior medical emergency arrangements should be made with area hospitals or similar services.

Employers should also provide copies of the MSDS and this Product Safety Bulletin and review these documents with appropriate medical personnel.

2.3.1 First Aid for Inhalation

If someone is overcome by exposure, assisting personnel should remove him or her to fresh air immediately. As needed, personnel trained in cardiopulmonary resuscitation (CPR) should give oxygen or artificial respiration. Once the person revives, assisting personnel should keep him or her warm and calm.

Medical personnel should monitor the patient for respiratory distress. If the person develops a cough or has difficulty breathing, medical personnel should evaluate him or her for respiratory tract irritation. If required, they may want to consider administering 100% humidified, supplementary oxygen.

2.3.2 First Aid for Eye Contact

Upon even minor eye contact, immediately flush eyes with clean lukewarm water for 20-30 minutes periodically holding eyelids open. Seek prompt medical attention.

2.3.3 First Aid for Skin

Upon skin contact of TBHP-70, flush skin with copious amounts of lukewarm water for at least 15 minutes preferably in a deluge shower. Remove clothing to minimize continued skin contact. Personnel providing assistance should remove the victim's clothing if he or she cannot. Finally, wash skin thoroughly with mild soap and water. Seek medical attention in the event of pain, reddening or irritation.

2.3.4 First Aid for Ingestion

If someone swallows even a minor quantity of TBHP-70, do not induce vomiting. Seek prompt medical attention or contact Poison Control Center.

2.4 Medical Management

2.4.1 Pre-Placement Medical Screen

Wearing personal protective equipment, such as respiratory protection and chemical protective clothing (see Sections 3.3 and 3.4), can potentially cause a significant increase in the work of the cardiorespiratory systems. Employees required to wear respiratory protection should be evaluated and approved for work by a medical professional as stated in 29 CFR 1910.134. 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; pulmonary function studies and an assessment of cardiorespiratory fitness.

A new employee or one transferred to TBHP-70 service should be screened for any prior history of medical conditions that could place him or her at increased risk because of potential exposures to TBHP-70. In persons with impaired pulmonary function, particularly obstructive airway disease, the irritant properties of TBHP-70 can potentially exacerbate symptoms. Also, persons with existing eye diseases may be at increased risk of harm from exposure. Persons with existing skin disorders may be more susceptible to dermal irritant effects of TBHP-70.

2.4.2 Periodic Screening

For comparative purposes, provide periodic medical evaluations that essentially duplicate the pre-placement evaluation.

3. Personal Safety and Health

3.1 Site Facilities

If workers may potentially contact *T-Hydro* TBHP in storage and handling areas, work locations should contain:

- quick-drenching equipment such as deluge showers and eyewash stations
- washing facilities for cleaning before consuming food or beverages and before using tobacco or cosmetics
- properly ventilated areas for breaks or meals

Install, test and maintain the quick-drenching equipment according to the American National Standards Institute, Inc. (ANSI) Z358.1 (see Appendix III). Workers should know the location and operation of this safety equipment. Keep washing facilities and break or lunch rooms separate from those places in which workers handle chemicals.

3.2 Hygiene Practices

Workers should use proper personal hygiene and good work practices while working with and around *T-Hydro* TBHP. After working with or around the product, they should wash their hands with lukewarm water and mild soap or detergent. Wash used protective clothing and equipment (such as gloves, aprons, protective suits and respirators) with lukewarm water and mild soap or detergent to decontaminate. Until washing, seal contaminated clothing in containers to prevent exposure of other workers.

3.3 Respiratory Protection

Good industrial hygiene practices require that engineering and work practice controls be considered before implementing a respiratory program. Table 3-1 provides guidance for respirator selection.

Besides proper respirator selection, facilities should have complete respiratory protection programs that meet the requirements of 29 CFR 1910.134 and ANSI Z88.2.

The use of contact lenses should not be permitted during respirator use in an atmosphere immediately dangerous to life and health, confined space entry, emergency operations or similar activities. Eyeglass inserts (spectacle attachments) designed for the specific respirator should be used.

3.4 Chemical Protective Clothing

Provide chemical protective clothing (CPC) to workers when there is potential for contact with *T-Hydro* TBHP during routine and non-routine operations. Select CPC according to the working conditions and the potential for contact with liquid or vapor. Choose CPC materials based on TBHP-70 chemical properties and the material's chemical resistance, durability, flexibility, thermal limits and cleanability.

3.4.1 Eye Protection

Because of *T-Hydro* TBHP corrosive properties, whenever a worker can have potential exposure to vapor or liquid, he or she should wear chemical safety goggles, cup-type plastic of gas-tight design, equipped with impact-resistant lenses. A face shield (8-inch minimum) may provide added splash protection. These eye-protective measures should meet ANSI Z87.1 specifications.

3.4.2 Head Protection

When there is danger from overhead leaks or spills, wear a hard hat that meets ANSI Z89.1 specifications.

3.4.3 Foot Protection

Wear rubber over-boots on top of leather shoes or boots to protect the leather from contamination and under pant legs to prevent the product from entering the boot.

3.4.4 Skin Protection

Options for protecting skin range from gloves and an apron to a full-containment suit and selection depends on the particular work activity.

T-Hydro TBHP has not been tested against most CPC materials. Protective clothing made of nitrile rubber does not degrade upon contact with the product and, therefore, may be adequate. However, since the quality and thickness of the CPC may vary according to the manufacturer, evaluate product-specific permeation data before selection.

Where the potential for exposure to *T-Hydro* liquid exists, as in a spill cleanup or containment, workers should wear chemical resistant suits with non-wicking seams. Routinely inspect all suits to identify any damage that may compromise worker safety.

3.5 Direct Reading Instruments

Many direct reading instruments can readily analyze TBHP. The advantage of using direct reading instruments is providing real-time analysis and instantaneous air concentrations. Combustible gas indicators, infrared spectrophotometers, flame ionization detectors, photoionization detectors and portable gas chromatographs have successfully measured TBHP. The detection capabilities and calibration requirements vary between these instruments. Appendix I contains a partial list of product vendors. The proper selection, calibration, use and interpretation of the instruments require a trained professional.

3.6 Air Sampling and Analysis

Assessing worker exposure to *T-Hydro* TBHP requires an extended sampling period. An accepted method of air sampling is collection of the material on a silica gel tube. Appendix II documents the Lyondell method. A qualified professional should develop a monitoring program to include sampling strategy, quality assurance and statistical analysis of results.

Table 3-1 *T-Hydro* TBHP Respiratory Protection Selection Guide

Condition (Vapor Concentration)	Respiratory Protection* (see Section 3.3) Recommended Above 1 ppm
1-10 ppm	A chemical-cartridge respirator with a half facepiece and organic/vapor cartridge
11-50 ppm	A chemical cartridge respirator with a full facepiece and an organic/vapor cartridge
51-1,000 ppm	Any supplied-air respirator with a full facepiece, helmet or hood operated in a pressure-demand mode Any SCBA with a full facepiece
Greater than 1,000 ppm or entry into unknown concentrations	SCBA with a full facepiece operated in pressure-demand mode A combination respirator that includes a Type C supplied-air respirator with a full facepiece operated in pressure demand or other positive pressure or continuous flow mode and an auxiliary (5-minute) SCBA operated in pressure demand or other positive pressure mode
Fire Fighting	Any SCBA with a full facepiece operated in pressure-demand mode
Escape	Any escape SCBA A chemical cartridge respirator with full face and an organic-vapor cartridge

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

4. Engineering

This section provides guidelines for *T-Hydro* TBHP and is not a design handbook. Additional requirements are imposed by the Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119). Facilities should review this standard. Mixtures of TBHP with other materials or compounds may significantly affect engineering practices, and require further studies to determine applicability of the following guidelines. Exercise competent chemical and engineering judgment and use qualified professionals to ensure specific requirements are met.

4.1 Bulk Storage

Lyondell storage tanks are constructed of 304 stainless steel (SS). Refer to Section 8.2 for information on diluent systems, nitrogen padding and relevant safety guidelines and standards. Design and construct tanks as atmospheric or low pressure vessels according to API 620 and 650 or a pressurized storage per ASME Code, Section VIII, Division I.

4.2 Piping

Piping and piping components should comply with the latest edition of ASME/ANSI B31.3 and NFPA 30. Lyondell has successfully used 304 SS. Avoid using threaded connections.

4.3 Electrical Area Classification

All electrical equipment and wiring installations used where *T-Hydro* TBHP is stored or handled must conform to Class I, Group C.

4.4 Pump Specifications

Lyondell has successfully used single mechanical seal, centrifugal pumps. If additional safety, performance or environmental considerations require reduced fugitive emissions, multiple mechanical seals with a flush fluid compatible with *T-Hydro* TBHP (such as demineralized water) may be preferable. The preferred casing and impeller materials are austenitic SS or their cast equivalents.

4.5 Instrumentation

As a minimum, instrumentation generally includes pressure, liquid temperature and level indicator devices on vessels. Instruments can be pneumatic or electronic, using nitrogen or air. Instrument fluids should be compatible with *T-Hydro* TBHP; leaks may result in a reaction and rapid pressure build up. Oxygen service instruments are generally acceptable and should have minimum hold up and safety venting/blow out provisions.

4.6 Relief Requirements

Emergency venting should conform to the requirements in API RP-2000. Flame arresters, when required, should meet the requirements of API RP-2028 and 2210 and UL 525. Pressure relieving systems for pressure vessels should follow API RP-520 parts 1 and 2. Design an overpressure relief system adequate for a possible cool flame combustion (see Section 8.2.1).

4.7 Leak Detection Devices

In areas where potential leaks are not immediately obvious, instrumentation able to detect TBHP vapors in air (see Section 3.5) can be used.

4.8 Material Guidelines

Use only dry, moisture free nitrogen for *T-Hydro* TBHP service.

Material Guide

Part	Material
Gaskets	Spiral wound: *Teflon* filled, type 316 SS windings and inner ring, carbon steel outer ring per API 601
O-rings	*Teflon*, *Kalrez* or *Chemraz* 505 subject to process temperature limitations
Pipe Thread	*Teflon* tape when threaded connections are unavoidable
Pump Seals	For mechanical seals stationary faces: tungsten carbide, silicon carbide
Valve Packing	Die-formed rings: *Teflon*
Hoses	316 SS double braided, bellows type with 316 SS two-way automatic shut off, quick disconnects. All hoses must have suitable pressure and temperature ratings.

4.9 Chemical Compatibility

T-Hydro TBHP is compatible with glass, austenitic SS and their cast equivalents, polyethylene and *Teflon* material. *T-Hydro* TBHP should not contact mild steel, copper and its alloys (e.g., brass or bronze), zinc and galvanized steel or other zinc plated metals, aluminum, cast iron, wood or other carbonaceous materials such as composition gaskets due to contamination hazards (see Section 1.3.3).

5. Fire Safety

5.1 Fire and Explosion Properties

The flash point for *T-Hydro* TBHP is 43°C (109°F) and the boiling point is 96°C (205°F). Based on these properties along with many others shown in Section I, various U.S. organizations have classified *T-Hydro* TBHP fire and explosive properties. The following table provides the hazard classifications:

Hazard Classifications

Organization	Hazard	Classification
NFPA Code 30	flammability	Class II, combustible liquid
NFPA Code 43B	reactivity	Class IV, organic peroxide*
NFPA Code 70	flammability	Class I, Group C
NFPA 704 Hazard Ratings (given in NFPA 43B)	Health Flre Reactivity	3 2 2
OPPSD overall (see Section 1)		Class 1, Low

* Class IV peroxides burn in the same manner as ordinary combustibles and present minimal reactivity hazard.

If *T-Hydro* TBHP is concentrated, explosions are possible. Dilution with water to a 65% solution (maximum) may be used to prevent potentially hazardous concentrations during a fire.

5.2 Fire Fighting Measures

Fire fighters must protect themselves against TBHP vapor or liquid as well as carbon monoxide and isobutylene released from incomplete combustion. Fire fighters should use full protective clothing and equipment, including self-contained breathing apparatus (see Section 3).

If a leak or spill has not ignited, blanket with fire fighting foam. Prevent flow to sewers and public waters. Cool with water fog or spray any stored flammables that are exposed to an external fire so the containers do not explode and add to the fire hazard.

A qualified fire safety professional should decide whether a fire should be extinguished or allowed to burn. The basis for this decision should be:

- the fire's proximity to *T-Hydro* TBHP storage vessels
- the degree to which the product container is protected from the heat of the fire
- the potential for explosion
- the degree of containment of the burning material

In addition, weigh the hazards from exposure to combustion products against those from exposure to unburned vapor.

Apply water from a safe distance upwind of the fire. Evacuate all personnel not directly involved with controlling the fire to a safe location. If *T-Hydro* solution spills on the ground, contain it as quickly as possible, as TBHP runoff may be an environmental hazard (see Section 7).

If a vapor cloud of TBHP is generated or a TBHP fire becomes uncontrollable and threatens the community, consider evacuating downwind residences. The extent of evacuation depends on numerous factors, including:

- wind direction and speed
- air stability
- proximity of the community and other facilities
- the expected timing of effective response

One method to determine the extent of evacuation necessary is monitoring the vapor cloud with a direct-reading instrument as described in Section 3. Lyondell has established a short-term exposure limit called the Vulnerable Zone Short-Term (a 1-hour and a 15-minute) Exposure Limit (VZ-STEL). The one hour VZ-STEL for *T-Hydro* TBHP is 5 ppm and the 15 minute VZ-STEL is 20 ppm. These values represent our best estimate of airborne concentrations of *T-Hydro* TBHP to which members of the community can be exposed for short periods of time with no adverse health effects. The VZ-STEL is merely a guide to be used in developing strategies for handling episodic releases.

5.3 Fire Prevention

Follow design criteria, handling procedures and training to prevent the concentration of *T-Hydro* TBHP. Prohibit steam purging of systems until they are properly flushed with a suitable solvent such as mineral oil, kerosene, tertiary butyl alcohol or water, as steam may concentrate residual TBHP to unstable levels. In the selection of solvents, consider the contamination hazards in Section 1.3.3. Keep storage and handling areas free of ignition sources including heat, sparks, flames and static electricity. Design such areas to prevent ignition or exposure to fire (see Section 8).

Adopt a comprehensive program for fire prevention. The following management systems contribute to such a program:

- electrical equipment and wiring installations used where *T-Hydro* TBHP is stored or handled should conform to Class I, Group C as specified in NFPA 70
- maintenance of effective bonding and grounding of metallic storage or receiving containers
- design of vessels, transfer and process systems to prevent spills, leaks or vapor releases
- periodic inspection, testing and maintenance of all safety-critical items; e.g., sensors, alarms, controls and flame arresters
- inspection and maintenance of elastomeric parts
- use of trained, qualified operating and mechanical personnel
- enforcement of a "No Smoking" policy in TBHP storage or handling areas
- stringent use of welding, cutting and burning (hot work) permit systems

5.4 Fire Fighting Planning

Facilities using internal fire brigades should follow the OSHA Fire Brigade Standard (29 CFR 1910.156). This standard includes information on organization, personnel qualifications, fire-fighting equipment and training requirements.

Facilities using community fire companies should provide them with information on *T-Hydro* TBHP operations and storage, including an illustration of storage locations and quantities of TBHP present. Periodically, conduct drills with the fire company and regularly update facility information.

Any facility using *T-Hydro* TBHP should plan to deal with emergencies, including the potential for serious fires and community evacuation. Preplanning, drills and effective communication with local fire and police departments contribute to effective emergency responses.

After fire has been extinguished, any residual TBHP should be cleaned up to prevent another fire or environmental contamination. Individuals involved in this work should be thoroughly trained in proper techniques, be correctly protected and use appropriate equipment (see Section 3). Water runoff from TBHP fires may be subject to operating permit and local/national regulations covering environmental releases and ignitable hazardous waste (see Section 7).

6. Hazard Communication

6.1 OSHA Hazard Communication

Under Hazard Communication and Right-to-Know Laws, workers and communities should be informed of the potential hazards of *T-Hydro* TBHP. At the federal level, the OSHA Hazard Communication Standard 29 CFR 1910.1200 requires that employers using hazardous chemicals in their workplace develop written programs and train workers on potential hazards.

6.2 Worker Training

The OSHA Standard 29 CFR 1910.1200 requires employers to provide information and train employees on its hazards, methods for detecting releases and methods of protection from exposure. This bulletin, and in particular, Sections 1, 2, 3 and 5 provide much of the primary information which should be used to develop your compliance program. The Lyondell MSDS is another important primary and concise source of information and contains a label information page. You must supplement this bulletin and the MSDS with information on other potential hazards arising from specific circumstances related to your facility and intended use of the product.

6.3 Labeling

Labeling is an important communication tool. Containers of *T-Hydro* TBHP or mixtures containing greater than or equal to one percent *T-Hydro* TBHP must be labeled according to the OSHA Hazards Communication Standard. Section 11.2 presents the DOT (Department of Transportation) labeling requirements.

6.4 Emergency Planning

The Emergency Planning and Community Right-To- Know Act of 1986 (also referred to as the Superfund Amendments and Reauthorization Act or SARA Title III) does not list TBHP as a hazardous substance and therefore does not have a reportable quantity (RQ) under this law.

Facilities which use or store TBHP should notify their local emergency response authorities and work with them to develop emergency response plans. Companies within the EU should comply with the requirements of Directives 82/501/EEC and 88/610/EEC relating to major accident hazards of certain industrial activities including production and storage sites, covering emergency planning and information communication to the public. Companies outside the EU may have equivalent regulations. Companies should check their local and national regulations and ensure they comply with the requirements.

6.5 National and State Regulations

National regulations may have different or more stringent requirements regarding hazard communication. Countries within the EU will have legislation complying with the requirements of Directive 89/391/EEC, while others will have equivalent legislation, protecting workers from the hazards of exposure to chemicals. National regulations should be reviewed in order to assess the applicability of these regulations to the use of TBHP. States also have adopted Right-to-Know Laws. To assist your compliance with these and other laws, Appendix IV contains a partial listing of the relevant regulations.

T-Hydro Solution Label Information

Manufacturer:	Lyondell Chemical Company One Houston Center, Suite 700 1221 McKinney Street Houston, Texas 77010	
Telephone Numbers		
Emergency:	+1-800-424-9300 Chemtrec +1-800-245-4532 North America +31-0-10-275-57-77 Europe	
Customer Service:	+1-888-777-0232 for information in U.S. only	
User Statement:	For industrial use only Keep out of the reach of children	
Signal Word:	Danger	
Physical Hazards:	Combustible, reactive	
Health Hazards:	Inhalation hazard Corrosive to skin Corrosive to eyes Ingestion hazard Mucous membrane irritant Skin contact hazard	
Precautionary Measures:	Do not handle near heat, sparks or open flame Do not get in eyes Avoid prolonged or repeated breathing of vapor Avoid contact with skin Use only with adequate ventilation/personal protection No contact with oxidizable materials Prevent contact with food, chewing or smoking materials	
DOT Information		
ID Number:	UN 3109 Packing Group-II	
Hazard Class:	5.2 (8) (3)	
Proper Shipping:	Organic Peroxide type F, Liquid. Contains 70% tert-butyl hydroperoxide in water	
Component Name:	Tert-Butyl hydroperoxide Water	CAS Number: 75-91-2 CAS Number: 7732-18-5
In case of fire:	Water spray, water fog, alcohol type foam or dry chemical.	
In case of spill:	Reactive material. Release can cause fire, explosion, health and/or environmental hazards. Extinguish all ignition sources. Use foam or water spray. Impound/recover large land spill. Soak up small spill. Report per regulatory requirements.	
First Aid		
Inhalation:	If overcome by exposure, remove victim to fresh air immediately. Give oxygen or artificial respiration as needed. Obtain emergency medical attention. Prompt action is essential.	
Eye Contact:	For even minor eye contact, immediately rinse with clean water for 20-30 minutes. Retract eyelids often. Obtain emergency medical attention. Prompt action is essential.	
Skin Contact:	For even minor contact, immediately remove contaminated clothing and flush with lukewarm water for 15 minutes. Wash skin thoroughly with mild soap/water. Seek medical attention in the event of pain, reddening or irritation.	
Ingestion:	If swallowed, do not induce vomiting. Seek prompt medical attention.	
Protective Equipment		
Respiratory:	Use NIOSH/MSHA approved full face air-purifying or supplied air respirator as appropriate.	
Eye:	Both chemical splash goggles and face shield.	
Skin:	Impervious protective suit plus impervious gloves, boots and full head/face protection.	

7. Environmental

Analyze any TBHP-containing waste. The physical appearance of a TBHP/water mixture is not a good indicator of TBHP concentration in water. TBHP/water mixtures are single phase for TBHP concentrations less than about 15% and greater than about 65% depending on temperature (see Figure 1-12). TBHP is soluble in most organic solvents.

The biotreatability of aqueous TBHP streams has not been defined. TBHP can be converted to tertiary butyl alcohol (TBA) by coming into contact with reducing agents which may be available in waste water streams. Acids and transition metal ions can also convert TBHP to TBA as well as other by-products. No data exists at this time estimating the percent TBHP that converts to TBA in a typical waste water stream. Studies indicate TBA is treatable in acclimated and well operated biological treatment systems, but the conditions and/or retention time required may exceed typical conditions of domestic systems.

The primary pathways for TBHP removal from soils probably are biodegradation and transport to groundwater. TBHP has a calculated log K_{OW} value of -1.30, which indicates that *T-Hydro* TBHP will not tend to bioaccumulate in plants and animals.

7.1 Air/Water Quality Considerations

TBHP is considered a Volatile Organic Compound (VOC) under the Clean Air Act (CAA) of 1990. It is not a Hazardous Air Pollutant (HAP) and therefore not subject to control under Title III of the Act. As a VOC, TBHP is subject to the new regulations for ozone non-attainment areas. These regulations, which vary by area depending on the severity of non-attainment, require emission controls on industrial sources of VOCs. Any facility with the potential to emit TBHP may be subject to emission control requirements. Consult with federal, state and local officials to determine regulation requirements for the facility.

The discharge of wastewater containing TBHP (as with most pollutants) to waters of the United States is regulated under the National Pollutant Discharge Elimination System (NPDES) permit program of the Clean Water Act. TBHP is not listed as a priority pollutant under this Act, and Federal Water Quality Criteria for the protection of human health and/or aquatic organisms have not been developed for this material.

TBHP is not specifically regulated under the EPA pretreatment standards. TBHP may be subject to case-by-case determination of NPDES permit limits.

7.2 Waste Management

7.2.1 Waste Classification

Wastes containing TBHP, which are defined as solid wastes (see 40 CFR Part 261), may be classified as characteristically hazardous if the flash point is below 60°C (140°F) or characteristically reactive. Solid wastes containing TBHP may include, but are not limited to, contaminated water, soil and debris, process wastes and empty containers. TBHP wastes may be defined as ignitable (D001) and/or reactive (D003) hazardous wastes based on the TBHP concentration. State regulations may have more restrictive definitions and should be reviewed.

7.2.2 Spill Prevention and Response

Facilities using *T-Hydro* TBHP (as with other organic liquids) should have a comprehensive spill prevention and emergency response plan developed and implemented. This plan should address spill detection methods, emergency notification procedures, community contacts for notification and advice on evacuation needs, fire prevention and protection, provisions for spill containment and cleanup, environmental protection and compliance with applicable national, state and local regulations.

Design facilities involved in the storage and/or handling of *T-Hydro* TBHP to contain and/or control spills from process areas and transfer operations. Minimize soil, surface water and ground water contamination from an accidental spill by installing curbs, sumps and impervious containment areas. Appropriate materials of construction for containment areas include concrete, compatible synthetic liners or compacted clay. A dual liner system may be desirable in environmentally sensitive areas.

Pumps, piping and equipment designed to operate within potential spill areas should be compatible with *T-Hydro* TBHP (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.

In the event of a *T-Hydro* TBHP spill, evacuate all non-essential personnel and extinguish all ignition sources immediately (see VZ-STEL in Section 5.2). Prevent flow to sewers or public waters and contain spill. The spill can be covered with fire fighting foam to minimize evaporation and potential fire hazards.

In the event of a release to the environment of 100 pounds or more of a characteristic hazardous waste containing TBHP in the United States (See Section 7.2.1), notify the National Response Center at +1-800-424-8802. Other national, state and/or local reporting requirements may also apply.

7.2.3 Waste Handling, Storage and Disposal

Users must comply with National regulations on the handling, storage and disposal of hazardous waste. In the United States, EPA regulations at 40 CFR Parts 262-272 apply to the storage, handling, treatment and disposal of hazardous wastes. OSHA regulation 29 CFR Part 1910.120 (Hazardous Waste Operations and Emergency Response or HazWOpER) applies to personnel engaged in hazardous material activities such as spill response under CERCLA, cleanup operations under RCRA, hazardous waste storage operations and emergency response. Training and management requirements are also given under RCRA. Shipment of waste is governed by Department of Transportation (DOT) rules. In the EU, Directives 91/156/EEC and 91/689/EEC cover waste management, waste disposal and environmental protection. Countries outside the United States and the EU may have similar regulations. Users of *T-Hydro* TBHP who generate, store, reclaim or tender for transportation and dispose any hazardous waste should review these regulations for applicability. Hazardous waste may be held on site for up to 90 days without a RCRA permit, provided that the waste is placed in approved containers and stored in clearly identified areas. Design hazardous waste storage areas to collect any spillage in a separate section. Clearly label, date and inspect containers stored in such facilities. Prevent stored wastes from contacting incompatible materials and causing an uncontrolled decomposition and/or reaction in the storage containers. Inspect hazardous waste areas regularly. State regulations may specify additional design requirements for hazardous and non-hazardous waste accumulation areas.

Aqueous waste streams with higher concentrations of TBHP or contaminated sailor debris may be incinerated. Avoid contacting TBHP waste streams with incompatible materials (see Section 4.9) that could cause an uncontrolled decomposition or reaction.

Concentrated liquid waste may be reacted harmlessly by combining with dilute (less than 10%) sodium bisulfite (reducing agent) and alkali solution, mixing thoroughly until reaction heat dissipates. Resulting solution may be biologically treatable. Assure effluent complies with applicable regulations.

Characteristic hazardous wastes require disposal at permitted facilities and are subject to land disposal restrictions under RCRA requirements (40 CFR 268). The disposal of non-hazardous wastes on land may also be regulated under this program.

Containers used to hold *T-Hydro* TBHP must be drained and then thoroughly rinsed with water. Collect and properly dispose of rinsate generated by this washing. It may be desirable to complete a certificate of cleaning for documentation that the containers were appropriately cleaned and can be reused. Any container which has not been completely washed should be considered a potential fire or explosion risk and should not be cut, burned, soldered or welded.

8. Product Storage

Considerations in the design and construction of organic peroxide storage facilities include physical hazards and potential environmental, health and safety effects. Specific design requirements for facilities receiving, storing and handling *T-Hydro* TBHP depend on the following:

- types of containers used (drums or bulk)
- mode of delivery
- processing methods
- quantities of *T-Hydro* solution stored and handled
- characteristics of materials stored and handled nearby
- the character of the adjacent community
- risks posed by adjacent facilities

8.1 Drum Storage

Lyondell currently uses a packaging code UN1H1/Y1.8/100 polyethylene drum (see Section 11.3.2).

The three classifications of drum storage facilities are: segregated, cut-off and detached (NFPA 30 and 43B). Segregated storage areas are in the same interior area, separated by distance from incompatible materials. Cut-off storage is an interior area separated by walls. Detached storage areas are in a separate building or an outside area located away from other structures.

Regardless of classification, storage areas should be:

- Identified with the words "Organic Peroxide" and the most severe class of organic peroxide stored in the area.
- Maintained within the recommended storage temperature range which is 10°C to 38°C (50°F to 100°F) for *T-Hydro* TBHP.
- Equipped with electrical installation and equipment meeting the requirements of NFPA 70.
- Maintained with a clear space of at least 1 meter (3 feet) between *T-Hydro* TBHP storage and any uninsulated metal wall.
- Equipped with fire suppression equipment according to NFPA 14.
- Restricted to drum storage of piles not more than 3 meters (10 feet) high or 5 meters (16 feet) wide with one main aisle dividing piles.
- Designed with spill containment considerations. Door or window openings should have approved fire doors or windows installed according to NFPA 80. Segregated storage areas should:
  - have a 2.5 meter (8 foot) clear space between them and any other storage
  - be more than 7.5 meters (25 feet) from flammable liquids or incompatible materials unless separated by a one-hour fire resistant wall
  - have 1.25 meters (4 feet) clear to any combustible construction

Floors with open space located below the *T-Hydro* TBHP storage area should be water tight and equipped with drainage away from the storage area. Provide segregated areas storing more than 100,000 pounds of TBHP with automatic sprinkler protection designed to provide 0.25 gpm per square foot over a 3,000 square foot area for wet pipe sprinkler systems or a 3,900 square foot area for dry pipe sprinkler systems. For segregated areas that meet the requirements of NFPA 13 and 15 and have automatic sprinkler protection, storage capacities are unlimited.

Cut-off storage areas should be one-story construction without basements or crawl spaces and should have automatic sprinklers and vents to discharge decomposition gases. All storage areas of noncombustible construction require automatic sprinkler protection when quantities of *T-Hydro* TBHP or a combination of Class IV peroxides exceed 200,000 pounds. Discharge densities and design requirements are the same as those specified for segregated storage areas. Walls common with other buildings should have two-hour fire resistance ratings.

Detached storage buildings should be single-story construction without basements or crawl spaces. Provide buildings with vents to discharge decomposition gases. Detached storage areas with a minimum 50 foot separation from normally occupied buildings and property lines require automatic sprinkler protection when quantities of *T-Hydro* TBHP or combination of Class IV peroxides exceed 300,000 pounds. Discharge densities and design requirements are the same as those specified for segregated storage areas.

Lyondell discourages outside, unprotected drum storage of *T-Hydro* TBHP unless provisions are made to control temperature fluctuations and potential contamination.

8.2 Storage Tanks

Considerations in site selection and tank spacing include:

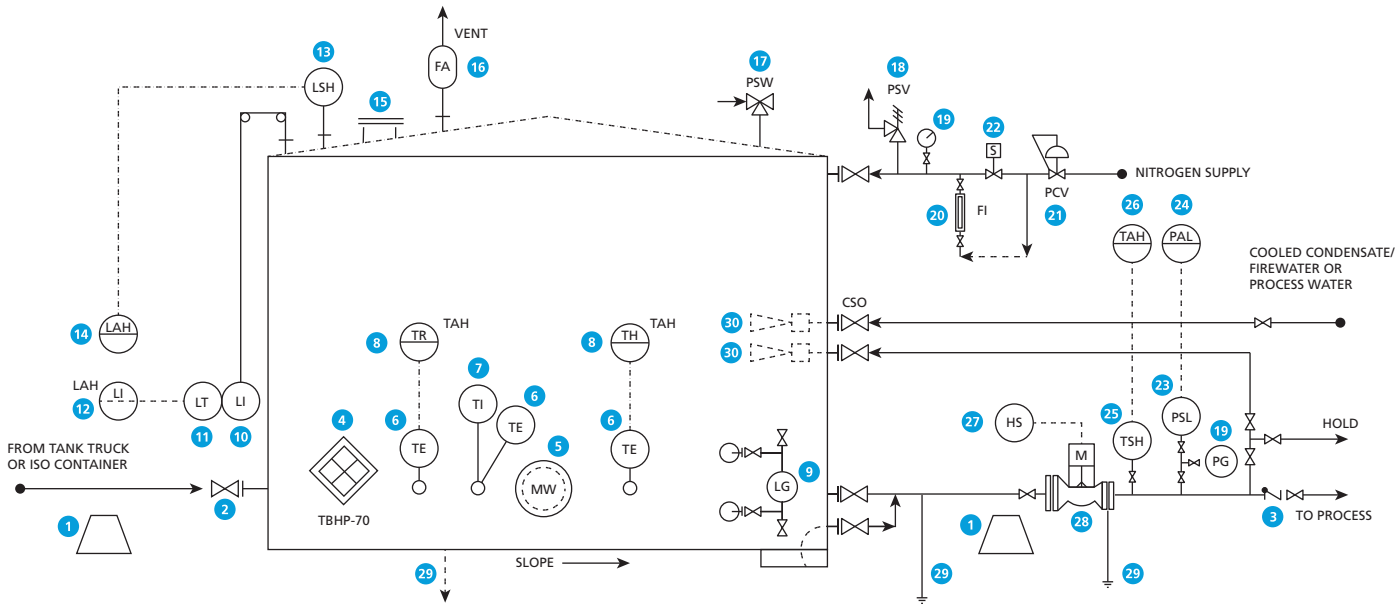
- their proximity to other flammable material storage facilities
- nearby ignition sources
- fire fighting accessibility
- potential consequences of a release beyond the plant boundaries
- spill containment
- product segregation
- environmental compliance

Installations should comply with NFPA 30, 43B and 70.

Design and construct *T-Hydro* TBHP tanks as low pressure or atmospheric vessels according to API 620 and 650 or as pressurized storage per ASME/ANSI Section VIII, Division 1. If the vessel is cladded, caution should be used to ensure the cladding does not crack or separate from the shell, providing a site for decomposition to occur. Thermal protection and relief valves should be installed on long pipe runs. Figures 8-1 and 8-2 illustrate typical TBHP tank designs.

The EPA has issued Standards of Performance (40 CFR 60.110) that regulate the storage of volatile organic liquids (VOLs). These regulations specify certain storage tank roof construction as well as emission-control and monitoring devices. Because *T-Hydro* TBHP vapor pressure exceeds 0.75 psia at the recommended maximum storage temperature of 38°C (100°F), vessels with a capacity greater than or equal to 40,000 gallons are subject to 40 CFR 60.110. Because the vapor pressure is below 4.0 psia, storage vessels with less than 40,000 gallons are exempt from special roof construction and closed vent requirements.

Figure 8-1 Typical Atmospheric Storage Tank Configuration



1 Containment	6 Temperature Element	11 Level Transmitter	16 Flame Arrestor	21 Pressure Cont. Valve	26 Temp Alarm High
2 Block Valve	7 Temperature Indication	12 Level Indication w/ Level Alarm High	17 Vacuum/pressure Relief	22 Solenoid Valve	27 Hand Switch
3 Check Valve	8 Temperature Recorder w/ Temperature Alarm High	13 Level Switch High	18 Pressure Safety Valve	23 Pressure Switch Low	28 Pump
4 N.F.P.A. Identification	9 Level Gauge	14 Level Alarm High	19 Pressure Gauge	24 Pressure Alarm Low	29 Approved Ground
5 Manway	10 Level Indicator (Local)	15 Gauge Hatch	20 Rotameter	25 Temperature Switch High	30 Mixing Eductor

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.

8. Product Storage ...

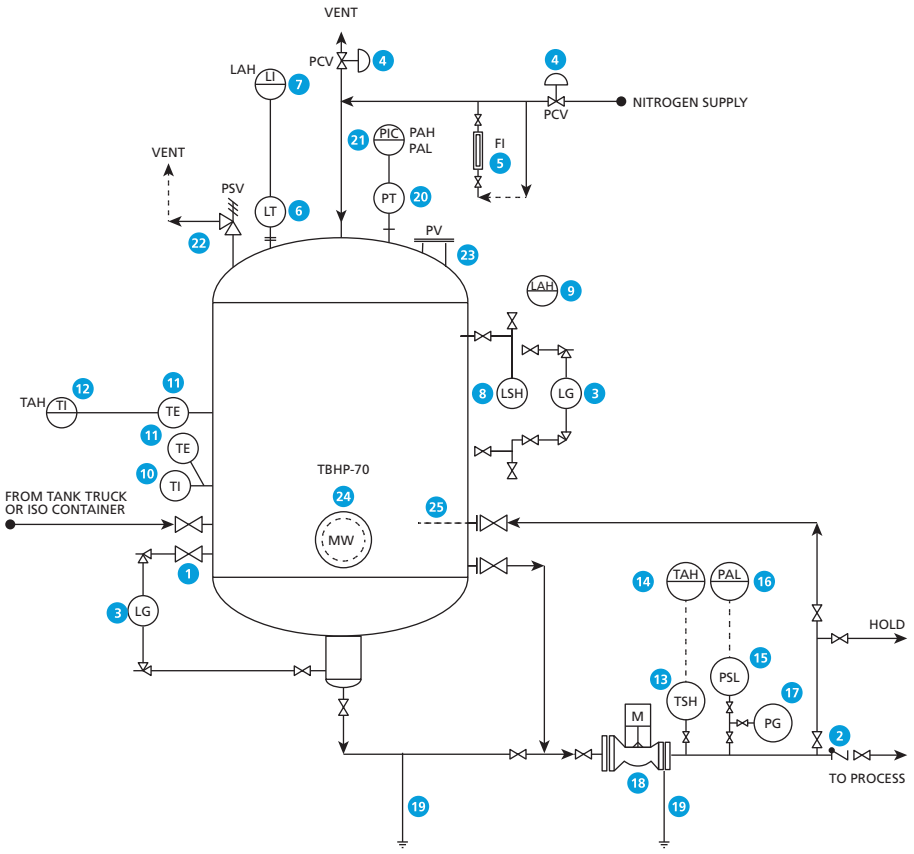
In spite of the safety of *T-Hydro* solution relative to other peroxides, testing has shown that under conditions where TBHP is concentrated in the liquid, explosions are possible. Lyondell recommends taking one of these two precautions to lower this risk: 1) provide for water dilution or 2) add a combustion modifier. Water injection acts as a diluent to prevent TBHP from concentrating during a fire. To allow for safe dilution without overfilling, the liquid level should be limited to approximately 70-80% of the full tank volume. Water dilution or combustion modifiers do not prevent flammability in the vapor phase.

Addition of a combustion modifier entails installing polyethylene *INTALOX* saddles which capture free radicals. These saddles are three inch, low density polyethylene having a melt index (ASTM D 1238-82 Condition E) above 0.2 grams per 10 minutes. The quantity of PE saddles to *T-Hydro* TBHP ratio should be greater than 0.0123 by weight. Visually inspect and check the melt index of the saddles on a regular basis, at a minimum of once every year. Replace them when discoloration, fracture, severe deformation, low melt index or other indication of change is noticed.

Solubility characteristics of TBHP and water are somewhat unusual (see Figure 1-12). To maintain solution strength near the desired level with minimal loss to the water layer or thermal decomposition, keep the temperature in the range from 10°C to 38°C (50°F to 100°F). At the standard 69 to 70 percent concentration, the solubility of water in *T-Hydro* TBHP decreases with temperature. Heating or cooling can result in a second phase (about 85 percent water and 15 percent TBHP) settling to the bottom of the storage tank. Because this phase is denser, it will accumulate at the low points. To maintain the product quality, periodically draw down any accumulated second phase water to preclude the inadvertent transfer of the water phase along with the *T-Hydro* solution phase.

The solution begins to freeze at about -3°C (27°F) with the appearance of ice crystals. As the temperature drops, the concentration changes until a second solid phase appears at about -11°C (12°F). Upon remelting and remixing, the resultant solution has essentially the same composition as the original material. Neither the solution nor the solidified product has been found to be impact or shock sensitive. The need for insulation or a temperature control system depends on local temperature conditions.

Figure 8-2 Typical Pressure Storage Tank Configuration



1 Block Valve
2 Check Valve
3 Level Gauge W/Gauge Valves
4 Pressure Control Valve
5 Rotameter
6 Level Transmitter
7 Level Indication w/ Alarm High
8 Level Switch High
9 Level Alarm High
10 Local Temperature Indication
11 Temperature Element
12 Remote Temperature Indication w/ Alarm High
13 Temperature Switch High
14 Temperature Alarm High
15 Pressure Switch Low
16 Pressure Alarm Low
17 Pressure Gauge
18 Pump
19 Approved Ground
20 Pressure Transmitter
21 Pressure Indicating Controller w/ Alarms High And Low
22 Pressure Safety Valve
23 Emergency Relief Device
24 Manway
25 Mixing Eductor

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.

8.2.1 Venting

Normal venting allows the tank to breathe due to liquid withdrawal or addition and thermal changes. Conservation venting reduces evaporative losses. Typical venting systems for *T-Hydro* TBHP include vapor collection and containment.

The vapor-air mixture above *T-Hydro* liquid is not flammable when the temperature is below 43°C (109°F). However, as decomposition occurs, oxygen is formed above the liquid. Sweeping the tank with nitrogen will increase the flammable temperature in the vapor-nitrogen mixture to 74°C (165°F) and should provide a safe condition in the vapor space. (Refer to Figure 8-1 and Figure 8-2). Because decomposition is slow in the absence of contaminants, the nitrogen use is small. A water scrubber can recover residual TBHP from the vent gases if a containment system is not in place. Although the tank is provided with a nitrogen sweep, a vacuum relief system is also important.

Use over-pressure relief systems that provide adequate protection. Exposing a tank to an external fire can cause high pressures resulting in a boiling liquid expanding vapor explosion (BLEVE). To prevent these explosions, provide adequate pressure relief which allows the vapors to escape and burn at the vents and thereby prevents tank rupture. Pressure relief can entail additional self-closing breather valves, loose manhole covers that lift under pressure, gauge hatches, hinged manhole covers, rupture discs or commonly used emergency relief valves. The roof-to-shell seam of a vertical cone roofed tank should be more weakly constructed than the bottom-to-shell seam. This design prevents failure at the tank bottom and the resulting release of a liquid flood. Refer to 29 CFR 1910.106 to determine the emergency venting rate. Lyondell uses an emergency relief valve and a lifting-type manhole cover.

8.2.2 Drainage and Diking

Situate tanks within containment systems that can detect and control releases from any tank connection or from piping to and from the tank. Consult API RP-2350 for proper design considerations for overfill prevention.

Dikes should have a capacity as large as the worst credible accidental release plus 10 percent volume for flush and rain water. Dike walls should be not less than three feet high inside or more than six feet high above the interior grade. The six-foot limit prevents vapor accumulation in stagnant areas and avoids possible asphyxiation or explosions. Include drain valves in the design. During normal operations, all drain valves should be in a closed position with fire seals to prevent the spread of fire. If possible, locate all pumps and ancillary equipment outside the primary containment area and provide with curbing to collect drips, leaks and minor spills. Materials within the same diked tank area should be compatible. Slope drainage surfaces around tanks towards collection basins or sumps. Ensure that all materials and compositions collecting in basin or sumps are compatible under all possible spill scenarios. Incorporate tanks bottom supports with a passive leak detection system. NFPA 30 contains diking requirements, such as slopes, remote impounding and construction recommendations.

If the composition of accumulated liquids is acceptable to the designated tank or disposal system, dispose of them in the presence of a trained field operator. Refer to 40 CFR 60, Subpart Kb, for monitoring, record-keeping and inspection requirements.

8.3 Off-Loading Stations

For fire protection, worker safety and environmental protection, instrumentation at off-loading stations to warn operators of the potential overfilling and a totally independent device to shut off flow whenever overfill is imminent should be installed. Neither device should replace regular operating tools for determining tank level.

As part of the off-loading procedure, test the shutoff device prior to each use. Locate loading racks at least 150 feet from all equipment and tanks. Electrical wiring and devices should comply with the requirements of NFPA 70. Piping should comply with NFPA 30 and the latest version of ASME/ ANSI B31.3.

Curb the unloading area to divert spillage into the drainage system and prevent runoff into surrounding areas. Locate unloading stations at elevations lower than surrounding areas to avoid releasing liquid into adjacent areas. Make provisions to protect surface and ground waters from release contamination. Segregate adjacent unloading areas by curbing. Construct the unloading area surface (both under and around the bulk transport vessel) with an impermeable membrane or ballast installed over an impermeable barrier suitable for *T-Hydro* TBHP retention. Pitch drainage surfaces towards a collection basin or sump.

9. Transfer Operations

Detailed site specific procedures and checklists should be written by persons who understand both *T-Hydro* TBHP hazards and proper operating procedures. Only properly trained workers should perform unloading and transfer operations.

9.1 Work Preparation

When unloading vessels or containers, workers should have the following equipment and supplies available:

- Non-sparking tools
- Unloading block valve
- Grounding system

Before unloading, check and inspect the appropriate safety equipment (see Sections 3.3, 3.4 and 5.3). Place appropriate barriers and warning signs. Determine that sufficient tank capacity (ullage) is available to accept the shipment. Ensure that all high-level warning devices are activated and functioning. Verify that the material is *T-Hydro* TBHP by confirming that the identification number on the tank car is UN 3109 and by review of the shipping manifest or sample verification.

Visually inspect containers for structural damage or tampering in transit. Wet spots may be an indication of leaks. Look for evidence of discharge from pressure relief valves.

9.2 Drums

Properly bond and ground the line, pump and equipment. Figure 9-1 shows a typical drum unloading configuration.

Exposures can be reduced by using local exhaust ventilation connected to a vapor collection or scrubber system. Nitrogen supply with pressure regulator and check valve will reduce flammability hazards.

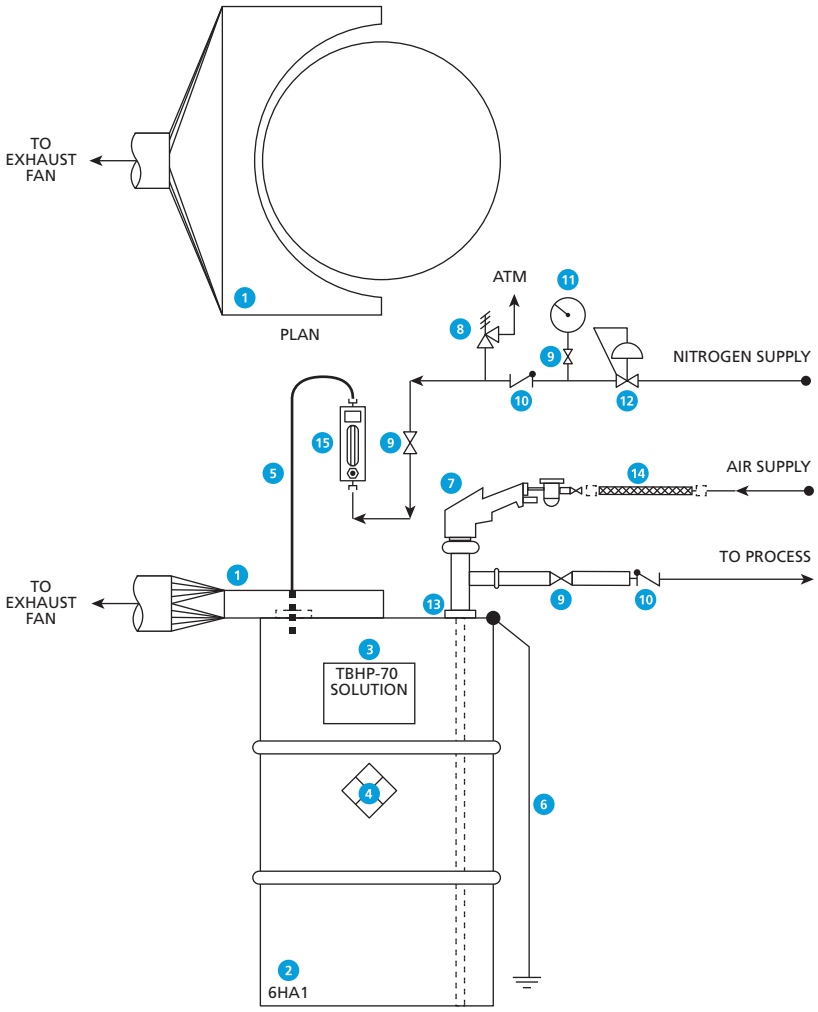
Use a "wand" or dip tube to empty from the bottom of the container. When moving the wand to the next drum, use care to prevent drips. Use a bucket of water to catch the drips. For disposal of collected waste, see Section 7. Do not pressurize any drum. When a drum has been emptied, replace its bung as soon as possible.

9.2.1 Unloading Procedures

To safely off-load a drum, the following procedure should be considered (see Figure 9-1).

1. Gather all additional necessary equipment. For drum unloading:
    a. An air-operated drum pump or Class I Group C electric motor pump should be used (see Section 4.4).
    b. Stainless steel double-braided accordion type hose with two-way shutoff quick disconnect couplings should be used if possible.
2. Purge all lines and connections with nitrogen before transfer of *T-Hydro* TBHP.
3. Visually inspect hoses and fittings prior to use.
4. Set drum on its end with the bungs at the top. Save all bungs for resealing the drum when empty.
5. Check that drums and equipment are properly grounded and bonded. Specifically design such systems to maintain continuity to earth ground.
6. Loosen the 0.75-inch bung cautiously to reduce pressure in the drum.
7. Carefully remove the two-inch top bung.
8. Connect the nitrogen line to the 0.75-inch bung. Place the unloading pump into the two-inch opening with the flexible hose connected to the pump and the unloading valve. Do not make any mechanical connections between the drum and pump to prevent pressurization of drum.
9. Open unloading valve and start nitrogen flow.
10. Engage pump to start transfer of material. Periodically check pump for leakage during use.
11. When the drum is empty, close the unloading valve and shut off the nitrogen source.
12. Disconnect unloading and nitrogen lines. Replace bungs.
13. Dispose of drum in compliance with existing federal, state and local regulations (see Section 7.2).

Figure 9-1 Typical Drum Unloading Tank Configuration



1 Hood
2 UN-Certified Number Embossed on Base
3 Label
4 NFPA Identification Code
5 Flexible Hose
6 Bonding Line
7 Air Motor Complete with Muffler, Flow Regulator Valve, Filter and Tubeset for Drum
8 Pressure Relief Valve
9 Isolatlng Valve
10 Check Valve
11 Pressure Gauge
12 Pressure Control Valve
13 Bung Label
14 Flexible Hose with Two-Way Quick Disconnect
15 Rotameter with Needle Valve

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 ...

9.3 Tank Trucks

Lyondell ships *T-Hydro* TBHP in Department of Transportation specified (DOT 412) cargo tank motor vehicles with a nitrogen pad (see Figure 9-2). The nitrogen pressure should be low enough so total pressure does not exceed the relief valve setpoint of 25 psig. The specification prohibits bottom outlets. The tank trucks contain *INTALOX* polyethylene saddles as a combustion modifier. If possible, locate the loading facility in a relatively remote, level location, distant from general activity. Refer to 49 CFR 177 Subpart B for information on unloading regulations.

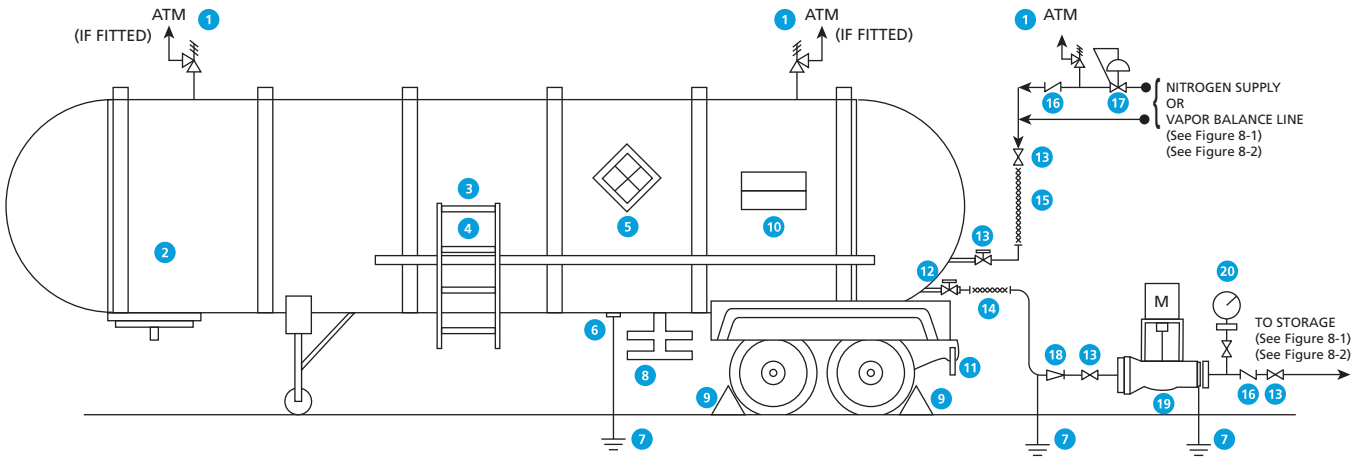
The following procedures are comparable to those used by Lyondell for unloading tank trucks and can be used as a basis for developing site-specific procedures. A suggested unloading checklist is provided in Figure 9-3.

9.3.1 Unloading Preparation

The following procedures prepare the tank truck for unloading:

1. Gather all necessary equipment. For tank truck unloading, also include road barriers, warning lights and/or wheel chocks (this should be checked).
2. Instruct driver to position tank buck for unloading at designated station; then set brakes, shut off engine and leave cab. The driver should remain in a designated area.
3. Safeguard truck from nearby traffic by putting up road barriers or warning lights.
4. Chock both sides of one tank truck wheel.
5. Connect ground cable and check for electrical continuity.
6. Remove and read the label attached to the tank truck's outlet valve to confirm that its contents are *T-Hydro* TBHP.
7. Visually inspect hoses and fittings prior to use.
8. Determine that the receiving storage tank has sufficient capacity (ullage) to hold the entire contents of the tank truck.
9. Identify all pipelines so that proper valve alignment can be made.
10. Determine that the unloading station's spill-collection sump drain is closed and substantially free of accumulated liquid.

Figure 9-2 Typical Tank Truck Configuration



1 Pressure Relief Valve
2 ADR Tank Details
3 Rotary Gauge (Liquid Level)
4 Thermometer and Pressure Gauge
5 Danger Level, Each End of Truck (See Figure 11-1)
6 Approved Ground Clamp
7 Ground Wire
8 Side Protection
9 Wheel Chocks
10 Hazard Identification Placard Each End of Truck (See Figure 11-2)
11 Rear End Protection
12 Isolatlng Valve
13 Isolatlng Valve
14 Flex Hose Assembly
15 Flex Hose Assembly
16 Check Valve
17 Pressure Control Valve
18 Strainer
19 Pump
20 Pressure Gauge with Diaphragm Seal

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.

9.3.2 Unloading Procedures

The unloading procedures for tank trucks are:

1. Connect liquid transfer line to unloading valve and nitrogen line to vapor valve. Stainless steel double-braided accordion-type hoses with two-way shutoff, quick-disconnect couplings are preferred. If these couplings are not used, purge all lines and connections with nitrogen before transferring.
2. Open nitrogen supply valve and the tank truck vapor valve. Adjust nitrogen pressure to no more than 20 psig on tank truck. Nitrogen pressure and/or a pump may be used to unload.
3. Verify seal number on truck matches seal number on BOL. Open the unloading valve and, if used, the pump intake valve, allowing liquid to fill the pump. The unloading valve must be opened slowly to avoid activating the excess now valve. Start pump and begin pumping into the storage tank. Maintain positive pressure of at least 10 psig on the tank truck to keep from pulling a vacuum. Closely monitor this operation.
4. Immediately make a visual check for leaks, especially at places where seals and O-rings are present. If leaks are observed, shut down immediately and take remedial action.
5. Check to determine that the receiving tank level is rising at the expected rate for the transfer system.
6. Monitor the transfer. When the tank truck is empty, close pump-discharge valve and immediately shut off pump.
7. Blow the transfer lines clear. Close all valves and vents. Vent pressure from transfer lines. Disconnect liquid transfer and nitrogen lines.
8. Pad with slight nitrogen pressure (3–5 PSIG).
9. Reseal valve with wire cable seal and record seal number on paperwork.

9.3.3 Release of Empty Truck

The following steps complete the process of unloading tank trucks:

1. Disconnect the ground cable. Remove the wheel chocks and traffic-control devices.
2. Ensure that tank truck placards meet DOT requirements for the return trip.
3. Release the vehicle to the driver.
4. If there were any mechanical problems with the tank truck, advise LyondellBasell Customer Service North America +1-888-777-0232 or Europe +33-3-4424-9205.

Figure 9-3 TBHP-70 Solution Unloading Checklist

Tank Truck Number: _____ Date: _____

Operator: _____ Time: _____ AM/PM

Prior to Unloading Tank Truck	Yes	No
Wheels chocked and parking brakes engaged	☐	☐
Ground cable to truck connected and checked for continuity	☐	☐
Check bill of lading & labels to confirm contents	☐	☐
Eyebath and safety shower flushed and ready	☐	☐
Inspected for leakage around valves and fittings	☐	☐
Storage tank capacity and tank truck liquid level determined before filling	☐	☐
Liquid unload and vapor return lines connected, purged and tested for leaks	☐	☐
Proper piping alignment made and checked	☐	☐
Someone in attendance during transfer	☐	☐

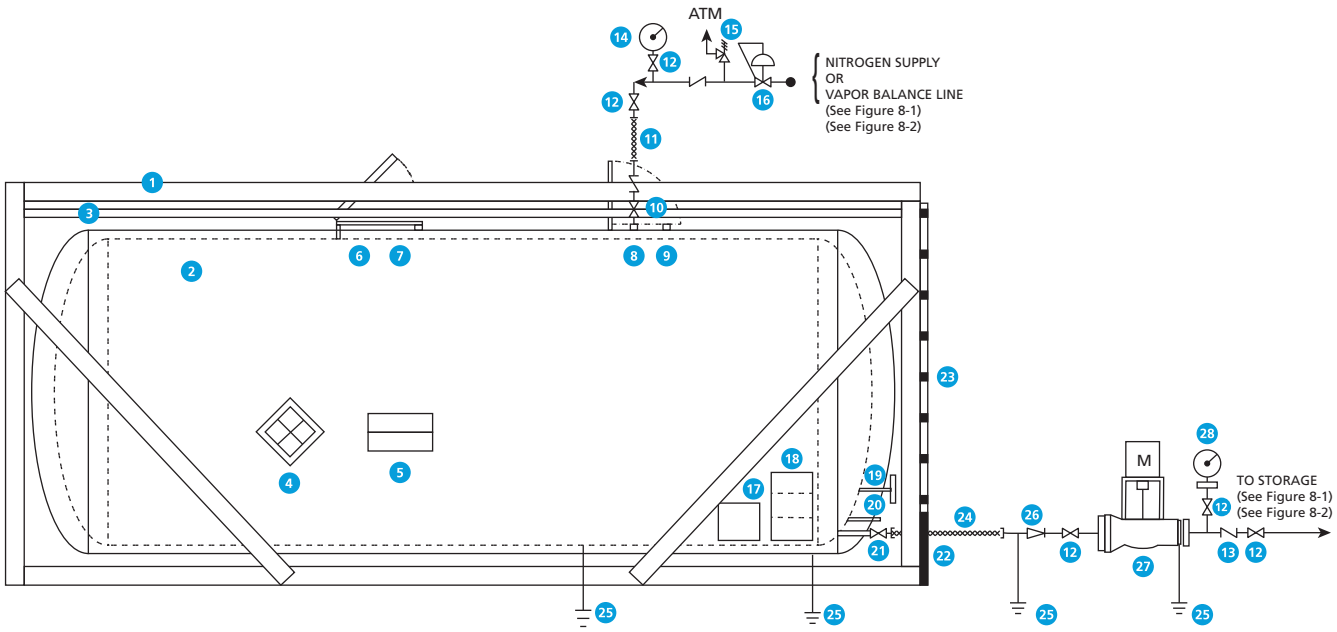
After Unloading Tank Truck	Yes	No
When tank truck is empty, shut down the pump	☐	☐
Transfer line blown clear	☐	☐
Unloading line valve closed to the storage tank	☐	☐
Nitrogen pad pressure on truck	☐	☐
Tank truck vapor valve and liquid unloading valve closed	☐	☐
Transfer line vented of pressure	☐	☐
Transfer and nitrogen lines disconnected	☐	☐
Inspected for leakage around valves and fittings	☐	☐
Ground cable disconnected, labels checked	☐	☐
Wheel chocks removed	☐	☐

9. Transfer Operations ...

9.4 ISO Tanks

Lyondell ships *T-Hydro* TBHP in intermodal bulk transport tanks meeting the T23 portable tank specifications. The relief valve setting is 10.9 psig as required by DOT and UN regulations. Portable tanks contain *INTALOX* polyethylene saddles as a combustion modifier. The unloading valve is located at the top of the tank (see Figure 9-4). International Organization for Standardization (ISO) tank work preparation and unloading procedures are essentially the same as those in Section 9.3.

Figure 9-4 Typical IMO Tank Configuration



1 Tank Frame
2 Tank Shell in Stainless Steel with Insulation and Aluminum Cladding Protection
3 Walkway
4 Danger Label Each Side (See Figure 11-1)
5 Hazard Identification Each Side (See Figure 11-2)
6 Manhole
7 Safety Relief Valves (2) w/ Tank
8 Nitrogen/Vapor Inlet
9 Provision For Filling / Drain System
10 Ball Valve
11 Flex Hose Assembly
12 Isolating Valve
13 Check Valve
14 Pressure Gauge
15 Pressure Relief Valve
16 Pressure Control Valve
17 Sender's Name Emergency Number
18 Carrier's Name Container Owner/ Lessor's Name Certification
19 Thermometer
20 Steam Heating (not used for P.O. service)
21 Bottom Discharge Valve
22 Data Plate
23 Ladder
24 Flex Hose Assembly
25 Ground Cable
26 Strainer
27 Pump
28 Pressure Gauge w/ Diaphragm Seal

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 and Equipment Repair

10.1 Work Preparation

Proper preparation for cleaning or maintaining *T-Hydro* TBHP storage vessels and equipment by fully trained workers can help prevent fire or harm to workers or the environment.

Establish a hazardous-work permit system before performing any maintenance or inspection activities involving hot work (29 CFR 1910.119), lockout/tagout (29 CFR 1910.147) or confined-space entry (29 CFR 1910.146 see Appendix III for citations). The permit should identify all job-related hazards and include a work plan to address them. For information on precautions during hot work, cutting and welding in organic peroxide storage areas, refer to NFPA 30, 43B and 51B. Use engineering controls and appropriate PPE (see Section 3).

Experienced, trained workers should conduct *T-Hydro* TBHP equipment cleaning in compliance with a written, approved procedure. Review of the procedure should include a hazards analysis, such as a job safety analysis (JSA), to identify hazards and necessary protective measures. The emptying of *T-Hydro* TBHP vessels or storage tanks can present danger of ignition, toxic vapors and improper disposal of the drained solution.

Before opening tanks and equipment that contain *T-Hydro* solution, empty all liquid. Blow down lines with nitrogen and then rinse with water or suitable solvent to clear out any residual *T-Hydro* solution. Because steam may concentrate residual *T-Hydro* TBHP to unsafe levels, do not use it to clean or purge lines or vessels unless they have been properly flushed with a suitable solvent such as mineral oil, kerosene, tertiary butyl alcohol or water. In the selection of solvents, consider the contamination hazards. Never use acetone or other ketones to clean systems containing *T-Hydro* TBHP (see Section 1.3.3). Take caution that lines and vessels carrying *T-Hydro* TBHP do not contain pools or pockets that may concentrate over time.

10.2 Control of Hazardous Energy

A facility must have procedures for controlling hazardous energy sources that comply with the requirements of 29 CPR 1910.147. The procedures protect workers in areas where *T-Hydro* TBHP vessels or equipment are cleaned, maintained or entered. After a system is purged, ensure that all potential sources of *T-Hydro* TBHP 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 *T-Hydro* solution, a lower flammability limit of 5.75 vol% should be used to determine permit requirements. Appropriate respiratory protection for TBHP vapor exposures (see Section 3.3) may also be required.

10.4 Maintenance and Inspection

Follow regular inspection, testing and preventive maintenance schedules for safety critical equipment (29 CFR 1910.119). The inspection program should include periodic visual inspection of equipment and storage areas for signs of deterioration, leaks or malfunctions. Base the inspection frequency upon experience. Inspect visible parts in transfer systems each time they are used. Visual inspection can be augmented by using instruments that detect *T-Hydro* vapors (see Section 3.5).

11. Transportation Regulatory Requirements

The Distribution Safety Program of Lyondell has been implemented in accordance with the American Chemistry Council's *Responsible Care* Distribution Code of Management Practices. Lyondell selects risk-limiting packaging configurations and transport modes according to this Code.

This section is written in accordance with the Code of Federal Regulation, Title 49 revised October 1, 1991, with changes (see Appendix IV for citations). These changes include a requirement that those offering hazardous materials for transport be trained in the proper application of these regulations. This section does not address every packaging type which may be authorized by U.S. DOT, International Maritime Organization (IMO), International Civil Aviation Organization (ICAO) or International Air Transport Association (IATA).

Federal regulations describe authorized procedures to properly package, mark, label, placard and manifest shipments. These procedures depend upon the quantity and type of hazardous material and the method of transport. If one plans to transport hazardous material internationally by air, then the requirements of the IATA and ICAO must be met. International shipment by water requires compliance with the IMO regulations.

11.1 Classification

The Organic Peroxides Table in 49 CFR 173 indicates *T-Hydro* (tert-Butyl hydroperoxide ≤72%) as having an identification number of UN 3109. UN 3109 equates to "Organic Peroxide type F, liquid" which is a hazardous material for transportation purposes. The Hazardous Materials Table (49 CFR 172 Subpart B) and the Organic Peroxides Table give the following designations:

Proper shipping name:	Organic Peroxide type F, liquid (Contains 70% tert-Butyl hydroperoxide in water)
Hazard Class:	5.2 (8) (3)
Identification Number:	UN 3109
Packing Group:	II
Labels Required:	Organic Peroxide, Corrosive, Flammable Liquid
Appendix A to HMT:	Not Listed
Appendix B to HMT:	Not Listed

The IMO assigns *T-Hydro* (tert-Butyl hydroperoxide ≤72%) with a hazard class of 5.2 and requires a corrosive subsidiary risk label (class 8). Subsidiary hazard marking is authorized in 49 CFR 172.

DOT regulations (49 CFR 172 Subpart C) require the following description on the bill of lading for *T-Hydro* TBHP:

Organic Peroxide type F, liquid (contains 70% tert-Butyl hydroperoxide in water), 5.2 (8) (3), UN 3109, PG II.

In Europe, the bill of lading description for *T-Hydro* TBHP should be:

UN3109, Organic Peroxide Type F, Liquid (70% Ter*t-hydro* Peroxide in water), 5.2

11.2 Marking, Labeling and Placarding

Regulations require identification numbers on each side and each end if the packaging capacity is 1,000 gallons or more; on two opposing sides if the packaging capacity is greater than 119 gallons but less than 1,000 gallons. Markings for non-bulk packaging (119 gallons or less) include the proper shipping name, identification number preceded by UN or NA, the technical name and the consignee or consignor's name and address.

Non-bulk packages require labels be located on the same surface and near the marking(s). For ISO tanks, markings include the proper shipping name, technical name with concentration of peroxide and identification number. The proper shipping name is "Organic Peroxide type F, liquid (contains 70% tert-Butyl Hydroperoxide in water)."

Marking, labeling and placarding requirements are explained in detail in 49 CFR 172 Subparts D, E and F, respectively. Subparts E and F show sample labels and placards. Labels and placards applicable to organic peroxide, flammable liquids and corrosive material are depicted in Figures 11-1 and 11-2 (note the flammable liquids label is not required in Europe). Tank trucks and ISO containers must remain placarded when emptied unless the special requirements of Subpart F are met.

For Europe, the CLP Regulation (EC) No 1272/2008 and the Dangerous Substances Directive (67/548/EEC) are applicable for Classification, Labeling and Packaging of Dangerous Goods.

11.3 Packaging

There are authorized packaging exceptions in 49 CFR 173 Subpart D for Division 5.2 materials.

Non-bulk packaging is explained in 49 CFR 172 Subpart E and bulk packaging is described in Subpart F.

11.3.1 Sample Containers

Sample containers prepared per Packing Methods OP1A through OP8A as found in 49 CFR 173 are authorized. The volume and type of containers authorized range from 0.5 liter plastic receptacles to 225 liter steel drums.

11.3.2 Drums

In the Americas, Lyondell uses a packaging code UN1H1/Y1.8/100 high density polyethylene drum.

11.3.3 Tank Trucks

DOT authorizes the transport of *T-Hydro* in DOT 412 cargo tanks (49 CFR 173 Subpart E). To reduce the risk of possible explosions if TBHP becomes concentrated, polyethylene *INTALOX* saddles are added (see Section 8.2). DOT Special Permit 6610 applies to the testing and replacement of the saddles.

11.3.4 ISO Tanks

ISO tanks are a specific class of Intermodal (IM) tanks designed and constructed to permit their use interchangeably in two or more modes of transport. When ISO tanks are transported by road, Lyondell recommends using a drop chassis trailer. Periodically inspect the chassis. Polyethylene *INTALOX* saddles are added to reduce the risk of possible explosions if TBHP becomes concentrated (see Section 8.2).

During transport, our ISO tanks are at least 80% full (49 CFR 173 Subpart B) and no greater than 90% full at 15°C (59° F) (IMDG 13.1.55.14). Tanks in *T-Hydro* service are equipped with four safety relief valves set to 0.75 barg (10.9 psig). These 24,000-liter tanks are insulated.

11.3.5 Marine Transportation

Lyondell transports *T-Hydro* in ISO tanks on container vessels. Offering *T-Hydro* in accordance with 49 CFR Part 176 Subpart J, 46 CFR and the IMO's IMDG Code requires stowage on deck and away from crew living quarters.

11.3.6 Air Transportation

T-Hydro TBHP may be transported by air, both domestically and internationally, if the following specific regulations on packaging and quantity limits are met. Air shipments must comply with ICAO regulations. The DOT regulations (49 CFR 175) cited in this section generally incorporate these regulations.

11.4 Transportation Emergencies

All Lyondell MSDSs include telephone numbers for both CHEMTREC (+1-800-424-9300) and LyondellBasell Serious Chemicals Distribution Incident hotline (+1-800-245-4532). These numbers are staffed 24 hours a day. In the event of a transportation emergency, CHEMTREC should be contacted first.

11.4.1 Reporting Requirements

A transportation incident involving *T-Hydro* TBHP may necessitate the notification of federal authorities. Refer to 49 CFR Part 171 Subpart B for details of response and reporting requirements. See Section 7 for additional reporting requirements.

Figure 11-1 Sample of a Flammable Liquid Placard

Figure 11-2 Sample of a Corrosive Material Placard

Appendices

Appendix I. Names and Addresses of Manufacturers

Chemical Protective Clothing

Gloves	Ansell Healthcare 200 Schulz Drive Red Bank, NJ 07701 USA +1-800-800-0444	Ansell Healthcare Europe Boulevard International 55 1070 Brussels Belgium +32 (0) 25 28 74 00

Combustible Gas Detectors

TLV Sniffer	Bacharach, Inc. 621 Hunt Valley Circle New Kensington, PA 15068-7074 USA +1-724-334-5051	Bacharach Europe Ninaberlann 83 7447 AC Hellendoorn The Netherlands +31 548 659065

Explosimeter

	MSA Fire P. O. Box 426 Pittsburgh, PA 15230 USA +1-800-MSA-FIRE	MSA AUER GmbH Thiemannstr. 1 12059 Berlin Germany +49 (0) 3068-861305

Infrared Spectrophotometers

MIRAN Series Flame Ionization Detectors Century OVA 128 Century OVA 108	The Foxboro Company 600 North Bedford Street P.O. Box 500 East Bridgewater, MA 02333 USA +1-508-378-5277

Photoionization Detectors

Photovac's TIP	Photovac, Inc. 300 Second Avenue Waltham, MA 02451 USA +1-781-290-0777
HNU Model P101	HNU Systems, Inc. 780 Corporate Park Dr Pembroke, MA 02359 USA +1-800-724-5600

Appendix II. Lyondell Sampling and Analytical Method

Tertiary Butyl Hydroperoxide

Issued:	10/13/92
Formula:	$C_4H_{10}O_2$ 70% in H_2O
M.W.:	90.12
OSHA:	No exposure limit established
ACGIH:	No exposure limit established
Properties:	See Section 1. General Information, Table 1-1
Synonyms:	TBHP CAS #75-91-2

Sampling

Sampler:	Silica Gel Sorbent Tube (260/520 mg)
Flow Rate:	0.05 to 0.20 L/min
Vol-Min:	6L
Max:	48L
Shipment:	Routine
Sample Stability:	Stable for 7 days at ambient temperature
Field Blanks:	10% of samples

Accuracy

Range Studied:	0.301 – 11.61 ppm
Bias:	Not significant
Overall Precision (Sr):	0.081

Measurement

Technique:	GC/FID
Analyte:	tert butyl hydroperoxide
Desorption:	1mL methanol, 30 min
Injection Volume:	1 µL
Temperature-Dector:	250°
Temperature-Column:	Initial Oven Temp.: 45° Initial Time: 3 min Rate: 8°C/min Final Temp.: 75°C Final Time: 0 min
Injection:	Ambient (on-column)
Column:	Restek Rtk – 5 megabore 30 m x 0.53 mm i.d.; 1.0 film thickness
Calibration:	Standard concentration of TBHP in methanol with 0.1% isobutyl acetate
Range:	0.065 mg to 0.093 mg
Estimated LOD:	0.050 mg
Precision (Sp):	0.050 @ 0.065 to 0.973 mg per sample

Applicability

The working range is 0.301 to 11.61 ppm for a 48-L air sample.

Interferences

To avoid breakthrough, sample at 0.05 L/min for 4-hour sessions if large concentrations of tert-Butyl hydroperoxide are expected.

Reagents

1. Eluent: methanol, chromatographic quality, containing 0.1% isobutyl acetate as the internal standard
2. Helium
3. Hydrogen
4. Air

Equipment

1. Sampler: silica gel sorbent tube (260/520 mg)
   SKC Catalog No. 226-15
2. Personal sampling pump: 0.05 to 0.2 L/min, with flexible connecting tubing
3. Gas chromatograph, FID, integrator or data system
4. Vials, 2-mL PTFE-lined caps
5. Syringes, 10 µL and other convenient sizes for preparing standards, readable to 0.1 µL
6. Volumetric flasks
7. Pipets

Sampling

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling, attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between .05 and 0.2 L/min for 4 hours.
4. Cap the samplers. Pack securely for shipment.

Sample Preparation:

5. Place the front and back sorbent sections of the sampler tube in separate vials. Discard the glass wool and foam plugs.
6. Add 1.0 mL eluent to each vial. Attach cap to each vial.
7. Allow to stand 30 min with occasional agitation.

Calibration and Quality Control:

8. Calibrate daily with at least five working standards over the range 32.4 to 324.4 µg/mL TBHP.
   a. Add known amounts of TBHP to eluent in 1010-mL volumetric flasks and dilute to the mark. By serial dilution, prepare solutions containing 32.4 µg/mL TBHP.
   b. Analyze together with samples and blanks (steps 11 and 12).
   c. Prepare calibration graph (ratio of peak area of analyte to peak area of internal standard vs. mg TBHP).
9. Determine desorption efficiency (DE) at least once for each lot of silica gel used for sampling in the calibration range (step 8). Prepare three tubes at each of five levels plus three media blanks.
   a. Remove and discard back sorbent section of a media blank sampler.
   b. Inject a known amount (1 to 20 µL) of TBHP or DE stock solution directly onto front sorbent section with a microliter syringe.
   c. Cap the tube. Allow to stand overnight.
   d. Prepare a graph of DE vs. mg TBHP recovered.
10. Analyze three quality control blind spikes and three analyst spikes to ensure that the calibration graph and DE graph are in control.

Measurement:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on previous page. Inject sample aliquot manually using solvent flush technique or with autosampler.

    NOTE: If peak area is above the linear range of the working standards, dilute with eluent, reanalyze and apply the appropriate dilution factor in calculations.

12. Measure peak area. Divide the peak area of analyte by the peak area of internal standard on the same chromatogram.

Calculations:

13. Determine the mass, mg (corrected for DE) of TBHP found in the sample front (W_f) and back (W_b) sorbent sections and in the average media blank front (B_f) and back (B_b) sorbent sections.

    NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.

14. Calculate concentration, C, of TBHP in the air volume samples, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b) * 10^3}{V} \text{ ; in units of mg / m}^3$$

Evaluation Method

TBHP was issued on October 13, 1992 and was validated using a generated atmosphere of TBHP over the range of 0.301 to 11.61 ppm in a 48-L sample. Overall precision S_r was 0.081 with an average recovery of 102.7%, representing an insignificant bias.

Appendices ...

Appendix III. References (*T-Hydro* TBHP)

ACOIH
American Conference of Governmental Industrial Hygienists
6500 Glenway Avenue, Bldg. D-7
Cincinnati, OH 45211-4438
USA

ACGIH; *Threshold Limit Values and Biological Exposure Indices*

ANSI
American National Standards Institute
11 West 42nd Street
New York, New York 10036
USA

ANSI B16.21; *Non-metallic Flat Gasket for Pipe Flanges*
ASME/ANSI B31; *American National Standard Code For Pressure Piping*
ANSI Z41.1; *Safety Toe Footwear*
ANSI Z87.1; *Occupational and Educational Eye and Face Protection*
ANSI Z88.2; *Practices for Respiratory Protection*
ANSI Z89.1; *Protective Headwear for Industrial Workers*
ANSI Z358.1; *Emergency Eye Wash and Shower Equipment*

API
American Petroleum Institute
1220 L Street, NW.
Washington, DC 20005
USA

API RP-520; *Recommended Practice for the Design and Installation of Pressure-Relieving System in Refineries. Part I – Design*
API RP-520; *Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries. Part II – Installation*
API 601; *Metallic Gaskets for Raised-Face Pipe Flanges and Flanged Connections (Double-Jacketed Corrugated and Spiral-Wound)*
API 620; *Recommended Rules for the Design and Construction of Large Welded, Low-Pressure Storage Tanks*
API 650; *Welded Steel Tanks for Oil Storage*
API RP-2000; *Venting Atmospheric and Low-Pressure Storage Tanks*
API RP-2003; *Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents*
API RP-2028; *Flame Arresters in Piping System*
API RP-2210; *Flame Arresters for Vents of Tanks Storing Petroleum Product*
API RP-2350; *Overfill Protection for Petroleum Storage Tanks*

ASME
American Society of Mechanical Engineers United Engineering Center
345 East 47th Street
New York, New York 10017
USA

ASME Code, Section VIII, Division 1; *Boiler and Pressure Vessel Code*
ASME/ANSI B31; *American National Standard Code For Pressure Piping*

ASTM
American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103
USA

CEFIC
European Chemical Industry Council
Avenue E. van Nieuwenhuyse, 4 box 1
B-1160 Brussels
Belgium

DOT
Department of Transportation
400 Seventh Street, S.W.
Washington, DC 20590
USA

49 CFR 171; *General Information, Regulations and Definitions*
49 CFR 172; *Hazardous Materials Table, Special Provisions, Hazardous Materials Communication Requirements and Emergency Response Information Requirements*
49 CFR 173; *Shippers -General Requirements for Shipments and Packaging*
49 CFR 174; *Carriage by Rail*
49 CFR 175; *Carriage by Aircraft*
49 CFR 176; *Carriage by Vessel*
49 CFR 177; *Carriage by Public Highway*
49 CFR 178; *Shipping Containers Specifications*
49 CFR 179; *Specifications for Tank Cars*
49 CFR 180; *Qualifications and Maintenance of Cargo Tanks*

EPA
United States Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460
USA

40 CFR 60; *Standards of Performance*
40 CFR 260; *Hazardous Waste Management System: General*
40 CFR 261; *Identification and Listing of Hazardous Waste*
40 CFR 262; *Standards Applicable to Generators of Hazardous Waste*
40 CFR 263; *Standards Applicable to Transporters of Hazardous Waste*
40 CFR 264; *Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities*
40 CFR 265; *Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities*
40 CFR 266; *Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities*
40 CFR 267; *Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities*
40 CFR 268; *Land Disposal Restrictions*
40 CFR 270; *EPA Administered Permit Programs: The Hazardous Waste Permit Program*
40 CFR 271; *Requirements for Authorization of State Hazardous Waste Programs*
40 CFR 272; *Approved State Hazardous Waste Management Programs*
40 CFR 372; *Toxic Chemical Release Reporting: Community Right-to-Know*

IARC
International Agency for Research on Cancer
49 Sheridan Street
Albany, New York 12210
USA

IATA
International Air Transport Association
1155 Mansfield Street
Montreal 113, P.Q., Canada
IATA; Dangerous Goods Regulations

ICAO
International Civil Aviation Organization
1000 Sherbrooke Street West
Suite 400
Montreal, Quebec, Canada H3A 2R2
- ICAO; *Technical Instructions for Safe Transport of Dangerous Goods, By Air*

IMO
International Maritime Organization
Albert Embankment
London SEI England
- IMDG; *International Maritime Dangerous Goods Codes, Volumes I through V*
- IMO; *International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk*

NFPA
National Fire Protection Association
Batterymarch Park
Quincy, Massachusetts 02269
USA
- NFPA 10; *Portable Fire Extinguishers*
- NFPA 11; *Foam Extinguishing Systems, Low Expansion and Combined Agent*
- NFPA 13; *Installation of Sprinkler Systems*
- NFPA 14; *Installation of Standpipe and Hose Systems*
- NFPA 15; *Water Spray Fixed Systems for Fire Protection*
- NFPA 30; *Flammable and Combustible Liquids Code*
- NFPA 43B; *Storage of Organic Peroxide Formulations*
- NFPA 70; *National Electrical Code Article 500 -Hazardous (Classified) Locations*
- NFPA 80; *Fire Doors and Fire Windows*
- NFPA 704; *Standard for the Identification of the Fire Hazards of Materials*

NIOSH
National Institute for Occupational Safety and Health
US Department of Health, Education and Welfare
4676 Columbia Parkway
Cincinnati, Ohio 45226
USA

NTP
National Toxicology Program
P.O. Box 12233
Research Triangle Park, North Carolina 27709
USA

OPPSD
Organic Peroxide Producers Safety Division
Society of Plastics Industry (SPI)
1667 K Street, NW, Suite 1000
Washington, DC 20006
USA

OSHA
Occupational Safety and Health Administration
200 Constitution Avenue, N.W.
Washington, DC 20210
USA
- 29 CFR 1910.106; *Flammable and Combustible Liquids*
- 29 CFR 1910.119; *Process Safety Management of Highly Hazardous Chemicals*
- 29 CFR 1910.120; *Hazardous Waste Operations and Emergency Response (HAZWOPER)*
- 29 CFR 1910.134; *Respiratory Protection*
- 29 CFR 1910.146; *Permit-Required Confined Space*
- 29 CFR 1910.147; *Sources of Standards*
- 29 CFR 1910.151; *Medical Services and First Aid*
- 29 CFR 1910.156; *Fire Brigades*
- 29 CFR 1910.1000; *Air Contaminants*
- 29 CFR 1910.1200; *Hazard Communication*

UL
Underwriter's Laboratories
333 Pringston Road
Northbrook, IL 60062
USA
- UL 525; *Flame Arresters for Use on Vents of Storage Tanks for Petroleum Oil and Gasoline*

UN
United Nations
First Avenue and 42nd Street
New York, NY 10017
USA
Recommendations on the Transport of Dangerous Goods

US COAST GUARD
US Coast Guard, Headquarters
2100 Second Street, S.W.
Washington, DC 20093-0001
USA
- 46 CFR 153; *Ships Carrying Bulk Liquid, Liquified Gas or Compressed Gas Hazardous Materials*

Appendix IV. Regulatory Summary

The following summary presents some of the federal, state and international laws and enabling regulations that require review prior to handling, storage or distribution of tertiary butyl hydroperoxide (TBHP), the main ingredient of *T-Hydro* solution. Where the addition of water to TBHP (as, for example, in the *T-Hydro* solution) would significantly change a cited regulation, this fact is noted. This overview is not and should not be construed as an all inclusive source of information. In addition, other international, federal, state and local laws and regulations may be applicable.

Federal

Clean Air Act

The Clean Air Act required the EPA to set national ambient air quality standards for pollutants determined to be injurious to health or welfare.

TBHP is not listed as a potential human health hazard under Section 111.

Amendments to the Clean Air Act enacted in 1990 required the EPA to establish technology standards applicable to the sources of listed pollutants.

TBHP is not listed as a hazardous air pollutant in Section 112(b).

Clean Water Act

The Clean Water Act was enacted to ensure the chemical, physical and biological integrity of the nation's waters by setting national water standards for publicly owned treatment works and industry and by creating the National Pollutant Discharge Elimination System (NPDES) permit program. The following sections of the law may be of interest to the user of TBHP.

Section 307 Priority Pollutants (40 CPR 401.15) – TBHP is not listed.

Section 311 (40 CFR 116.4) List of Chemicals considered hazardous if spilled in navigable waters. Regulations specify spill procedures to be followed in the event of accidental spillage. TBHP is not listed.

Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA)

CERCLA, more commonly known as "Superfund," established a list of more than 700 hazardous substances that, when released in quantities equal to or exceeding a specified reportable quantity (RQ), must be reported to the National Response Center. Most CERCLA hazardous substances are subject not only to CERCLA regulations but also to the Superfund Amendments & Reauthorization Act (SARA) Title III, Section 304, emergency notification requirements (see below).

TBHP is not a listed hazardous substance and, therefore, does not have a RQ under this law.

The National Response Center hotline for reporting spills is +1-800-424-8802. EPA maintains a RCR.A/Superfund hotline for information. This number is +1-800-424-9346; in Washington, D.C., the number is +1-202-382-3000.

Resource Conservation and Recovery Act (RCRA)

The major objectives of RCRA are to protect human health and the environment while conserving valuable material and energy resources. The Act is concerned with all stages in the hazardous waste management cycle – generation, storage, transportation and disposal – and requires notification to EPA within 90 days by anyone who generates, transports, treats, stores or disposes of the specific covered wastes.

Process waste streams from TBHP manufacturing are not specifically identified as hazardous wastes (40 CPR 261.31 and 40 CPR 261.32).

For TBHP, discarded off-specification product, spill cleanup residue and empty TBHP containers are not considered listed hazardous wastes (40 CFR 261.33). However, liquid waste material should be evaluated for the characteristic of ignitability (40 CFR 261.21) and reactivity (40 CFR 261.23).

Mixtures containing TBHP and/or TBHP destined for disposal which exhibit flash points less than 140°F are also considered ignitable hazardous waste (40 CFR 261.21). Mixtures also may exhibit the characteristic of reactivity due to the peroxide content of the waste (40 CFR 261.23).

Safe Drinking Water Act (SDWA)

The 1986 amendments to the Safe Drinking Water Act required the EPA to establish a priority list of contaminants which are known or anticipated to occur in public water systems and which "may" require regulation under the SDWA.

TBHP does not appear on the priority list of contaminants established by the EPA under this law (56 FR 1473, 1/14/91).

EPA's Safe Drinking Water hotline is +1-800-426-4791; in the Washington, D.C. area, the number is +1-202-382-5533.

Department of Transportation (DOT)

The Hazardous Materials Transportation Act of 1974 gave the Department of Transportation authority to regulate the transportation of hazardous materials in interstate commerce. DOT regulates such matters as classification, packaging and hazard communication (labeling). DOT also has established spill notification requirements. Regulations governing the transport of hazardous materials can be found at 49 CFR 172 and 173.

TBHP ≤72% mass concentration is classified as an Organic Peroxide, Type F, Liquid and is listed as hazard class 5.2. The identification number is UN 3109; packing group II, packing method OP8A. The hazard label required is "Organic Peroxide."

Shipments of solutions containing TBHP, "more than 90% with water" are forbidden. (The terminology in quotations is taken directly from DOT regulations (49 CFR 172.101).)

Occupational Safety & Health Administration (OSHA)

The following OSHA regulations apply to TBHP and, where appropriate, are described in more detail in various sections of this document.

29 CFR 1910.119, Appendix A-Highly Hazardous Chemicals; threshold quantity, 5,000 pounds

29 CFR 1910.1000, Subpart Z, Permissible Exposure Limits – No established standards.

29 CFR 1910.1200, Hazard Communication Standard

Superfund Amendments & Reauthorization Act (SARA)

Sections 302/304 of SARA detail emergency planning and emergency notification requirements under which facilities must report releases of extremely hazardous substances and CERCLA listed hazardous substances in excess of threshold planning quantities (TPQs) and reportable quantities (RQs). Facilities also must submit copies of MSDSs (Sections 311/312) and report emissions of toxic chemicals (Section 313).

TBHP is not listed as an extremely hazardous substance (Section 302; 40 CFR 355).

Lyondell has classified *T-Hydro* solution as an immediate (acute) health hazard, a fire hazard and reactive. (Sections 311/3 12).

TBHP is not listed as a toxic chemical (Section 313; 40 CFR 372).

Toxic Substances Control Act (TSCA)

The Toxic Substances Control Act gives EPA authority to regulate production, use, labeling, distribution and/or disposal of chemical substances and mixtures; to delay production; to ban or restrict manufacturing or marketing of existing or new chemical substances which present an unreasonable risk of injury to health or the environment; to require testing, recordkeeping and reporting. All manufacturers, importers, processors, distributors and disposers of chemical substances subject to the law are affected by its provisions and implementing regulations.

Section 8(b) Chemical Substances Inventory – TBHP is listed (Vol. 1., page 7, 1985 Edition). TBHP mixed with water, as in *T-Hydro* solution, does not change the inventory status.

Section 12(b) Export Notification (40 CFR 707, Subpart D) -TBHP is not listed.

Information on TSCA regulations can be obtained from the TSCA Assistance Office at EPA; +1-202-554-1404.

State

California

California Safe Drinking Water & Toxic Enforcement Act of 1986 (Prop. 65)
Prop. 65 prohibits discharge of chemicals "known to the State" to cause cancer or reproductive toxicity into drinking water supplies. An employer must notify all workers of possible exposure to a chemical. Facilities must also provide the state and local agencies with information regarding spills or releases of these chemicals to the environment.

TBHP is not listed.

Additional information about Prop. 65 can be obtained from the Health and Welfare Agency, State of California, Office of the Secretary, 1600 Ninth Street, Room 450, Sacramento, CA 95814 USA.

Connecticut

Connecticut Manufacturing Employer Hazardous Materials Notification Act
This law requires any manufacturing employer who "uses, produces or stores any hazardous material" to complete a survey. Hazardous materials are defined by reference to the federal Department of Transportation hazardous material table. Also included as hazardous materials are federal RCRA hazardous wastes and federal CERCLA hazardous substances.

TBHP is not listed.

The authority for these regulations is Connecticut Gen. Stat. Ann., Section 29-307a.

Florida

Florida Employee Right-to-Know Law
Provisions of this law require employers to give local fire departments a list of plant areas containing "toxic substances." Toxic substances are those recommended by the state's Toxic Substances Advisory Council.

TBHP is designated as a toxic substance.

The authority for this list is Florida Statutes Annotated, Section 442.101.

Illinois

Illinois Toxic Substances Disclosure to Employees Act
While some provisions of this law have been preempted, Illinois is enforcing certain requirements relative to MSDSs for defined toxic substances.

TBHP is not defined as a toxic substance.

The authority for this list is the Illinois Rev. Statute, Chapter 48, paragraph 1403. Questions may be directed to the Illinois Department of Labor, Toxic Substances Division, #1 W. Old State Capitol Plaza, Room 300, Springfield, IL. 62701 USA.

Appendices ...

Illinois Chemical Safety Act
Under this law, covered businesses using, storing or manufacturing defined chemical substances must have a written Chemical Safety Contingency Plan.

TBHP is not a covered substance.

The authority for these requirements is Illinois Rev. Statute, Chapter 111 1/2, Paragraph 951.

Louisiana

Louisiana Hazardous Materials Information, Development, Preparedness and Response Act
This law subjects covered facilities to "right-to-know" type requirements. Covered materials include federal SARA extremely hazardous substances and any hazardous chemicals as defined under the federal OSHA standard.

TBHP is not listed.

The authority for these regulations is Louisiana Admin. Code, Title 33, Part V, Section 10101.

Louisiana Spill Reporting
Louisiana has established reportable quantities (RQs) to determine the need for notification for unauthorized discharges. The notification requirements are in addition to notification requirements established under the Louisiana right-to-know requirements.

A RQ has not been established for TBHP.

These regulations are established under Louisiana Administrative Code, Title 33, Chapter 39.

Massachusetts

Massachusetts Right-to-Know Law
This law established reporting, labeling, MSDS, recordkeeping and related regulations for certain toxic or hazardous substances.

TBHP is listed on the Massachusetts Substance List subject to the Right-to-Know law.

The authority for this listing is Massachusetts General Laws Annotated, Chapter IIF and Title 105 Massachusetts Regulations Code, Section 670.000, Appendix A. Questions about the regulations can be directed to The Commonwealth of Massachusetts, Executive Office of Human Services, Department of Public Health, 150 Tremont Street, Boston, MA 02111 USA.

Massachusetts Spill Reporting
The Oil and Hazardous Materials List establishes reportable quantities (RQs) for substances which require reporting of unauthorized discharges.

TBHP is listed with a reportable quantity (RQ) of 10 pounds.

The authority for these regulations is Title 310 Massachusetts Regulations Code Sections 40.30 and 40.900 Appendix I, Department of Environmental Quality Engineering.

Michigan

Michigan Critical Materials
All Michigan businesses discharging wastewater must file certain required reports with the State. When wastewater discharge is required to be reported, the use or manufacture of designated "critical materials" also is required.

TBHP has not been designated as a critical material.

Authority for these requirements is contained in Michigan Act 293, PA 1972 and 1990 Michigan Public Acts 19, Section 6B; Michigan Administrative Code r.323.1231.

New Jersey

New Jersey Right-to-Know Act
This law requires facilities containing, distributing or handling a hazardous substance to complete a Right-to-Know survey. The survey provides workers and the community with information pertaining to the specific hazardous substance.

TBHP is listed on the New Jersey Hazardous Substance List. The New Jersey identification number is 1790; the New Jersey hazardous material number is 2094. TBHP also is classified as a New Jersey Special Hazard subject to restriction of trade secret claims. The Hazard Code is "MU."

Regulations are codified in the New Jersey Administrative Code, Title 8, Department of Health Chapter 59. Additional information about the New Jersey Hazardous Substance List is available from the New Jersey Department of Environmental Protection, Division of Environmental Quality, Bureau of Hazardous Substances Information, 401 E. State Street, CN 405, Trenton, N. J. 08625-0405 USA. Information about labeling regulations is available from the State of New Jersey Department of Health, CN 360, Trenton, NJ 08625-0360 USA.

New Jersey Spill Tax
New Jersey has established a list of substances defined as hazardous according to the Spill Compensation and Control Tax Act (N.J. Statutes, Annotated, Section 58: 10-23.11h).

TBHP is not a list substance.

The authority for the listing is N.J. Administrative Code, Section 7:1E-1.3.

New York

New York Bulk Storage Registration/Release Reporting
New York requires the registration of bulk storage tanks and notification of releases of listed hazardous substances under the Substances Hazardous or Acutely Hazardous to Public Health, Safety or the Environment Act and the Hazardous Substances Bulk Storage Act.

TBHP is not listed.

Authority is found in New York Compo Codes R and Regulations, Parts 595, 596 and 597.

Pennsylvania

Pennsylvania Worker & Community Right-to-Know Act
This law creates the state's system for communicating information about "hazardous substances." A hazardous substance is defined and listed by Pennsylvania through reference to a number of source lists. The state also classifies certain substances as "environmental hazards" and/or "special hazardous substances." The law established MSDS, labeling and recordkeeping requirements and requires facilities or distributors handling hazardous substances to complete a Hazardous Substance Survey Form (HSSF) annually, before April 1, for the previous calendar year.

TBHP is listed with a threshold of 1%.

The authority for these regulations is Pennsylvania Code, Title 34, Labor and Industry, Chapter 301-323.

Rhode Island

Rhode Island Hazardous Substance Right-to-Know Act
This law requires employers who use, transport, store or in any other manner expose employees to toxic or hazardous substances, as defined by the state, to provide notice, labeling and training.

TBHP is listed with the hazard code "F" = Flammable.

The authority for these regulations is Rhode Island General Laws, Section 28-21-1.

International

Australia

Australian Inventory of Chemical Substances
TBHP is listed.

Canada

Canadian Workplace Hazardous Materials Information System (WHMIS)
WHMIS established requirements for classifying hazardous substances that will be used in the workplace and for preparing MSDSs and container warning labels. Substances are classified by the manufacturer or importer to determine whether or not they are controlled products. When a product has been evaluated and is found to be a controlled product, the ingredient disclosure list (IDL) must be consulted and any ingredient present in a concentration greater than that specified must be disclosed on the MSDS.

Lyondell has classified *T-Hydro* solution as B3 (moderately combustible liquid); C (oxidizing material); DI (toxic material causing immediate and serious toxic effects; and E (corrosive material). TBHP is listed on the IDL as a substance which must be disclosed if the weight-to-weight concentration in the product is 1% or greater. The WHMIS number is 247.

Canadian Domestic Substances List
TBHP is listed.

European Economic Community

European Inventory of Existing Commercial Chemical Substances (EINECS)
TBHP is listed on EINECS. The EINECS number is 200 915 7. Listing on EINECS is accepted by certain other European countries which have adopted EINECS as their base inventory; i.e., Austria, Finland, Switzerland. However, other "registration" requirements may apply in those countries.

Japan

Japanese List of Existing & New Chemical Substances (ENCS)
TBHP is listed. The ENCS number is (2)-224.

Korea

Korean List of Existing Chemicals
TBHP is listed. The Korean listing number is 2-128.

Miscellaneous

National Fire Protection Association (NFPA) Hazard Rating
The NFPA ratings assign a numeric value to specific aspects of each hazard. For *T-Hydro* solution, these ratings are as follows:

Health: 3. Materials that, on short exposure, could cause serious temporary or residual injury, including those requiring protection from all bodily contact.

Flammability: 2. Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating may release vapor in sufficient quantities to produce hazardous atmospheres with air.

Reactivity: 2. Materials that readily undergo violent chemical change at elevated temperatures and pressures.

Additional information on the NFPA hazard rating system can be obtained from the National Fire Protection Association, Batterymarch Park, Quincy, MA, 02269 USA, (+1-800-344-3555).

Appendices ...

Appendix V. Glossary

ACC – American Chemistry Council

ACGIH – American Conference of Governmental Industrial Hygienists

AIHA – American Industrial Hygienists Association

ANSI – American National Standards Institute

API – American Petroleum Institute

ASME – American Society of Mechanical Engineers

ASTM – American Society for Testing and Materials

BOD – biochemical oxygen demand

Bonding – the connection of two or more conductive objects by means of a conductor (most commonly a wire or metal plate)

CAAA – Clean Air Act Amendments

CANUTEC – Canadian Transport Emergency Center

CERCLA – Comprehensive Environmental Response, Compensation and Liability Act

CEFIC – European Chemical Industry Council

CFR – Code of Federal Regulations

CGI – combustible gas indicators

CHEMTREC – Chemical Transportation Emergency Center

COD – chemical oxygen demand

Confined Space – an area that by design has limited openings for entry and exit. A confined space has unfavorable natural ventilation and is not intended for continuous worker occupancy.

CPC – chemical protective clothing

CPR – cardiopulmonary resuscitation

Deflagration – propagation of flame velocity is less than the speed of sound in the unreacted medium

Detonation – propagation of flame velocity is greater than the speed of sound in the unreacted medium

DOT – Department of Transportation

EPA – Environmental Protection Agency

Flash Point – The minimum temperature at which a liquid gives off vapor in sufficient concentrations to form an ignitable mixture with air near the surface of liquid.

GAC – granular activated carbon

Grounding – the connection of one or more conductive objects to the ground; a specific form of bonding. Grounding is also referred to as earthing.

HAP – hazardous air pollutant

HazWOpER – Hazardous Waste Operations and Emergency Response

IARC – International Agency for Research on Cancer

IATA – International Air Transport Association

ICAO – International Civil Aviation Organization

IDLH – immediately dangerous to life and health; the airborne concentration of a toxic material from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects

IM – intermodal

IMDG – International Maritime Dangerous Goods

IMO – International Maritime Organization

In vitro – isolated from the living organism and artificially maintained, as in a test tube

ISO – International Organization of Standardization

K_{OC} – soil adsorption/mobility; the partitioning of a chemical between soil or sediment, usually expressed as K (the concentration of a chemical in soil (µg/g) to that in water (µg/ml) or as K_{OC} (which is K divided by the organic carbon content of the soil or sediment)

LC_{50} – lethal concentration that will kill 50 percent of the test animals within specified time

LD_{50} – dose required to produce the death in 50 percent of the exposed species within a specified time

LEPC – local emergency planning committee

LFL – lower flammability limit

MACT – maximum achievable control technology

MSDS – material safety data sheet

MSHA – Mine Safety and Health Administration

NEC – National Electrical Code

NFPA – National Fire Protection Association

NIOSH – National Institute for Occupational Safety and Health

NPDES – National Pollutant Discharge Elimination System

OPPSD – Organic Peroxide Producers Safety Division

OSHA – Occupational Safety and Health Administration

Outage – amount by which a packaging falls short of being liquid full

OVA – organic vapor analyzer

PEL – permissible exposure level

POTW – publicly owned treatment works

PPE – personal protective equipment

ppm – parts per million

RCRA – Resource Conservation and Recovery Act

RQ – reportable quantity

SADT – self-accelerating decomposition temperature

SARA – Superfund Amendment and Reauthorization Act

SCBA – self-contained breathing apparatus

SIP – state implementation plan

SS – stainless steel

STEL – short-term exposure limit

TOC – total organic carbon

TPQ – threshold planning quantity - under the Superfund Amendments Reauthorization Act (SARA Title III) Section 302, 304, 311/312, a chemical specific quantity, in pounds, that triggers certain reporting requirements

TWA – time-weighted average

UL – Underwriters Laboratory

Ullage – amount by which a packaging falls short of being liquid full

UN – United Nations

Vapor Pressure – the pressure exerted by a volatile liquid while under defined equilibrium conditions. Vapor pressure is usually measured in millimeters of mercury (mm Hg).

VOC – volatile organic compound

VZ-STEL – Lyondell's established estimate of concentration of a substance to which nearly all individuals can be exposed for a time period and suffer no irreversible health effects

Inside back cover

LyondellBasell

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