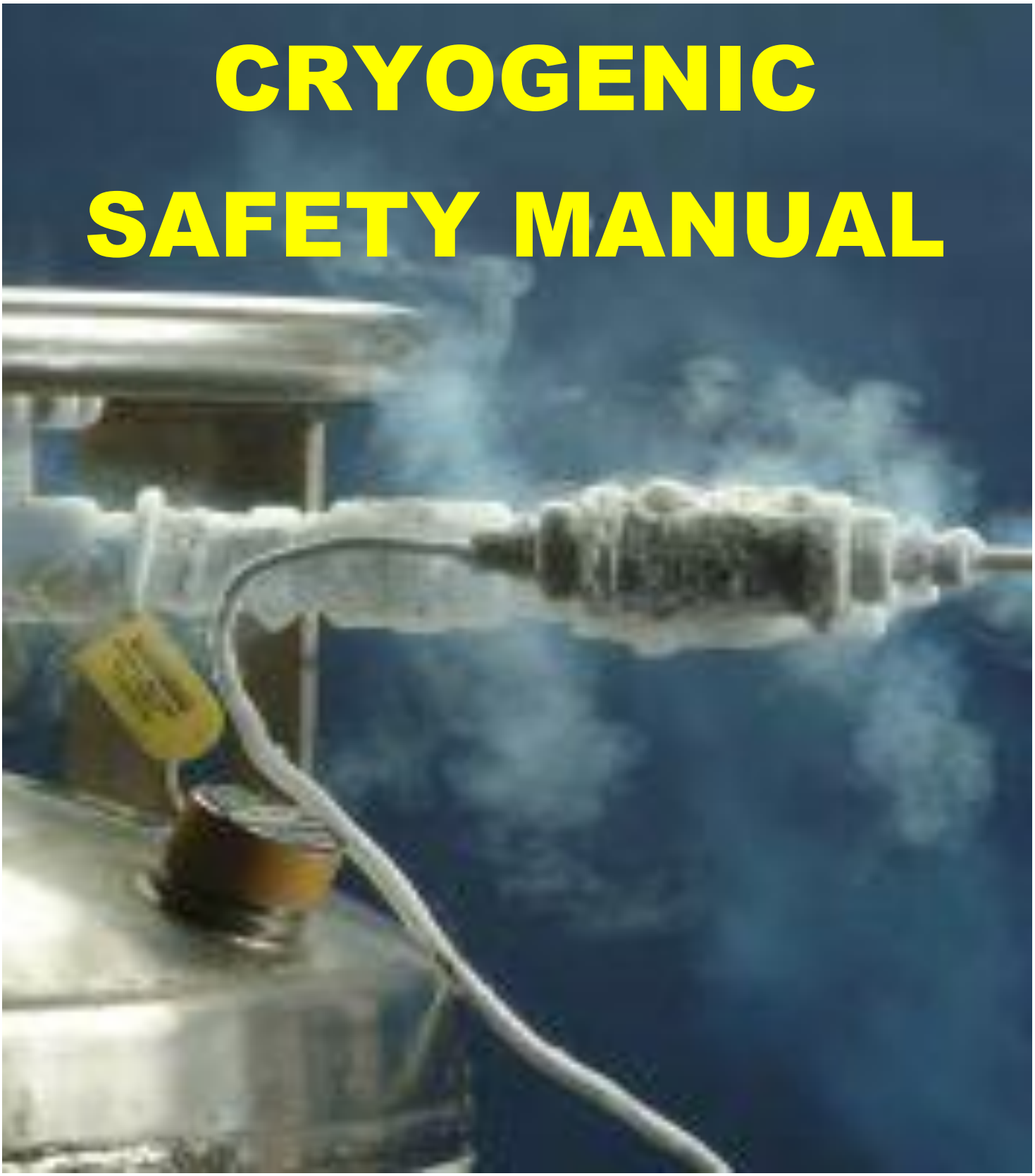
CRYOGENIC SAFETY MANUAL



PREFACE

We feel extremely pleased to roll out the Cryogenic Safety manual of Ellenbarrie Industrial Gases Limited. It discusses the safety measures to be taken while dealing with cryogenic products and the instruments that contain these.

The manual consists of the codes of conduct pertaining to safety rules, regulations and methods of safe working while dealing with cryogenic products. These directives are the standard operating norms pertinent to cryogenics and it shall be everyone's responsibility to abide by it.

In case of any clarification please feel free to refer to the chapter on "Variance from requirements" in the OH&S.

Please use this literature as a guide to ensure that our company remains at all times a safe place to work, for you and your colleagues. You are also welcome to share your valuable suggestions/ feedback with us, as there is always scope for the good to be better and the better, best.

Padam Kumar Agarwala

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Purpose

Industrial cryogenic air separation has some potential hazards that must be recognized and addressed. The hazards include electricity, gases under pressure, very low temperatures, the ability of Oxygen to accelerate combustion, and the asphyxiating properties of Nitrogen, Argon, and the rare gases. Besides, cryogenic air separation technology is not static; it has been progressing for many years and will continue to do so because of engineering development efforts by various agencies associated with the business. Consequently, plant process cycles, equipment, and operating conditions can be and are of varying kinds. This Cryogenic Safety Manual provides guidance on the safely dealing with cryogenic products and instruments.

Scope

All who may be associated or concerned with air separation plant operations in Ellenbarrie Industrial Gases Limited. It also serves to acquaint persons not versed in air separation technology with those factors considered important to safety.

This guide applies to safety in the operation, and maintenance of cryogenic air separation plants. Emphasis is placed on equipment and operational and maintenance features that are peculiar to cryogenic air separation processes.

Limitation

The Cryogenic Safety Manual is based on the experience of the persons and contributing agencies responsible for making it. Therefore, this publication has some generalized statements and recommendations on matters on which there may be diversity of opinion or practice.

Users should recognize that it is presented with the understanding that it cannot take the place of sound engineering judgment, training, competent supervision and experience. It does not constitute, and should not be construed to be, a code of federal rules or regulations.

The Cryogenic Safety Manual has some technical contents derived out of publications by Compressed Gas Association, European Industrial Gases Association and Asia Industrial Gases Association, however, there are editorial changes primarily in formatting, units used and spelling.

Further, as this publication is not intended as universal safe practices manual for specific design and safety features, it is also important to refer to the operating manuals of the equipment suppliers.

Cylinder filling facilities, which are an adjunct to some air separation plants, are not covered.

Disclaimer

All technical guidelines under Ellenbarrie Industrial Gases Limited's name, including codes of practice, safety procedures and any other technical information contained in this manual were obtained from sources and documents believed to be reliable and are based on technical information and experience currently available at the date of their issuance.

Where Ellenbarrie Industrial Gases Limited recommends reference to or use of its publications by its employees, such reference to or sue Ellenbarrie Industrial Gases Limited's publications by its employees or third parties are purely voluntary and not binding.

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Ellenbarrie Industrial Gases Limited's publications are subject to periodic review and users are cautioned to obtain the latest edition.

Reference

i. The Indian Explosives Act and Rules.
ii. The Motor Vehicle Act and Central Motor Vehicle Rules.
iii. The Factories Act and concerned Factory Rules.
iv. The Gas Cylinder Rules and the Static & Mobile Pressure Vessels Rules.
v. The Manufacturing, Storage & import of Hazardous Chemicals Rules.
vi. Indian Standard Codes of Practices.
vii. Compressed Gas Association standards.
viii. Asian Industrial Gases Association standards.
ix. European industrial Gases Association standards.

1. Definitions

1.1.1 Asphyxiation

To become unconscious or die from lack of Oxygen.

1.1.2 Casing

Outside walls of a cold box or cryogenic piping duct. The cross section can be circular or rectangular.

1.1.3 Deriming

Periodic preventive maintenance procedure where the process equipment is warmed up while simultaneously being swept with clean dry gas to remove any accumulated moisture, carbon dioxide, and atmospheric impurities. Also known as defrosting, de-icing, and thawing.

1.1.4 Double block and bleed

Piping/valve system used when two or more systems, or parts of systems, have to be completely isolated from each other; generally consists of two line-sized blocking valves and a small bleed valve located between the blocking valves.

1.1.5 Dry boiling

Condition occurring where Oxygen-enriched liquid enters cavities and sections of piping or equipment and is totally vaporized, thereby concentrating any less volatile impurities by extremely high factors.

1.1.6 Labyrinth

Type of gas seal that uses a series of teeth to minimize leakage of the process fluid.

1.1.7 Lockout

Condition where a device cannot be operated without a willful, conscious action to do so to ensure safety by positively isolating energy sources (pressure, electrical, temperature, and chemical). An example is when electricity is turned off and

cannot be regained without removing a protective device such as a padlock from the actuating device. Another example is a valve where the handle is removed and stored securely until it is safe to operate the valve. A locked-out device shall be immediately tagged out.

1.1.8 Tagout

Written notification that a piece of equipment is out of service and cannot be operated without clearance from authorized personnel.

1.1.9 Pressure relief device (PRD)

Self-contained device designed to protect a vessel or piping from achieving pressures higher or lower (vacuum) than its design to avoid failure of the piping or vessel; includes safety relief valves and rupture disks.

1.1.10 Safety instrumented system (SIS)

System used to implement one or more functions necessary to prevent a hazard from arising and/or to mitigate its consequences. A SIS is composed of any combination of sensors (e.g. example, pressure, flow, and temperature transmitters), logic solvers or control systems (e.g. programmable controllers, distributed control system), and final elements (e.g. control valves).

2. Cryogenic Hazards

2.1 Primary hazards

2.1.1 Potential to Cold contact burns

Liquid or low-temperature gas from any of the specified cryogenic substances will produce effects on the skin similar to a burn.

Note: *The potential for freezing by contact with the extreme cold of cryogens necessitates varying degrees of eye, hand and body protection. When a cryogenic fluid is spilled on a person, a thin gaseous layer apparently forms next to the skin. This layer protects tissue from freezing, provided the contact with the cryogen involves small quantities of liquid and brief exposures to dry skin. However, having moist skin, exposure to moving cryogens, or extended periods of time, can freeze tissue. The most likely cause of frostbite to the hands and body is contact with cold metal surfaces. Since there is no protective layer of gas formed, frostbite will occur almost instantaneously, especially when the skin is moist. The damage from this freezing (frostbite) occurs as the tissue thaws. Intense hypothermia (abnormal accumulation of blood) usually takes place. Additionally, a blood clot may form along with the accumulation of body fluids, which decreases the local circulation of blood.*

2.1.2 Potential to Asphyxiation

Degrees of asphyxia will occur when the Oxygen content of the working environment is less than 20.9% by volume. Effects from Oxygen deficiency become noticeable at levels below 18% and sudden death may occur at 6% Oxygen content by volume. This decrease in Oxygen content can be caused by a failure/leak of the cryogenic vessel or transfer line and subsequent vaporization of the cryogen. Respiratory problems caused by the inhalation of cold gas. Short-term exposure generally causes discomfort; however, prolonged inhalation can result in effects leading to serious illness such as pulmonary edema or pneumonia.

Note: *When liquid cryogens are expelled into the atmosphere at room temperature, they evaporate and expand on the order of 700 to 800 times their liquid volume. Even small amounts of liquid can displace large amounts of Oxygen gas and decrease the Oxygen content of the atmosphere below a safe level with a possibility of asphyxiation. Whenever possible, handling of cryogenic fluids where release into the atmosphere is possible shall be done in open, well ventilated areas. When there is the possibility of an* ***Oxygen deficiency hazard*** *(****ODH****), Oxygen monitors will be installed. If such a monitor triggers an ODH alarm, personnel are to leave the area immediately.*

Effect Thresholds for Exposure (Healthy Individuals at Sea Level) to Reduced Oxygen

Volume % Oxygen	Effect
17 %	Night vision reduced, Increased breathing volume, Accelerated heartbeat
16 %	Dizziness, Reaction time for novel tasks doubled
15 %	Impaired attention, Impaired judgment, Impaired coordination, Intermittent breathing, Rapid fatigue, Loss of muscle control
12 %	Very faulty judgment, Very poor muscular coordination, Loss of consciousness, Permanent brain damage
10 %	Inability to move, Nausea, Vomiting
6 %	Spasmatic breathing, Convulsive movements, Death in 5-8 minutes

2.1.3 Potential to Explosion - Pressure

Heat flux into the cryogen from the environment will vaporize the liquid and potentially cause pressure buildup in cryogenic containment vessels and transfer lines. Liquid entrapment may occur within two control valves located in a line. Heat flux into the cryogen is unavoidable regardless of the quality of the insulation provided. Since cryogenic fluids have small latent heats and expand 700 to 800 times to room temperature, even a small heat input can create large pressure increases.

2.1.4 Potential to Explosion - Chemical

Cryogenic fluids with a boiling point below that of liquid Oxygen are able to condense Oxygen from the atmosphere. Repeated replenishment of the system can thereby cause Oxygen to accumulate as an unwanted contaminant. Similar Oxygen enrichment may occur where condensed air accumulates on the exterior of cryogenic piping. Violent reactions, e.g. rapid combustion or explosion, may occur if the materials which make contact with the Oxygen are combustible.

Note: *Liquid Oxygen liquefies at a higher temperature than liquid Helium or Nitrogen. Consequently, liquid Oxygen can condense on the exterior of cryogenic containers or transfer lines. An explosive situation may result if this Oxygen-rich liquid is allowed to soak insulating or other materials which are not compatible with Oxygen.*

2.2 Secondary hazard

2.2.1 Potential for Noise Induced Hearing Loss (NIHL)

The noise produced by compressors and their drives, by expansion turbines, by high velocity gases through their pipes and valves and by pressure relief valves, vents, or bypasses shall be considered from the standpoint of potential hazard of hearing damage to employees.

2.2.2 Potential for Reduced Vision

Hazardous concentrations and/or reduced visibility can also occur at considerable distances from the point of discharge, depending on topography and weather conditions. Cold gases are heavier than air, tend to settle and flow to low levels, and can create a dense water vapour fog.

3 Hazard control measures

3.1 General precautions

a) Adequate pressure relief shall be provided to all parts of a system to permit routine out-gassing and prevent explosion due to heat flux.

b) Dewar containers shall be moved carefully. Sloshing liquid into warmer regions of the container can cause sharp pressure rises.

c) Pressure relief devices shall be provided on each and every part of a cryogenic system. Pressure relief valves shall be installed in all vessels and piping which contain cryogenic fluids or might under some failure conditions contain cryogenic fluids (e.g. cryostat vacuum vessels). Precisely a pressure relief device shall be placed between two control valves in each and every system. Satisfactory operation of these devices shall be checked periodically and may not be defeated or modified at any time.
Note: *Failure scenarios might include (1) Failure of a cryostat insulating vacuum to atmosphere (2) Failure of a cryostat insulating vacuum to the contained cryogen (3) Flow of cryogen from a connected system due to a valve failure or operator error and (4) Trapping of cryogenic fluid due to valve failure or operator error.*

d) Vents shall be protected against icing and plugging. When all the vents are closed, enough gas can boil off in a short time to cause an explosion. Vents shall be maintained open at all times.

e) Some materials may become brittle at low temperature and fail in the case of overpressure or mechanical shock. Only suitable materials may be used to store or transfer liquid cryogens.

f) Some oils can form an explosive mixture when combined with liquid Oxygen. Surfaces where there exists a possibility of liquid Oxygen condensation shall be thoroughly cleaned and degreased.

g) In areas where high Oxygen concentrations can be expected, electrical equipment with open or unprotected make-and-break contacts shall be avoided.

h) Noise abatement and use of personnel ear protection shall be used. Periodic audiometric checks of personnel might be necessary depending on exposure times and noise levels.

i) Personnel shall be protected from hot lines (> 60°C) by either insulating the line or preventing access while the line is hot.

j) Acetylene cylinders shall not be stored or used near the air intake of an operating Main Air Compressor.

k) Air quality can have an impact on the air separation plant. Analysis of the intake air might be necessary where the likelihood of atmospheric air contamination is high. Analysis methods can vary from periodic determination of total hydrocarbon concentrations to continuous analysis for both the identification and concentration level of each individual hydrocarbon.

3.2 Oxygen Compatibility

Note: *"Oxygen compatible" and "Oxygen safe" are terms used to refer to materials that are not harmed or impeded by the presence of Oxygen. Oxygen compatible refers to the materials comprising the equipment which is intended for use with pure Oxygen. It implies that the material is suitable for use with pure Oxygen. Describing a material as Oxygen compatible does not mean that the material is ready for use with pure Oxygen, merely that the material itself is suitable, if properly prepared, for use with pure Oxygen.*

a) While common construction materials such as carbon steel, Aluminium and copper are used extensively in fabricating air separation plant components, it is important to remember that the use of these materials is selective and shall be compatible with the operating conditions.

b) Common carbon steel shall not used at temperatures less than -29°C because at these temperatures it loses its ductility, becomes brittle and is subject to failure under impact conditions. Safer options at these temperatures are metals like austenitic steel, Aluminium, Copper, Monel, Brass, Silicon Copper and 9% Nickel. STAINLESS STEEL < 100 KG/CM2

c) Non metallic materials such as gasket, valve packing, insulation and lubricants shall be carefully checked to determine if they can be used for a particular application. All factors associated with their use such as temperature, pressure, etc., shall be considered in deciding if a material can be used without decreasing the design safety integrity of an Oxygen system.

d) Insulation for LOX lines or other lines that might come in contact with LOX shall be non combustible to protect against a possible reaction in the event of a liquid leak. Insulation that is non-combustible in air shall be given preference. Binders, sealing compounds and vapor barriers that is Oxygen compatible in nature shall be provided in lines carrying Oxygen or Oxygen enriched gases or liquids. Process lines operating at temperatures colder than the liquefaction point of air shall be insulated with Oxygen compatible material.

Note: *In some cases, the materials may appear to be compatible but the shape and configuration of components may be important in minimizing the fire risk. Only components approved by the manufacturer shall be used when maintaining Oxygen equipment.*

3.3 Operational requirements

3.3.1 Training of Cryogenic Personnel

All personnel working with cryogenic fluids shall be made thoroughly familiar with the hazards involved. They shall also be made familiar with all emergency measures that might be required in the event of an incident. Employees who have not worked with cryogenic fluids and systems shall be trained on the job by experienced employees until thoroughly familiar with safe methods of operation.

3.3.1.1 The training shall address:

a) The physical, chemical and physiological hazards associated with cryogenic fluids.

b) The proper handling procedures for cryogens and cryogenic containers.

c) The emergency procedures required in case of an incident.

d) The reporting procedures in case of an incident.

3.3.1.2 Additionally, each employee shall receive training by the responsible personnel on the specific cryogenic equipment or system he is expected to use. This shall cover:

a) Description of the equipment.

b) Operating procedures.

c) Maintenance schedule and procedures.

d) Specific hazards.

e) Reporting of incidents.

3.3.2 Cryogen Handling

3.3.2.1 Protective Clothing

Whenever handling or transfer of cryogenic fluids might result in exposure to the cold liquid, boil-off gas, or surface, protective clothing shall be worn. The term “protective clothing” shall include the following:

a) Face shield or safety goggles

b) Safety gloves (cryogenic)

c) Footwear should not have nails or exposed metallic protectors that could cause sparking.

d) Long-sleeved shirts, lab coats, aprons. Clothing shall be of flame retardant materials and shall have minimum nap. All clothing should be clean and oil-free.

e) Leather apron

f) Eye protection is required at all times when working with cryogenic fluids. When pouring a cryogen, working with a wide mouth Dewar or around the exhaust of cold boil-off gas, a full face shield shall be used.

g) Hand protection is required to guard against the hazard of touching cold surfaces. Loose insulating gloves shall be used.

h) If individuals inadvertently enter or are exposed to an Oxygen enriched atmosphere, they shall leave as quickly as possible. After leaving, (a) Avoid sources of ignition; (b) Do not smoke for at least half an hour; (c) Open the clothing and slap it to disperse trapped vapors.

3.4 Maintenance and Inspection

a) Cryogenic systems and equipment shall be inspected and maintained on a regular basis by qualified personnel to ensure safety. The schedule and nature of the maintenance shall be included in the operating procedures manual. The inspection and maintenance shall be documented.

b) Every cryogenic system or equipment shall be inspected by qualified personnel before being put into operation for the first time or after modification. This inspection (called a Pre-startup Safety Review-PSSR) by qualified personnel shall also take place after an unusual incident which might affect the integrity and safety of a piece of cryogenic equipment.

Note: *One shall note that these requirements for inspection, maintenance, calibration and documentation extend to the monitoring systems for Oxygen deficiency.*

3.4.1 Before starting maintenance work

a) Ensure that ventilation is adequate.

b) Check that fire extinguishers are in good condition and ready for use.

c) Check that escape routes are clear.

3.4.2 Lubricants

Lubricants shall be avoided. Only lubricants that are made for Oxygen service, and are specified by the equipment supplier, shall be used.

3.4.3 Tape

Tapes shall be avoided. Only tape that is marked as suitable for Oxygen service, and is specified by the equipment supplier, shall be used.

3.4.4 Cleanliness

a) Keep Oxygen equipment clean. Contamination by particulate matter, dust, sand, oils, greases or general atmospheric debris is a potential fire hazard. Portable equipment is particularly susceptible to contamination, and precautions shall be taken to keep it clean.

b) Use clean hands or gloves when assembling Oxygen equipment, e.g. attaching the pressure regulator, making connections.

c) Wear suitable clean clothing, free from oil and easily combustible contaminants.

3.4.5 Hot repair

Consists of at least one of the following:

a) Use of a tool of high heat (for example, a torch) that can be a safety hazard by itself

b) Repairs made to a device that is in operation, or

c) Repairs made in hazardous area when special precautions are necessary before, during, or after the work are performed.

d) All hot repairs require care, safety supervision, and specific. Use of a checklist or hazardous work permit is recommended.

3.4.6 Cleaning

The ability to clean, and the method(s) to be used shall be considered in the design and manufacture of equipment and components for Oxygen service.
Where possible, components shall not have recesses that cannot be directly inspected for cleanliness.
Preferably, components shall be cleaned prior to assembly, and cleanliness maintained throughout assembly and testing.
Where this is not possible, trial assemblies shall be dismantled after cleaning and components examined for cleanliness.

a) Only approved lubricants shall be used in the assembly of components.

b) All material used in or interconnected with Oxygen systems shall be suitable cleaned before the system is put into service. Mill scale, rust, dirt, weld slag, oils, greases and other organic material shall be removed.

c) Fabrication and repairing procedures shall be controlled to minimize presence of such contaminants and thereby simplifying the final cleaning procedures.
This prevents foreign materials from reaching other parts of the ASU.

d) Cryogenic process equipment and piping that handle inert fluids shall be cleaned for Oxygen service.
Note: *An improperly cleaned line in Oxygen service can be hazardous because particulates, greases and other organic material can ignite a fire.*

Note*: You shall never use Oxygen for:*

1. *Driving pneumatic tools;*

2. *Inflating vehicle tyres;*
3. *Pressurizing and purging systems;*
4. *Replacing air or inert gas;*
5. *Starting diesel engines.*

Oxygen shall not be introduced into any equipment unless it has been designed for Oxygen service by competent people with specialist knowledge.

Note: *Many serious accidents have been caused by using Oxygen instead of other gases such as air, compressed air or Nitrogen. Oxygen can react explosively with oils and greases. People have been injured or even killed when pumps, engines, tyres and pressure equipment have been blown apart by the explosion. Oxygen can also cause other materials to ignite spontaneously. The resulting fire can cause damage to equipment and injury to people.*

4.0 Cold box hazards

4.1 Hazard consideration before entering a Cold Box.

a) Oxygen-enriched or Oxygen-deficient atmosphere either within the cold box or within the piping or vessels to be worked on shall be addressed by using confined space entry procedures.

b) Working at heights shall be addressed if work is to be performed significantly above existing floor level.

c) Trapped or elevated pressure, cryogenic liquids, and the cold box insulation shall be considered and dealt with.

d) Cracks in the foundation of a cold box should be attended to immediately.

4.2 Prerequisites to any work within the cold box

a) Draining of all liquids.

b) Deriming.

c) Positively isolating product liquid and gas lines with double blocking and bleeding of valves or blinding of flanges.

d) Positively isolating the casing purge gas with double blocking and bleeding of valves or blinding of flanges.

e) Depressurizing.

f) Purging with dry air followed by atmosphere monitoring.

g) If entry into the cold box without complete warming (This is an extremely hazardous activity) is unavoidable careful and complete consideration shall be given to the extra hazards of the cold box environment such as limited visibility, cryogenic temperatures, and Oxygen-enriched or Oxygen-deficient atmospheres.

h) Part or all of the cold box insulation shall be removed before the start of any work within the casing. The extent of insulation removal depends on the type of insulation used in the cold box and the location of the equipment to be worked on. Cold boxes insulated with powdered insulation such as perlite, vermiculite, and microcel should be completely emptied.

i) Cold boxes insulated with wool-type insulation can be entered for local repairs by tunneling through the wool after thorough purging of insulation space with air. These tunnels shall be adequately shored to guard against insulation collapse and positively ventilated with fresh air.

j) Personnel handling the rock wool shall always wear appropriate protective clothing, gloves, and goggles to avoid skin and eye irritation. This insulation also shall be checked periodically for moisture. If moist, it should be discarded and replaced with fresh rock wool.

k) Hazards of working in Oxygen-enriched or Oxygen-deficient atmospheres Strict precautions shall be taken before entering any confined spaces such as cold box casings, vessels, storage tanks, ducts, or other closed or poorly ventilated areas with potentially Oxygen-enriched or Oxygen deficient atmospheres, as serious injuries or fatalities can occur. Atmospheres within all such confined spaces shall be checked and unprotected personnel prohibited from entering an atmosphere that does not fall within the range of 19.5% to 23.5% Oxygen.

Note: *Entering an area with an Oxygen-enriched or Oxygen-deficient atmosphere without following proper procedures may result in serious* injury or death.

5. Loading of Vacuum Insulated Transportation Tanker (VITT)

5.1 Definitions

a) **Parts per million (ppm):** Unit of concentration in parts per million by volume.

b) **Production site:** Operating site responsible for the production of the cryogenic liquids. Bulk logistics Operating unit responsible for the transport and delivery of cryogenic liquids organization: to customers via road tankers or trailer tankers.

c) **Product:** Liquid Nitrogen (LIN), liquid Oxygen (LOX), or liquid Argon (LAR).

d) **Vehicle:** The delivery tank truck or semi-trailer tanker.

e) **Operator:** Person in charge of loading the tanker at production facility. (Depending on location, this could be a driver, production facility operator, or dedicated tanker filler).

f) **Tow Away:** The flexible hose(s) which connect a bulk delivery vehicle used to transfer a product – gas or liquid – to/from a storage tank or utilization point may produce a serious accident should the driver or operator forget to disconnect before moving the vehicle when transfer is completed. The primary cause of these accidents is always due to human negligence or abuse of the equipment.

5.2 General Principles

Note: *The loading and unloading of cryogenic liquids are activities which could give rise to significant safety risks. It is therefore necessary that the proper safety procedures be set up and followed.*

As a minimum, operators who handle cryogenic liquids shall be equipped with the following Personal Protective Equipment (PPE):

1. Safety shoes.
2. Full length trousers.
3. Long sleeve shirt.
4. Leather apron.
5. Gloves suitable for use with cryogenic liquids.
6. Eye protection.
7. The preferred fabric for the clothes is pure cotton or flame retardant materials.

5.3 Checking for contamination

Note: *A tanker that is doing routine deliveries may only be exposed to atmospheric air contamination and the quality control for loading such a vehicle shall consist of checking:*

a) The Oxygen content in liquid Oxygen.

b) The concentration of trace Oxygen in liquid Nitrogen.

c) The concentration of trace Oxygen and, if possible, Nitrogen in liquid Argon.

d) Contamination due to water.

e) All delivery vehicles shall be fitted with a check valve on the transfer line to the customer storage to prevent any backflow contamination.

f) Any product conversion of transportable or static storage vessels shall only be carried out by qualified personnel following documented procedures.

g) A checklist for the vehicle and the tank shall be filled up and the deficiencies shall be attended to.

5.3.1 Back Contamination from the Consumer's Process

For protection against contamination it is essential that equipment shall be installed within the consumer's fixed supply system that will prevent such an occurrence, e.g. installation of non-return valves.
Note: *The non-return valve should be adequately sized and specified to accommodate the pressure range that the container, and/or the consumer's supply system, will operate within.*

5.4 Transfer hose and water

Note: *Since water vapor solidifies into crystals in a cryogenic liquid, it cannot be detected in the vapor given off by the cryogenic liquid. Therefore, it is not possible to obtain a representative sample of the water content in a cryogenic liquid at the production site by an analysis of the gas in the transfer hose. Instead, it is more important to implement measures to prevent the condensation of water in the transfer hose. The way in which loading hoses are isolated from the air when they are not in use, is important.*

a) All possible efforts shall be made to prevent the transfer of any ice in the transfer hose into the tanker of a vehicle being filled.

b) As an additional precaution, especially if the hose purge system is not installed, it is recommended that the hose be purged by backflow in the direction of the transfer of the liquid. No attempt shall be made to shift the hose during the transfer operation, to prevent fragments of ice from being loosened and carried off by the flow of the liquid.
Note: *This has the effect of driving back the water which is upstream in the hose before it turns to ice at the bottom of the hose.*

c) Connections shall be adequately affixed to transportable and static storage vessels as well as transfer hoses such that they cannot be easily removed.

d) Cautions shall be taken to ensure that transfer hoses cannot be misused and result in the transfer of incorrect product. Transfer hoses shall be fitted with the correct connections.

Note:

a) Contamination during transport may only result from one of the three main components of air: Nitrogen, Oxygen and water.

b) The customer's storage, because of its cryogenic temperature, acts as a cold trap to arrest any contamination that may arise from a backflow from the customer network to the storage. It is therefore assumed that a delivery vehicle is never contaminated by flow back from a customer's network, as long as deliveries are exclusively made into cryogenic storage. However, a tanker which has made a delivery to a point in the customer's network other than the cryogenic storage may run the risk of being contaminated. The tanker will have to be completely derimed or thawed (for e.g. when contaminated with water or CO_2) and purged. The tanker shall be analyzed for these impurities before it can be put back into service.

c) *The hose is the weak link in the logistical chain as regards the water problem. Every time the hose comes into contact with the air while still cold, the air in the hose gives off water and the corrugated stainless steel internal surface traps the moisture.*

5.5 Production responsibilities at loading point

Note: *The production site typically includes the following equipment downstream from the storage. They are, transfer pump, purging circuit, pressure sensors, analyzing device which can be hooked up either to the storage or the purging circuit, and transfer hose.*

a) The production site shall be responsible for defining the operating guidelines for and maintaining the transfer hose and its inlet and outlet connections (such as hose rack, hose cap and continuous purge flow).

b) The production site shall also make sure that the maximum pump discharge pressure is compatible with the service pressure of the equipment located downstream: pipes, valves, measurement and regulation devices, transfer hoses, and the vehicle tanker. If there is any incompatibility, one or more safety devices shall be fitted to protect the weaker elements.

c) Cryogenics tankers shall never be overfilled. Thermal expansion of tank liquid may cause the tank to rupture if it is filled exceeding the limit that has been fixed to contain the vapour.

Note:

a) A weighbridge is the only weighing device that meets the above criteria. It is equipped to issue drivers with a docket showing the weight loaded and the total vehicle weight before departure. Since it includes the date and time of loading, and the product and vehicle references, this document is one of the elements supporting traceability.

b) The Vehicle full tri-cock valve is not exactly enough to be used as a measure. It is an indicator which depends on the density of the liquid and the angle of inclination of the road tanker. It is also unsuitable for measuring quantities loaded at the production site, since vehicles arriving in the loading point are never completely empty.

c) A flow meter at the loading point is not suitable and cannot be used to determine vehicle loading completion if the original load of the vehicle is unknown.

5.6 Vehicle checks before loading

5.6.1 On arriving at the loading station, the driver shall:

a) Chock the wheels of the vehicle.

b) Put on the personal protection equipment.

c) Identify the working area (where unauthorized persons are not allowed).

d) Ensure that the product to be loaded is correct as marked on both storage and tanker.

e) Ensure that the tanker is adequately equipped with over-pressurization protection.

f) Ensure that the fill connections are suitable for the product to be filled.

g) Ensure that the tanker is effectively grounded.

5.6.2 The driver or operator can then proceed with the following operations:

a) Connect the vehicle to the loading point with the loading hose.

b) Purge the hose, allowing the purge of the residual content from the vehicle to the loading station. Note that the purge flow rate does not need to be high. A laminar flow speed, at a low rate of flow in the hose, is sufficient.
Note: *The effectiveness of a purge is not necessarily proportional to the noise it makes.*

c) Ensure the quality of the residual product in the tanker is at an acceptable level.
Note: *A residual positive pressure would show that the tanker has not been completely emptied and exposed to the air since the last loading. Generally a threshold of 0.2 to 0.3 bars gauge is sufficient.*

d) If analysis on loading is not possible purge the hose in the same way, at a low flow rate and from the vehicle to the loading station, for at least 5 minutes. This procedure will help to prevent any contamination on loading, but in the absence of definite information about the quality of the residual product in the vehicle's tanker before loading, the quality of the product loaded cannot be assured.

5.7 Loading operation

a) The driver shall monitor the pressure in the tanker and adjust the fill valves to obtain the desired pressure.
Note: *Normally the product is filled via the top fill line into the gas space of the vehicle tank. This is to re-condense the gas and lower the pressure in the tanker. Because of this, venting a tanker being filled is unnecessary as this will result in product losses which can be avoided. In order to maintain a minimum pressure in the tanker (normally more than 0.3 bar gauge), the driver or operator may divert the flow between the top and bottom fill valves.*

b) There is no need to open the full tri-cock valve before the tank level reaches 70% of the full load. As soon as the liquid issues from the full tri-cock valve or the loading scale indicates that the trailer is full, the driver or operator shall shut

off the transfer, close the appropriate valves and purge the transfer line as completely as possible before disconnecting the hose and replacing it on its stand.

c) Purging of the remaining liquid in the line shall be into the tanker and not to the loading station.

5.8 Completion of loading

a) The loaded vehicle shall be weighed before it is released for delivery.

b) If the weight of the loaded vehicle exceeds the total authorized loaded weight, the excess weight shall be purged. The production plant shall have the necessary equipment for purging vehicles of excess weight in total safety, using a clearly defined operating procedure.

c) The vehicle shall be weighed again before it proceeds with the delivery.

d) The driver shall carry out a further check of the vehicle, with special attention to pressure and valves closure. In particular, the main liquid outlet valve at the bottom of the tanker and the rear door shall be closed during transport. The inlet valve to the differential pressure gauge shall be kept closed.

e) All storage tanks and transport tankers shall be clearly identified with the names and types of products stored. The driver or operator shall ensure that the transport tanker is loaded with the correct product from the correct storage tank.

f) The driver can set off only once the documentation and checks are complete. The driver shall carry a copy of all the relevant legal documents pertaining to the transportation tanks.

5.9 Connectors and adaptors

a) The hose connector which connects the tanker to the storage shall be designed for the specific product type.

b) The use of adaptors shall be limited and if possible eliminated.

c) Connections shall be adequately identified for the product service.

5.10 Unloading procedure at delivery point

5.10.1 Quality criteria

a) The design of the delivery equipment and the operational procedures for delivery shall assure the absence of any measurable pollution during delivery, and no further analyses shall be required.

b) The quality of the product delivered into the customer's storage shall be identical to that measured in the production storage, within the sensitivity limit of the analyzers.

5.10.2 Preparation before unloading

On reaching the delivery point and before starting the unloading operation, the driver shall do the following:

a) Once the vehicle is parked, chock the wheels of the vehicle.

b) Put on the personal protection equipment, making sure that they conform to the safety equipment rules.

c) Verify that the delivery point complies with operational standards.

d) Verify that nothing abnormal has occurred since the last delivery: there is no leakage, the pressure and level gauges are in working order, there is no functional anomaly at the customer delivery point.

e) Verify that the relief valves and bursting disks of the overpressure safety device are in good condition.

f) If the delivery will be made using a pump driven by an electrical motor, confirm that the socket and the earthing of the delivery point are effective and in good condition.

g) Verify that the discharge pressure of the pumping unit of the vehicle is suitable for the maximum service pressure of the storage to be filled. Even though there is a safety system for preventing overpressure at the end of filling, the driver shall take measures to prevent such an incident.

h) After connecting the transfer hose between the storage and the vehicle, it is purged in the direction from the storage to the vehicle by first opening the hose purge valve of the vehicle, then opening very slightly the valve connecting the gas phase of the storage with the hose.

i) Lastly, note the pressure and the level in the storage before the delivery, in order to determine the operating rate of the pump to be used and to estimate the quantity to be transferred.

5.11 Unloading operation

a) Adjust the pressure in the tanker of the vehicle to ensure under-cooling of the liquid and a sufficient suction pressure at the pump.

b) If the vehicle does not have a pump, adjust the pressure of the tank on the vehicle to 2 or 3 bars above the pressure of the storage to allow the transfer to take place.

c) Start the pump. For pumps with an electric motor, it is recommended that the vehicle be equipped with an automatic system to check the order of phases to prevent the risk of running the pump in reverse. At a minimum, the installation of a manual phase switch is required.

d) When the pump is primed and its by-pass is closed, adjust the pump discharge valve to set the desired pressure and flow. Then adjust the distribution of the flow between the liquid phase and the gaseous phase in the storage in order to maintain the pressure at the level required by the customer.

e) During filling, the pressures of the vehicle tank and the storage of the customer shall be constantly monitored and adjusted. It is absolutely essential that the driver remain at the controls.

5.12 Completion of unloading

On completing the unloading, the driver shall do the following:

a) Disconnect the hose from the storage and return it to its place. The pressure regulator of the storage is put back in service. Close the filling valves ensure no safety valves are blowing or about to open, and ensure the filling inlet connector is closed and sealed by a plug or a solid flange.

b) Carefully close the enclosure around the storage, if there is one.

c) On the vehicle, verify the pressure, ensure the valves are closed, especially the pressure building valve and the main liquid outlet valve in the tanker bottom, which have to be closed during transport. Also ensure that the rear door of the vehicle is properly closed.

6. Conversion of Cryogenic Transport Tanks

Note: *When converting a cryogenic transport tank, which has previously been used for liquid Nitrogen (LIN) or liquid Argon (LAR), to liquid Oxygen (LOX), contaminants which are harmless in the inert gas may constitute an explosion risk in Oxygen. Liquid Oxygen can form easily ignitable mixtures with flammable materials which can rapidly give rise to explosive processes. A spark or the energy from an impact or friction can initiate the ignition of a mixture of liquid Oxygen and finely divided fuel and cause it to detonate, even at cryogenic temperatures.*

Caution!! : *It is recommended that cryogenic transport tanks in any other service are not converted into Oxygen service.*

6.1 Conditions that demand conversion of tanks to Oxygen service

Caution!! : *The liquid must be analyzed for hydrocarbons before transfer and certified to be acceptable.*

(1) Direct delivery to a cryogenic storage tank or process without the use of non-return valves. (2) Collection of liquid from a cryogenic storage tank without hydrocarbon analysis (or when liquid is certified as unacceptable).

6.2 Definitions

1. **Cryogenic Transport Tank:** A cryogenic transport tank means, a road tanker, i.e. a tank vehicle, a rail car, i.e. a tank wagon, a tank container and a portable tank.
2. **Oxygen Service:** Oxygen service includes any refrigerated liquefied gas that is classified as oxidizing, such as Oxygen, nitrous oxide, liquid air and their mixtures.
3. **Storage tank:** Storage tank means a tank for storage of refrigerated liquid gases and liquefied gases.
4. **Contamination:** Any combustible contaminant may react violently in Oxygen service and must be avoided. In this case contamination means only hydrocarbon compounds.
5. **Sources of contamination:** (1) Back contamination from a process, (2) Contamination from liquid taken from customer tank, (3) A high or a low volatile component, (4) Any activity that is not considered as normal service for tanker.
6. **Conversion to Oxygen service:** The procedure by which a tank is prepared to be used in Oxygen service or in service with an oxidizing gas, such as nitrous oxide after it has been in service with another gas.

6.3 Safe conversion of a cryogenic transport tank into Oxygen service

1. The cryogenic transport tank shall always be warmed up and purged with hydrocarbon-free Nitrogen before being filled with Oxygen.

2. Operators shall ensure that the cryogenic transport tank is suitable for the intended gas service.
3. The accessories and all the equipment shall be specifically checked to confirm their suitability for the intended service.
4. The conversion shall follow a written procedure approved by the Plant Manager.
5. Low-lying parts shall be checked for contamination.
6. Documentation of the change and the records shall be maintained for audit.

6.4 Warming and purging (Measures to prevent hydrocarbon contamination)

a) A non-return valve shall be fitted between the cryogenic transport tank and the storage tank.

b) All lines from a cryogenic transport tank connected directly to any process shall be fitted with a non-return valve.

c) In general products shall not be accepted by a cryogenic transport tank from any storage tank that is not connected with the production plant of the product.
Note: *Where accepting product is necessary the returned product shall be analyzed for hydrocarbons and an analysis certificate confirming acceptability issued and recorded prior to transfer.*

d) In application with a potentially high risk of contamination for the customer process, block and bleed valves and a non-return valve should be considered.
Note: *A non-return valve after the vaporizer supplying the customer process is only one link in a number of precautionary measures to avoid hazardous mixing of products.*

Note: *An exception to warming and purging is where cryogenic transport tanks are filled only from production plant storage and do not transfer product directly into customer tanks or systems (e.g. tank wagons). The risk of back contamination is negligible in this case and these tanks can be converted in the cold state i.e. without warming up and purging. In this case the approval by nominated authority and documentation of the change are still required. For conversion of cryogenic transport tanks in other service, then in addition to the above steps for normal service conversion there is a requirement for hydrocarbon analysis after the warming cycle.*

6.5 Outline procedure for safe conversion of a cryogenic transport tank into Oxygen service

a) The presence of non-volatile hydrocarbons in the low point of the system shall be checked for, for example the inlet of the evaporator coil or pump suction filter.
Note: *It is believed that hydrocarbons accumulate at these low points if they are introduced during the service life of the cryogenic transport tank.*

b) If the result is satisfactory the cryogenic transport tank is required to be warmed up. The objective is to ensure that any gaseous or volatile liquid hydrocarbons will be purged from the cryogenic transport tank, and detected where required.

c) Check for gaseous or volatile liquid hydrocarbons where required.

d) Cryogenic transport tanks that have failed the analysis tests shall not be considered any further for Oxygen service without an approved cleaning process.

e) The source of the contamination shall be determined.

f) The cleaning method shall follow an approved procedure that shall include sufficient information regarding cleaning materials, equipment, cleaning methods, inspection and acceptance criteria etc.
Note: *Processes for cleaning the contamination in the cryogenic transport tank may require cleaning of some of the equipment or the whole tank.*

g) The risk of combustible solvent remaining inside the tank shall be carefully considered and any residual cleaning fluid must be totally removed.

h) Proper labeling for transportable and static storage vessels is also critical for proper product identification. All labeling shall be clearly visible, in the appropriate languages.

7. Anti Tow-away System

7.1 Components of the systems to prevent tow-away

a) Training drivers and/or operators to remain out of the driver's cabin during filling and decantation.

b) Placing wheel chokes both ahead and behind the hind tyres.

c) Removing the ignition key, and handing these over to the filling supervisor.

d) Application of hand brakes and locking of the driver's cabin door.

7.2 Driver Training

a) Training shall ensure that the drivers and operators recognize the hazards and risks of the activity and that the content of the procedures are well understood.

b) The competencies in terms of knowledge and skills of the drivers/operators will be assessed before they are authorized to perform loading and unloading operations. The competencies will be reassessed at regular intervals. The training and assessments will be recorded in the individual records of the driver or operator.

c) Particular care shall be taken during the training to make drivers/operators aware of the anti tow-away systems as mentioned in 6.1. Transport equipment hired for short terms shall not be forgotten.

d) Training shall be given to both Company employed drivers/operators and those drivers/operators employed under contract terms.

e) Managers shall ensure that drivers/operators shall not use systems they have not been trained on.

7.3 Technical means to prevent tow-away incident

a) A shortened version of the procedure in the form of bullet points shall be posted at the fixed installation or in the piping cabinet of the delivery- vehicle.

b) Systems relying on procedures (the driver leaves his engine key to the person in charge of loading) that do not exclude human errors shall be doubly cross checked by both the driver and the loader before starting the vehicle.

c) Technical solutions relying on the use of warning signs (a warning placard is installed in front and at the rear of the vehicle as long as the transfer hose is connected) or on the use of warning signals (a lamp is lit in the drivers cab as long as the transfer hose is connected) that do not exclude human and mechanical errors shall be part of a maintenance program and their operation shall be checked periodically.

d) Where the safety devices are fitted to trailers hauled by tractors which are not dedicated to the trailer, checks shall be carried out to ensure that the change of tractor does not defeat the safety device.
e) The hand brakes of the vehicle shall always be applied no sooner the driver intends to disembark from the cabin.

Note: *Consequences of the tow-away*

a) A large quantity of gas or liquid under pressure may be released by the ruptured hose and produce a potentially hazardous atmosphere (enriched or deficient in Oxygen) which may lead to cold burns, asphyxiation, fire or explosion.

b) If the hose resists the pulling effort and does not break, the vehicle may, in certain cases, pull away part or the whole of the fixed equipment or damage the delivery vehicle pipe work.

c) Even minor accidents can lead to disruption of service, embarrassment and adverse publicity.

8. Emergency data interpretation

8.1 Material Safety Data Sheet (MSDS)

Note: *A Material Safety Data Sheet (MSDS) is a form with data regarding the properties of a particular substance. It is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. MSDS information may include instructions for the safe use and potential hazards associated with a particular material or product.*

1. An appropriate data sheet shall be made traceable with the unit using a particular chemical.
2. Information in the particular data sheets relevant to dealing with emergency situations arising out of use of hazardous chemicals have to be made conspicuous where these chemicals are being used.
3. Properly labeling of substances on the basis of physico-chemical, health and/or environmental risk shall be done. Labels can include hazard symbols used to denote a harmful substance.
4. MSDS of the materials shall be available with the customer.

Product Name: Compressed Oxygen Date: 10/15/2006

Ellenbarrie Industrial Gases Limited Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name:	Oxygen	**Trade Name:**	Oxygen.
Product Use:	Many.		
Chemical Name:	Oxygen.	**Synonym:**	NA.
Chemical Formula:	O_2	**Chemical Family:**	Permanent Gas.
Telephone:	**Emergencies:** *033-25828791,	**Supplier**	Ellenbarrie Industrial Gases Limited
	*033-27094398	**/Manufacture:**	3A, Ripon Street, Kolkata-700016
	*08924-205105	**Phone:**	033-22292441, 22291923, 22491922
		Fax:	033-22493396

**Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Ellenbarrie Industrial Gases Limited sales representative.*

2. Composition and Information on Ingredients

INGREDIENTS	% (VOL)	CAS NUMBER	LD_{50} (Species & Routes)	LC_{50} (Rat, 4 hrs.)	TLV-TWA (ACGIH)
Oxygen	100	7782-44-7	Not applicable.	Not applicable.	None.

3. Hazards Identification

Emergency Overview

WARNING! High pressure, oxidizing gas. Vigorously accelerates combustion. Self-contained breathing apparatus may be required by rescue workers.

ROUTES OF EXPOSURE: Inhalation.

THRESHOLD LIMIT VALUE: TLV-TWA Data from 2004 Guide to Occupational Exposure Values (ACGIH).

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION: Breathing 80% or more Oxygen at atmospheric pressure for more than a few hours may cause nasal stuffiness, cough, sore throat, chest pain and breathing difficulty. Breathing Oxygen at higher pressure increases the likelihood of adverse effects within a shorter time period. Breathing pure Oxygen under pressure may cause lung damage and also central nervous system effects resulting in dizziness, poor coordination, tingling sensation, visual and hearing disturbances, muscular twitching, unconsciousness and convulsions. Breathing of Oxygen under pressure may cause prolongation of adaptation to darkness and reduced peripheral vision.

SKIN CONTACT: No harm expected.

SKIN ABSORPTION: No evidence of adverse effects from available information.

SWALLOWING: This product is a gas at normal temperature and pressure.

EYE CONTACT: No evidence of adverse effects from available information.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE: No evidence of adverse effects from available information.

Page 1 of 7

A picture of the first page of a Material Safety Data Sheet (MSDS)

8.2 Transport Emergency card (TREM CARD)

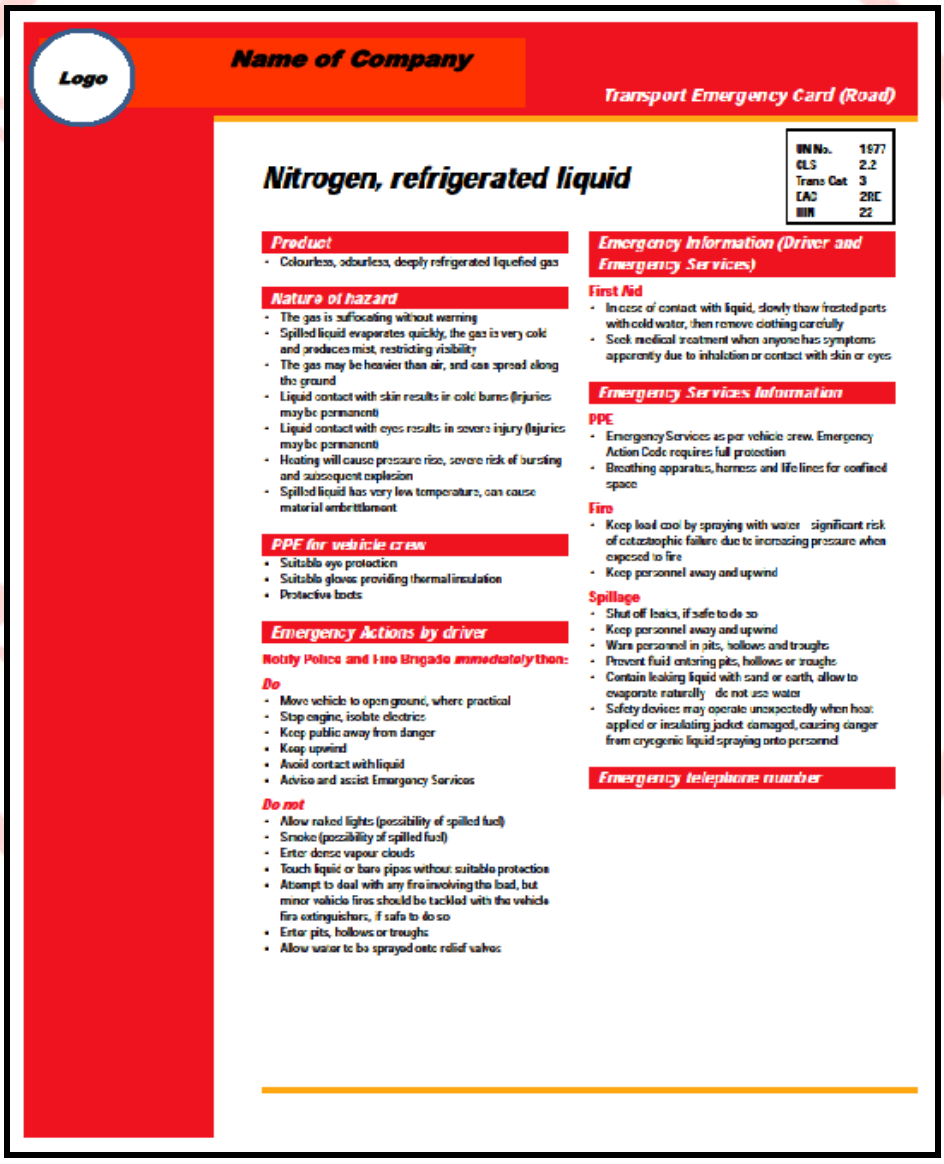
a) Transport emergency cards shall be carried in the cab of any vehicle carrying dangerous goods in quantities exceeding the exempted quantities.

The purpose is to instruct the driver in the event of an incident. They may also assist emergency response workers, as they carry information which is specific to the particular goods being carried.

b) There shall be a card for each dangerous goods item in the load.

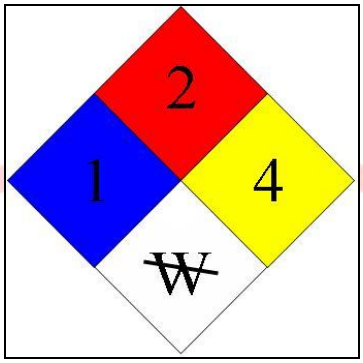
c) The consignor shall either supply the card/s or give enough information for the operator to obtain the correct card(s).

d) It is vital that the driver reads and understands the card for any product before loading it.



A picture of a Transport Emergency (TREM) Card

8.3 Hazard Rating Diamond



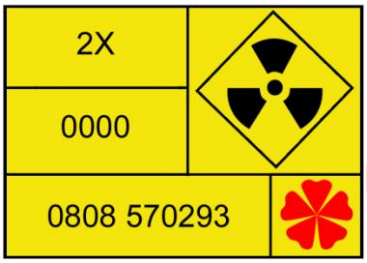
Note:

1. *The diamond-shaped label is made up of four smaller diamonds, namely blue, red, yellow, and white. The diamond's hazard information is valid for the material under normal circumstances.*
2. *The **blue diamond** conveys Health Hazard information for persons exposed to the material. 0=No hazard. 1=Can cause irritation if not treated. 2=Can cause injury. Requires prompt treatment. 3=Can cause serious injury despite medical treatment. 4=Can cause death or major injury despite medical treatment.*
3. *The **red diamond** conveys Flammability Hazard information. 0=Will not burn. 1=Ignites after considerable preheating. 2=Ignites if moderately heated. 3=Can be ignited at all normal temperatures. 4=Very flammable gases or very volatile flammable liquids.*
4. *The **yellow diamond** conveys Reactivity (or Stability) information. 0=Normally stable. Not reactive with water. 1= Normally stable. Unstable at high temperature and pressure. Reacts with water. 2= Normally unstable but will not detonate. 3= Can detonate or explode but requires strong initiating force or heating under confinement. 4=Readily detonates or explodes.*
5. *The **white diamond** conveys Special Hazard information.*

   ***W** denotes the material is water reactive. **OX** denotes an oxidizing agent. **COR:** Corrosive. **BIO:** Biological hazard. **POI**: Poisonous. : denotes the material is radioactive. **CRY or CRYO**: Cryogenic.*

   Some facilities use the white diamond to convey personal protective equipment requirements when using the material. One might see a picture of gloves, safety glasses, or a respirator in the white diamond.

8.4 HAZCHEM symbol



Note: *The top-left section of the plate gives the Emergency Action Code (EAC) telling the fire-brigade what actions to take if there's an accident. The middle-left section gives the UN Substance Identification Number describing the chemical. The lower-left section gives the telephone number that should be called if special advice is needed. The warning symbol at top-right indicates what danger the chemical presents. The bottom-right of the plate carries a company logo.*

8.5 HAZCHEM fire suppression

Number	Action
1	Jets
2	Foam
3	Fog. In the absence of fog equipment, a fine spray may be used.
4	Dry Agent. Water must not be allowed to come into contact with the substance at risk.

Note: *The system is designed to rank fire suppression methods in order of usability. For example a chemical marked with the number 2 or Fog can be attacked with methods 3 (Foam) or 4 (Dry Agent) but not with 1 (Jets). The "Dry Agent" method must be used for chemicals that have an undesirable reaction with water and must not be allowed to come in contact with water, therefore 4 is the highest ranking suppression method as all of the other methods use water.*

8.6 HAZCHEM safety parameters

Note:

1. *Each EAC contains at least one letter, which determines which category the chemical falls under, and which also highlights the violence of the chemical (i.e. likelihood to spontaneously combust, explode etc), what personal protective equipment to use while working around the chemical and what action to take when disposing of the chemical.*

Symbol	Violence	Protection	Substance control
P	V	Full	Dilute
R			
S	V	BA	
S		BA for fire only	
T		BA	
T		BA for fire only	
W	V	Full	Contain
X			
Y	V	BA	
Y		BA for fire only	
Z		BA	
Z		BA for fire only	
E	Consider evacuation		

2. *If a category is classed as violent, this means that the chemical can be violently or explosively reactive, either with the atmosphere or water, or both (which could be marked by the Dangerous when Wet symbol).*

3. *Substance control specifies what to do with the chemical in the event of a spill either dilute or contain. Dilute means that the chemical may be washed down the drain with large quantities of water. Contain requires that the spillage must not come in contact with drains or water courses.*

4. *BA for fire only is denoted within the emergency action code as a* white letter on a black background*, while a* **black letter on a white background** *denotes breathing apparatus at all times.*

5. *Protection is divided up into three categories of personal protective equipment, Full, BA and BA for fire only.*

a) *Full denotes that full personal protective equipment provisions must be used around and in contact with the chemical, which will usually include a portable breathing apparatus and water tight and chemical proof suit.*

b) *BA (acronym for breathing apparatus) specifies that a portable breathing apparatus must be used at all times in and around the chemical.*

c) *BA for fire only specifies that a breathing apparatus is not necessary for short exposure periods to the chemical but is required if the chemical is on alight.*

6. *In the event of a chemical incident, the EAC may specify that an evacuation may be necessary as the chemical poses a public hazard which may extend beyond the immediate vicinity. If evacuation is not possible, advice to stay indoors and secure all points of ventilation may be necessary. This condition is denoted by an E at the end of any emergency action code. It is an optional letter, depending on the nature of the chemical.*

3	Y	E	Use foam or dry agent, substance reacts violently/is explosive, Use BA if fire present, evacuate vicinity, contain spill.
3	Y	E	Use foam or dry agent, substance reacts violently/is explosive, BA use is essential, evacuate vicinity, contain spill.
2	X		Use fog, foam or dry agent, substance is not violent, use full PPE, contain spill.
4	R		Use dry agent only, substance is not violent, full PPE essential, dilute spill.
1	S	E	Use jets, fog, foam or dry agent; BA for fire only; evacuate vicinity; dilute spill.

9. Management of Change

Note: *The principle for management and control of plant and equipment modification is divided into 8 stages*

a) ***Initiation:*** *Generation of an improvement idea or a solution to a problem is communicated within a department, plant etc.*

b) ***Appraisal:*** *Evaluation of technical, operational, safety, environmental, quality and economical aspects of the change. Plant management will be provided with specialists to review the proposal. This is to prevent hasty or not well thought out changes being implemented. The review may identify additional information for decision-making.*

c) ***Approval:*** *The Management of Change documentation must be agreed by appropriate personnel, technical, safety, environmental and economical and final approval to be received by one manager overseeing the operations. When necessary, the detailed design and engineering activities must be carried out for the modification.*

d) ***Implementation:*** *An implementation plan/program must be documented. The plan/program may include purchasing, work planning, contractors, supervision etc.*

e) ***Verification:*** *The change must be verified to ensure that it is in accordance with the change note and all relevant requirements prior to restarting the Changed Process.*

f) ***Documentation:*** *Update all relevant documentation such as product specifications, operating procedures, control logic documentation, alarm trips schedules, drawings and manuals, pressure test certificates, cleanliness certificates, training records, etc. Trace and record the different changes with their date of change.*

g) ***Training:*** *Ensure that affected employees and contractors are trained on the impact of the change prior to the restart of the changed process.*

9.1 The categories of change shall include the following:

a) Changes within the authority of a plant site manager whose responsibility includes one or more of the following: (i) Production of gases and liquefied gases, (ii) Packaging of gases, (iii) Transportation of gas products, and (iv) Customer-gas facility installation. Such approval limits need rigorous definitions to avoid problems.

b) Changes for which the site manager needs third party approval (e.g. design authority, safety department).

9.2 Procedure for Management of Change

a) No modification shall be made to a plant, equipment, control systems, process conditions, and operating procedures without authorization from a responsible manager or his delegate.

b) Proposed modifications shall be evaluated for Safety, Health and Environmental impact and a signed document shall be available before the change can be implemented.

c) The document shall be signed for a second time before the equipment is released to become operational.

Note: *An Emergency MOC is a change that must be performed on a true emergency basis because of any of the following situations: (1) The process must be changed to correct a deficiency that would cause a hazardous condition that is an immediate threat to the safety and health of the site personnel or the public, (2) The process must be changed to prevent an immediate environmental release, (3) The process would be in jeopardy of not providing product to clients, owing to equipment failure or unforeseen design errors.*

10. Summary of advice

a) Be aware of the dangers of Oxygen if in doubt, ask.

b) Prevent Oxygen enrichment by ensuring that equipment is leak-tight and in good working order.

c) Check that ventilation is adequate.

d) Always use Oxygen cylinders and equipment carefully and correctly.

e) Always open Oxygen cylinder valves slowly.

f) Do not smoke where Oxygen is being used.

g) Never use replacement parts which have not been specifically approved for Oxygen service.

h) Never use Oxygen equipment above the pressures certified by the manufacturer.

i) Never use oil or grease to lubricate Oxygen equipment.

j) Never use Oxygen in equipment which is not designed for Oxygen service.