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Draft Indian Standard

Code of Safety for Cryogenic liquid

Part 3 Liquid Argon

(First Revision of IS 5931)

भारतीय मानक मसौदा

क्रायोजेनिक तरल के लिए सुरक्षा संहिता

भाग 3 तरल आर्गन

(पहला पुनरीक्षण)

(ICS 71.100.20)

Chemical Hazards Sectional Committee, CHD 07

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FOREWORD

(Formal clause to be added later)

Handling liquid argon safely is largely a matter of knowing their properties and using suitable procedures based on that knowledge. There arena number of general precautions and safe practices which shall have to be observed because of extremely low temperatures and high rates of conversion into gas of the liquid argon mentioned in this standard. There are also certain specific precautions which shall have to be followed where a particular liquid may react with contaminants or may present a hazard to life.

The elimination of accidents is vital to public interest. Accidents produce social and economic loss and impair individual or group productivity. Realization of this loss has led the authorities

to devote a good deal of attention to safety education. Apart from general precautions, some typical precautions are required to be taken during manufacture, storage and handling of liquid argon. The standard also prescribes safety measures for controlling hazards and essential information on symptoms of poisoning, first-aid, medical treatment, storage, handling, labelling and employee safety. This standard is intended to guide the users in the recognition of these hazards and in establishing safe handling procedures.

BIS has published a standard IS 5931: 1970 'Code of Safety for Handling of Cryogenic Liquids'. During the revision, considering the bulkiness of the standard, and recognizing the need for clarity, the committee decided to restructure it by splitting into various parts based on type of cryogenic liquids.

This (Part 3) prescribes a code of safety concerning hazards relating to liquid argon. It describes the properties and essential information for the safe handling and use of liquid argon, safety measures for controlling hazards and essential information on symptoms of poisoning, first-aid, medical treatment, storage, handling, labelling and employee safety.

The other parts of this standard are as following:

Part 1 Liquid Oxygen (*first revision*)

Part 2 Liquid Nitrogen (*first revision*)

Part 4 Liquid Helium (*first revision*)

Part 5 Liquid Hydrogen (*first revision*)

Part 6 Liquid Krypton (*first revision*)

Part 7 Liquid Neon (*first revision*)

The various clauses of the standard have been aligned with the format being applied for all Indian Standards on code of safety of chemicals.

SCOPE

1.1 This code describes the properties of liquid argon, the nature of hazards associated with it and the essential information on storage, handling, packing, labelling, and disposal of waste, cleaning and repair of containers, training of personnel, selection of personal protective equipment and first aid.

1.2 This code does not deal with the specifications for design of buildings, chemical engineering plants, storage vessels and equipment for operations control and waste disposal.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of standards given at below:

<i>IS No.</i>	<i>Title</i>
IS 1260 (Part 1): 1973	Pictorial marking for handling and labelling of goods: Part 1 Dangerous Goods
IS 2925: 1984	Specification for industrial safety helmets (<i>second revision</i>)
IS 4155: 2023	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals (<i>first revision</i>)
IS 8520: 2023	Guide for selection of industrial safety equipment for eye, face and ear protection
IS 10245 (Part 1): 2023	Respiratory Protective Devices-Specification: Part 2 Self-Contained Open Circuit Breathing Apparatus (<i>second revision</i>)
IS 15298 (Part 2) : 2016/ISO 20345: 2011	Personal protective equipment: Part 2 safety footwear (<i>second revision</i>)
IS 15803 : 2008	Respiratory protective devices - Self contained closed circuit breathing apparatus chemical oxygen (KO ₂) type, self generating, self rescuers - Specification

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 4155 shall apply.

4 PROPERTIES LIQUID ARGON

4.1 General Information

4.1.1 Liquid argon is tasteless, colorless, odorless, noncorrosive, non-flammable, and extremely cold. Belonging to the family of rare gases, argon is the most plentiful, making up approximately 1 percent of the earth's atmosphere. It is monatomic and extremely inert, forming no known chemical compounds.

4.1.2 Since argon is inert, special materials of construction are not required. However, materials of construction must be selected to withstand the low temperature of liquid argon.

4.1.3 Although used more commonly in the gaseous state, argon is commonly stored and transported as a liquid, affording more cost-effective way of providing product supply.

4.1.4 Liquid argon is a cryogenic liquid. Cryogenic liquids are liquefied gases that have a normal boiling point below -130 °F (-90 °C). Liquid argon has a boiling point of -303 °F (-

186 °C). The temperature difference between the product and the surrounding environment, even in winter, is substantial. Keeping this surrounding heat from the product requires special equipment to store and handle cryogenic liquids.

4.1.5 Chemical Name – Ar

4.1.6 Common Name & Synonyms - Argon (refrigerated), Cryogenic Liquid Argon, Liquid Argon, LAR

4.1.7 Uses

Argon is most commonly used in its gaseous state. It is widely used in the lighting industry for filling bulbs and with combinations of other rare gases for the filling of special bulbs and tubes for special color effects. The welding industry uses argon as a shielding gas to protect metal from oxidation during welding. Argon is also used extensively in the semiconductor manufacturing process as a purge gas.

4.2 Identification

4.2.1 Formula - Ar

4.2.2 CAS Number - 7440-37-1

4.2.3 UN Number - 1951

4.2.4 UN Class - 2.2 (Non-Flammable, non-Poisonous Gas) **Subsidiary Risk:** no data available

4.3 Physical Properties

4.3.1 Liquid argon is tasteless, colourless, odorless, noncorrosive, non-flammable, and extremely cold

4.3.2 Molecular Mass - 39.95 g/mol

4.3.3 Physical State - Liquefied gas.

4.3.4 Colour - Colorless.

4.3.5 Odour - No odor warning properties.

4.3.6 Boiling Point - -302 °F (-185.8 °C)

4.3.7 Melting Point - -309 °F (-189.3 °C)

4.3.8 Vapour Density (Air=1) - 1.38 (air = 1) Heavier than air.

4.3.9 Specific Gravity

a) Liquid (water = 1) ~ No data available

4.3.10 Viscosity at 30 °C – No data available.

4.3.11 Vapour Pressure at 76.6 °C - Not applicable.

4.3.12 Heat of Combustion - No data available.

4.3.13 Refractive Index at 25 °C - No data available.

4.3.14 Solubility in Water – 0.0 673 g/l

4.3.15 Solubility in other solvents – No data available.

4.3.16 *Light Sensitivity* - No data available.

4.4 Chemical Properties

4.4.1 *Reactivity* – No reactivity hazard. It is stable under normal condition.

4.4.2 *Polymerisation* – No data available

4.4.3 *Allotrope formation* – No data available

4.4.4 *Corrosion properties* –. No data available

4.5 Fire and Explosion Hazard Properties

4.5.1 *Ignition Temperature* - No data available.

4.5.2 *Auto Ignition Temperature* - No data available.

4.5.3 *Flash Point* - Not applicable.

4.5.4 *Upper Explosive Limit* - Not applicable.

4.5.5 *Lower Explosive Limit* - Not applicable.

4.5.6 *Fire Risk*

If tank, rail car or tank truck is involved in a fire, ISOLATE for minimum 800 m in all directions; also, consider initial evacuation for 800 m in all directions.

5 HEALTH HAZARD & TOXICITY INFORMATION

5.1 General Information

5.1.1 Health effects

5.1.1.1 Being odourless, colourless, tasteless, and non-irritating, argon has no warning properties. Humans possess no senses that can detect the presence of argon. Argon is nontoxic and largely inert. It can act as a simple asphyxiant by displacing the oxygen in air to levels below that required to support life. Inhalation of argon in excessive amounts can cause dizziness, nausea, vomiting, loss of consciousness, and death. Death may result from errors in judgment, confusion, or loss of consciousness that prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur in seconds and without warning.

5.1.1.2 For more information on oxygen deficient atmospheres. Extensive tissue damage or cryogenic burns can result from exposure to when using inert gas systems, always provide adequate air movement and ventilation, such as exhaust or floor fans. Be aware that increases in gas consumption rates may require additional ventilation.

5.1.1.3 Oxygen-deficient atmospheres may exist in poorly ventilated areas, confined spaces, areas immediately outside confined spaces, enclosures and low-grade areas. When working in confined spaces, all the requirements of confined space regulations must be strictly followed. Effective emergency procedures for entry and rescue can avoid serious injuries or fatalities. Low oxygen levels can also exist in “open areas,” including areas with ventilation, laboratories, buildings and outside near equipment.

5.1.1.4 Visual or odor indicators cannot detect an oxygen deficient atmosphere. The only way to detect low oxygen concentrations is with real-time monitoring. Use of a continuous oxygen monitor is strongly recommended in work areas where high concentrations of gas can accumulate.

5.1.1.5 A release of a cold vapor, such as from cryogenic liquid argon, can form a visible vapor cloud or plume created by the condensation of atmospheric moisture. As the released gas warms up to ambient temperature, the visible vapor cloud may disappear before the oxygen concentration returns to a sufficient level. Do not rely on the absence of a visible vapor cloud as safe breathable atmosphere.

5.2 Routes of entry

5.2.1 Skin

Contact with liquid argon may cause cold burns/frostbite. May cause severe frostbite.

5.2.2 Eyes

Contact with liquid argon may cause cold burns/frostbite.

5.2.3 Ingestion

Ingestion is not considered a potential route of exposure.

5.2.4 Inhalation

High concentrations of argon may cause asphyxiation. The symptoms may include loss of mobility/consciousness. Victim may not be aware of asphyxiation. Asphyxiation may bring about unconsciousness without warning and so rapidly that victim may be unable to protect themselves.

5.2.5 Long term effects - No data available

5.3 Toxicity information

- a) Time Weighted Average TLV (TWA) — No data available
- b) Short Term Exposure Limit (STEL) — No data available
- c) Immediately Dangerous to Life and Health (IDLH) — No data available
- d) Lethal Dose (LD50) (rat), Dermal — No data available
- e) LD_{Lo} (human) Oral— No data available
- f) Inhalation (Rat) LC: No data available

5.4 Antidote: Not applicable

5.5 Health Effects

5.5.1. Signs and Symptoms

The sign and symptoms related to oxygen-deficient atmosphere is as prescribed in Table 1.

Table 1 Effects of Oxygen-Deficient Exposure

(Clause 5.5.1)

S No.	Oxygen Concentration (percent vol)	Health Effects of Persons at Rest
(1)	(2)	(3)
i)	19	Some adverse physiological effects occur, but they may not be noticeable.
ii)	15–19	Impaired thinking and attention. Increased pulse and breathing rate. Reduced coordination. Decreased ability to work strenuously. Reduced physical and intellectual performance without awareness.
iii)	12–15	Poor judgment. Faulty coordination. Abnormal fatigue upon exertion. Emotional upset
iv)	10–12	Very poor judgment and coordination. Impaired respiration that may cause permanent heart damage. Possibility of fainting within a few minutes without warning. Nausea and vomiting.
v)	<10	Inability to move. Fainting almost immediate. Loss of consciousness. Convulsions. Death

5.5.2 Acute Toxicity

No data is available on the product itself.

5.5.2.1. Systemic effects

No data is available on the product itself.

5.5.2.2 Local effects

No data is available on the product itself.

5.5.3 Chronic Toxicity

No data is available on the product itself.

5.5.3.1 Systemic effects

No data is available on the product itself.

5.5.3.2 Local effects

No data is available on the product itself.

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 Availability and Use

6.1.1 While personal protective equipment is not an adequate substitute for good, safe working conditions, adequate ventilation and intelligent conduct on the part of employees working with

liquid argon, it is in many instances the only practical means of protecting the worker, particularly in emergency situations. Personal protective equipment protects only the worker wearing it, and other unprotected workers in the area may be exposed to danger.

6.1.2 Eyes are most sensitive to the extreme cold of liquid argon and its vapors. The recommended personal protective equipment when handling or using liquid argon is a full face shield over safety goggles; loose-fitting thermal insulated or leather gloves; and long sleeved shirts and pants without cuffs, especially whenever the possibility of exposure or a spill exists. In addition, safety shoes are recommended for those involved with the handling of liquid argon containers.

6.2 Non-Respiratory Equipment

6.2.1 *Eye and face Protection*

Eyes are most sensitive to the extreme cold of liquid argon and its vapors. The recommended personal protective equipment when handling or using liquid argon is a full face shield over safety goggles (*see IS 8250*).

6.2.2 *Head Protection*

Safety helmet with face shield is recommended while handling the liquid argon (*see IS 2925*).

6.2.3 *Foot and leg Protection*

Safety shoes are recommended when handling cylinders (*see IS 15298 (Part 2)*).

6.2.4 *Body, Skin and Hand Protection*

Never allow any unprotected part of the body to touch uninsulated pipes or vessels which contain cryogenic fluids. The extremely cold metal will cause the flesh to stick fast and tear when one attempts to withdraw from it.

6.2.4.1 *Hand Protection*

Loose-fitting thermal insulated or leather glove.

6.2.4.2 *Body Protection*

Long sleeved shirts and pants without cuffs, especially whenever the possibility of exposure or a spill exists.

6.3 Respiratory Equipment

Severe exposure to liquid argon may occur in tanks during equipment cleaning and repairs, during decontamination of areas following spills, or in case of failure of piping or equipment.

6.3.1 *Self-Contained Breathing Apparatus*

This apparatus permit the wearer to carry a supply of oxygen or air compressed in the cylinder (*see IS 10245 (Part 1)*) and the self-generating type which produces oxygen chemically (*see IS 15803*). These allow considerable mobility. The length of time, a self-contained breathing apparatus provides protection varies according to the amount of air, oxygen, or regenerating material carried. Compressed oxygen should not be used where there is danger of contact with flammable liquids, vapours, or sources of ignition, especially in confined spaces, such as tanks or pits.

7 STORAGE, HANDLING, LABELLING AND TRANSPORT

7.1 General

Follow the latest applicable Gas Cylinder Rules, Static & Mobile Pressure Vessel (U) Rules, Motor Vehicle Act & Rules and other Act, Rules & Code as applicable for Storage, Handling, labelling and Transportation procedure. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

7.2 Storage

7.2.1 Storage in Containers

7.2.1.1 Liquid argon is stored, shipped, and handled in several types of containers, depending upon the quantity required by the user. The types of containers in use are the dewar, cryogenic liquid cylinder, and cryogenic storage tank. Storage quantities vary from a few liters to many thousands of gallons.

7.2.1.2 Since heat leak is always present, vaporization takes place continuously. Rates of vaporization vary, depending on the design of the container and the volume of stored product. Containers are designed and manufactured according to the applicable codes and specifications for the temperatures and pressures involved.

7.2.3 Storage in Dewars

A loose-fitting dust cap over the outlet of the neck tubes prevents atmospheric moisture from pugging the neck and allows gas produced from vaporized liquid to escape. This type of container is a non-pressurized container. The unit of measure for the capacity of a Dewar is typically the liter. 5 l to 20 l Dewars are available. Product may be removed from small Dewars by pouring, while larger sizes will require a transfer tube. Cryogenic liquid cylinders that are pressurized vessels are sometimes incorrectly referred to as Dewars.

7.2.4 Storage in Cryogenic liquid cylinders

Cryogenic liquid cylinders are insulated, vacuum jacketed pressure vessels. They come equipped with safety relief valves and rupture discs to protect the cylinders from pressure build up. These containers operate at pressures up to 350 psig and have capacities between 80 l and 450 l of liquid. Liquid argon may be withdrawn as a gas by passing liquid through an internal vaporizer or as a liquid under its own vapor pressure.

7.2.5 Storage in Cryogenic storage tanks and Connected Transfer Lines

Tanks may be spherical or cylindrical in shape. They are mounted in fixed locations as stationary vessels or on railroad car or truck chassis for easy transportation. Sizes range from 500 to 420 000 gallons, and all tanks are powder- and vacuum-insulated in the annular space. Tanks are equipped with various circuits to control product fill, pressure build up, pressure relief, product withdrawal, and tank vacuum.

7.2.5.1 *Transfer lines connected to storage*

A liquid transfer line is used to safely remove liquid product from Dewars or cryogenic liquid cylinders. A typical transfer line for Dewars is connected to a bayonet that provides a means of using product vapor pressure buildup or an external pressure source to remove the liquid. For cryogenic liquid cylinders, the transfer line is connected to the cylinder's liquid withdraw a valve. Liquid product is typically removed through insulated withdrawal lines to minimize the loss of liquid product to gas. Insulated flexible or rigid lines are used to withdraw product from storage tanks. Connections on the lines and tanks vary by manufacturer.

7.2.6 *Storage place if inside a Building*

Due to the large expansion ratio of liquid to gas, it is very important to provide adequate ventilation in areas using liquid argon. A minimum of six air changes per hour are suggested in these areas. Provide monitoring for areas where oxygen displacement may occur. 19.5 percent oxygen concentration as the minimum for working without supplied air should be ascertained.

7.2.7 Use a back flow preventative device in the piping. Do not change or force fit connections. Always keep container in upright position. Open/close valve slowly. Close when not in use.

7.2.8 Do not allow storage temperature to exceed 50 °C (14 °F). Containers should be stored in a purpose build compound which should be well ventilated, preferably in the open air.

7.2.9 Full containers should be stored so that oldest stock is used first. Do not store in a confined space. Full and empty cylinders should be segregated.

7.2.10 Store containers in location free from fire risk and away from sources of heat and ignition. Return empty containers in a timely manner.

7.2.11 Stored containers should be periodically checked for general condition and leakage. Protect containers stored in the open against rusting and extremes of weather.

7.2.12 Containers should not be stored in conditions likely to encourage corrosion. Cryogenic containers are equipped with pressure relief devices to control internal pressure.

7.2.13 Under normal conditions these containers will periodically vent product. All vents should be piped to the exterior of the building. Observe all regulations and local requirements regarding storage of containers.

7.3 Handling

7.3.1 Liquid argon shall be stored and used only in a well-ventilated place. If enough argon gas evaporates from the liquid in an unventilated space, the percentage of oxygen in the air may become dangerously low making anybody present there, symptoms, such as dizziness, unconscious without any warning. Remaining in this atmosphere long enough may become fatal.

7.3.2 Argon build-up is most likely to occur when a room is closed, overnight for example. If there is any doubt about the amount of oxygen in a room, the room shall be ventilated

completely before entering it. Waste nitrogen shall not be disposed of in a confined area or a place where someone else may enter.

7.3.3 Liquid argon is colder than liquid oxygen. Therefore, if it is exposed to the air, oxygen from the air may condense into the liquid argon. If this is allowed to continue for any length of time, the oxygen content of the liquid argon may become appreciable and the liquid will require the same precautions as for handling liquid argon. However, most liquid argon containers are entirely closed except for a small neck area and the argon gas issuing from the surface of the liquid forms a barrier which keeps air away from the liquid and prevents oxygen contamination.

7.3.4 Before entering any large liquid argon storage tank, it shall be made sure that all pipes to the tank are blanked or positively closed off. The tank shall then be purged with air. If a check with instruments shows that the atmosphere normal air, it shall be safe to enter. Unless all lines are physically isolated, inside atmosphere shall be checked frequently with instruments during work. If, for any reason, the supply of fresh air in the tank is doubtful, breathing apparatus shall be used with its own supply of oxygen or air. Whenever anybody enters a tank, he should make sure that he is equipped with a life line and that an observer is stationed outside to check on his reactions while working. It is a good practice to have the ventilating equipment rapidly changing the air in tanks at all times when personnel are working inside them.

7.3.5 Only experienced and properly instructed persons should handle compressed gases/cryogenic liquids.

7.3.6 Do not remove or deface labels provided by the supplier for the identification of the cylinder contents.

7.3.7 Before connecting the container, check the complete gas system for suitability, particularly for pressure rating and materials.

7.3.8 Before connecting the container for use, ensure that back feed from the system into the container is prevented. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier.

7.3.9 If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Do not remove or interchange connections. Ensure the complete gas system has been checked for leaks before use. Prevent entrapment of cryogenic liquid in closed systems not protected with relief device. A small quantity of liquid produces large volumes of vaporized gas at atmospheric pressure.

7.3.10 Containers used in shipment, storage, and transfer of cryogenic liquid are specially designed, well-insulated containers equipped with a pressure relief device and valves to control pressure. Under normal conditions, these containers will periodically vent product to limit pressure buildup. Ensure that the container is in a well-ventilated area to avoid creating an oxygen-deficient atmosphere.

7.3.11 Use adequate pressure relief in systems and piping to prevent pressure buildup; liquid in a closed container can generate extremely high pressures when vaporized by warming. Employ suitable pressure regulating devices on all containers when the gas is being emitted to systems with lower pressure rating than that of the container. Only transfer lines designed for cryogenic liquids shall be used.

7.3.12 Do not subject containers to abnormal mechanical shock. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. When doubt exists as to the correct handling procedure for a particular gas, contact the supplier.

7.3.13 Liquid Argon is extremely cold. Cryogenic liquids and their vapours can rapidly freeze human tissue and can cause many common materials such as carbon steel, rubber, and plastics to become brittle or even break under stress.

7.3.14. Cryogenic liquids in containers and piping at temperatures at or below the boiling point of liquefied argon [-302.6 °F (-185 °C)] can cause clod burn if touched.

7.3.15 All cryogenic liquids produce large volumes of gas when they vaporize. A cryogenic liquid cannot be indefinitely maintained as a liquid, even in well-insulated containers.

7.3.16 If these liquids are vaporized in a sealed container, they can produce enormous pressures that could rupture the container. For this reason pressurized cryogenic containers are normally protected with multiple devices for over-pressure prevention. Common pressure relief devices are a pressure relief valve for primary protection and a rupture disc for secondary protection.

7.3.17 Vaporization of a cryogenic liquid in an enclosed area can cause asphyxiation by displacing the air.

7.3.18 The cold “boil-off” gases condense the moisture in the surrounding air, creating a highly visible fog. This fog can also be formed around cold equipment when no release of the cold liquid or vapors has occurred. Fog clouds do not define the vapor cloud. They define the area where the vapors are still cold enough to condense the moisture in the air.

7.3.19 The vapors can extend well beyond the fog cloud, depending on the product and atmospheric conditions.

7.3.20 Although fog clouds may be indicative of a release, they must never be used to define the leak area and should not be entered by anyone. The dense fog clouds associated with the handling or transfer of cryogenic liquids can obstruct visibility. Care should be exercised so that any clouds do not interfere with vehicle traffic or safety escape routes.

7.3.21 Always handle cryogenic liquids carefully. Their extremely low temperatures can produce cryogenic burns of the skin and freeze underlying tissue.

7.3.4 When spilled on a surface, they tend to spread as far as the quantity of liquid spilled and the physical confines of the area permit.

7.3.23 They can cool large areas. The vapors coming from these liquids are also extremely cold and can produce burns.

7.2.24 Exposure to these cold gases, which is too brief to affect the skin of the face or hands, may affect delicate tissues, such as the eyes.

7.2.7 Stand clear of boiling and splashing liquid and the cold vapors that are released. Boiling and splashing always occur when charging a warm container or when inserting objects into the liquid. Always perform these operations slowly to minimize the splashing and boiling.

7.2.26 Never allow any unprotected part of your body to touch uninsulated pipes or vessels containing cryogenic liquids.

7.2.27 The extremely cold material may stick fast to skin and tear the flesh when you attempt to withdraw it. Even non-metallic materials are dangerous to touch at these low temperatures. Use tongs to immerse and remove objects from cryogenic liquids.

7.2.28 In addition to the hazards of frostbite or flesh sticking to cold materials, objects that are soft and pliable at room temperature, such as rubber or plastics, are easily broken because they turn brittle at low temperatures and may break when stressed.

7.4 Labelling

7.4.1 Each container (including tankers) should carry an identifying label or stencil as depicted in Fig. 2 in IS 1260 (Part 1). The storage containers shall be labelled or marked to identify as follows:

- a) Contents of the container;
- b) Name and address of the manufacturer or importer of the hazardous chemical; and
- c) Physical, chemical and toxicological data as per the criteria given in the relevant schedule of the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

Manufacturers name with label warnings required by regulations or ordinances form part of the label or placard.

7.4.2 Each tanker and each railroad car carrying one or more containers shall be labelled as:

<p style="text-align: center;">In case of leakage/fire:</p> <p style="text-align: center;">Keep away flames and oil/grease.</p> <p style="text-align: center;">Use water fog or water spray for cooling or dilution.</p> <p style="text-align: center;">Evacuate upwind from cold liquid and white water vapor.</p>

7.5 Transport

7.5.1 Transportation of Container

7.5.1.1 Liquid containers must only be unloaded from or loaded onto a delivery vehicle by means of a crane, fork truck, or a power-assisted tailgate. Liquid containers may be moved using a forklift if they are secured on a pallet, in a cradle, or some other device designed for this purpose. When the container is removed from a pallet, it should only be moved using a specially designed four-wheel handcart.

7.5.1.2 Liquid containers should only be transported in an upright position and should never be laid on their side. For proper ways to handle a liquid container is as given in **Fig 1**. Never roll these containers on their side. Liquid containers equipped with wheels should always be moved by pushing the container, never pulling it. This reduces the possibility of the container falling on co-worker in the event it becomes unstable. Pushing the liquid container up any type of grade will increase the force necessary to move it. A grade as low as 5 percent (5 inch rise in 10 feet of travel) will increase the force necessary to start to push the container by as much as 50 percent.

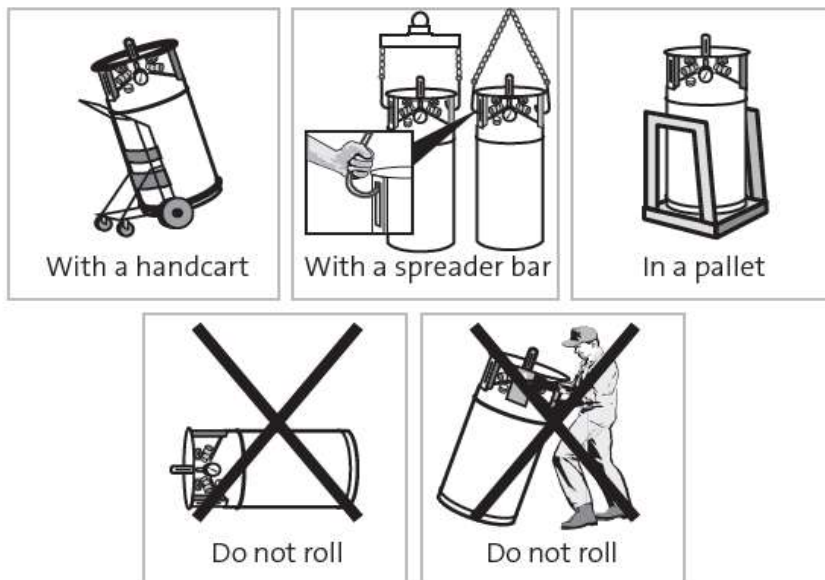


FIGURE 1. HOW TO HANDLE LIQUID CONTAINERS

7.5.1.3 Care must be exercised when transporting liquid containers in elevators. If possible, transport the container only on a freight elevator that is not generally used for personnel transport.

7.5.1.4 After the container is placed in the elevator, the elevator should be locked out to all other users. The sender should remain outside the elevator and activate it. Another person should be available on the receiving floor to take the liquid container off the elevator at its destination. If a freight elevator is not available, a passenger elevator can be used provided it is locked out to all other users. If it is absolutely necessary to have an attendant in the elevator with the container, an escape pack supplemental breathing apparatus must be carried in the elevator. Do not transport a liquid container at any time in an elevator with any other personnel in the car.

7.5.2 Driver

Only driver trained in handling should be employed for transportation of liquid argon. Driver should carry TREM card, material Safety Data Sheet and other legal documents for safety needs when vehicle is on road.

8 SPILLAGE, LEAKAGE AND WASTE DISPOSAL

8.1 General

All personal attending to spill/leak should use proper personal protective equipment and fire-fighting equipment while handling liquid argon.

8.2 Spillage

8.2.1 Do not touch or walk through spilled material

8.2.2 Stop leak if you can do it without risk.

8.2.3 Use water spray to reduce vapors or divert vapor cloud drift.

8.2.4 Avoid allowing water runoff to contact spilled material.

8.2.5 Do not direct water at spill or source of leak.

8.2.6 If possible, turn leaking containers so that gas escapes rather than liquid. Prevent entry into waterways, sewers, basements or confined areas.

8.2.7 Allow substance to evaporate. Ventilate the area.

CAUTION – When in contact with refrigerated/cryogenic liquids, many materials become brittle and are likely to break without warning.

8.4 Waste Disposal

8.4.1 Return unused product in original cylinder to supplier. Contact supplier if guidance is required.

8.4.2 Small amounts may be allowed to evaporate into the atmosphere. In case of large spills consult an expert and allow evaporation. Large amounts should only be handled by gas supplier.

9 FIRE PREVENTION AND FIRE FIGHTING

9.1 General

The liquid argon itself does not burn. Use extinguishing media appropriate for surrounding fire.

9.2 Fire fighting

9.2.1 Spill will rapidly vaporize forming an oxygen deficient vapor cloud. Vapor cloud may obscure visibility.

9.2.2 Do not direct water spray at container vent. Move away from container and cool with water from a protected position. Keep containers and surroundings cool with water spray. Wear self-contained breathing apparatus for firefighting if necessary.

9.2.3 Use extinguishing agent suitable for type of surrounding fire. Move containers from fire area if you can do it without risk. Damaged cylinders should be handled only by specialists

9.3 Fire Involving Tanks

Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at

source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. Always stay away from tanks engulfed in fire

10 TRAINING

10.1 All personnel directly involved in the commissioning, operation and maintenance of liquid argon storage systems shall be fully informed regarding the hazards associated with liquid argon and be properly trained, as applicable, to operate or maintain the equipment. Training shall be arranged to cover those aspects and potential hazards that the particular operator is likely to encounter.

10.2 Training shall cover, but not necessarily be confined to, the following subjects:

- a) Potential hazards of liquid argon;
- b) Site safety regulations;
- c) Emergency procedures;
- d) Use of firefighting equipment;
- e) Use of protective clothing/apparatus including breathing sets where applicable; and
- f) First aid treatment for cryogenic burns.

10.3 In addition, individuals shall receive specific training in the activities for which they are employed.

10.4 It is recommended that the training be carried out under a formalized system and that records be kept of the training given and where possible, some indication of the results obtained, in order to show where further training is required.

10.5 The training programme should make provision for refresher courses on a periodic basis and for changes of site personnel.

10.6 Safety in handling liquid argon depends upon the effectiveness of employee education, training and supervision. The education and training of employees to work safely and to use the personal protective equipment and other safeguards provided for them is a responsibility of supervisor. Employee education and training should emphasize the need of safely handling liquid argon according to the methods outlined in the manual, in order to avoid spilling or splashing, leaks, burns, inhalation of the vapor of burning material, or ingestion. Unauthorized and untrained employees should not be permitted in areas where liquid argon is being handled.

10.7 Before being placed on the job, all new employees should be instructed and trained to maintain a high degree of safety in handling procedures. Older employees should be re-instructed and trained periodically.

11 HEALTH MANAGEMENT, FIRST-AID AND MEDICAL TREATMENT

11.1 First Aid

11.1.1 General Principles

Persons exposed to oxygen-deficient atmospheres should be quickly moved to fresh air. If the victim is not breathing, artificial respiration should be administered immediately. If the victim is breathing, give supplemental oxygen.

11.1.2 *Contact with Skin*

In case of frostbite, obtain medical treatment immediately. As soon as practical, place the affected area in a warm water bath- which has a temperature not to exceed 40 °C (105 °F). Do not rub frozen parts as tissue damage may result. Cover wound with sterile dressing.

11.1.3 *Contact with Eyes*

In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Keep eye wide open while rinsing.

11.1.4 *Ingestion*

Ingestion is not considered a potential route of exposure.

11.1.5 *Inhalation*

Move to fresh air. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. In case of shortness of breath, give oxygen.

12 ADDITIONAL INFORMATION

Workers involved in emergency activities must not allow emotions to override safe work procedures and training. Only trained, qualified personnel equipped with supplied air and necessary safety equipment should attempt a rescue in accordance with safe rescue procedures. You cannot hold your breath and safely enter areas with low oxygen levels. Tragically, without supplied air equipment, attempts to save someone in an oxygen-deficient atmosphere most often result in additional victims.