USER MANUAL

ARGON PURIFICATION UNIT

Serial number: 05288

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***Revisione** (Revision)*	***Descrizione revisione** (Revision description)*	***Verificato** (Verifier)* ***D. Tommasin***	***Approvato** (Approval)* ***D. Milani***

History of Changes

Rev. No.	*Date*	*Pages*	*Description of Changes*
0	24/05/2006		Emission
1	26/05/2006	7	Condenser cryostat filling operation added (see point 9). Manual discharge valve V2 warning (see points 8 and 9).

1. SUMMARY

2. INTRODUCTION

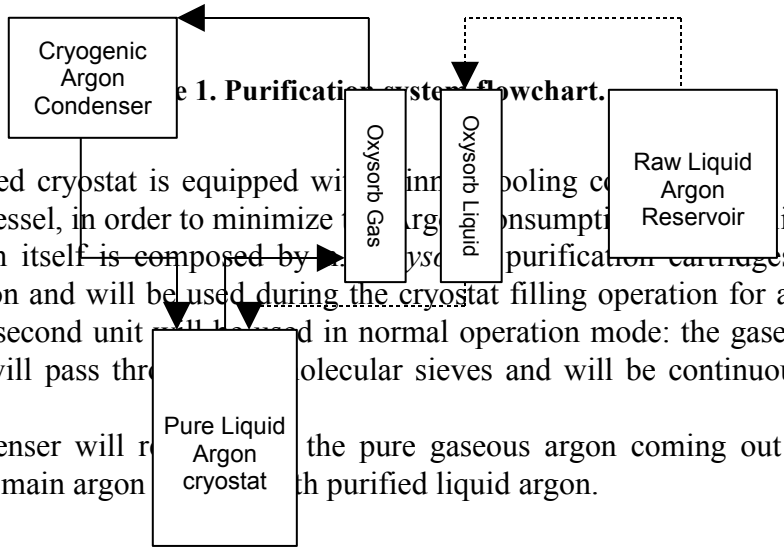
The aim of this operating manual is that of providing the end users with all relevant information concerning the installation and use of the unit.
The user is strongly recommended to carefully read this document before starting to install the system.
The system does not require any particular maintenance but the standard periodic one. The only equipments subjected to wear are sealing: flange gaskets and valve seals. For all these, replacement is required only in case a leak is detected.

3. DESCRIPTION

The system is composed, as represented in Figure 2, by:

- a main super-insulated cryostat, containing the pure liquid argon;
- a set of molecular sieves purifiers: one for liquid argon and one for gaseous argon;
- a cryogenic condenser to condensate back in the main cryostat the pure argon gas.

The purification process is a closed loop continuous iterative process:



e 1. Purificati syste flowchart.

The main super-insulated cryostat is equipped wi inn oling c argon pre-cooling operation of the inner vessel, in order to minimize rg nsumpti ing operations.
The purification system itself is composed by ysc purification cartridges: the first one is dedicated to liquid argon and will be used during the cryostat filling operation for a first gross liquid argon purification; the second unit will be used in normal operation mode: the gaseous argon boiling off the main cryostat will pass thr olecular sieves and will be continuously purified as it evaporates.
The liquid argon condenser will r the pure gaseous argon coming out of the molecular sieves and will feed the main argon th purified liquid argon.

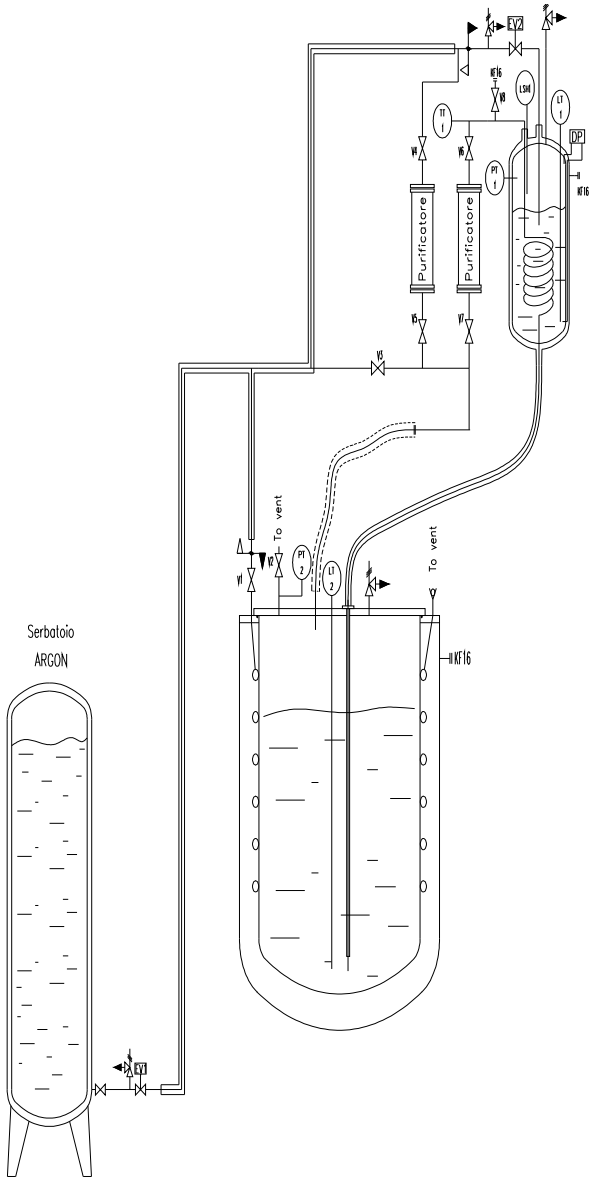


Figure 2. Purification system P&I.

The powering and control cabinet, installed on the unit skid, is designed to allow manual and automatic operation of the unit. It is equipped with a *Siemens* PLC. The first unit filling will be operated manually, while the continuous iterative purification process will be driven automatically by the control unit.

4. PURIFICATION UNIT START UP

Before the unit start up all the user instrumentation, if any, must be mounted inside the main cryostats. Before the start up operations all the cryogenics and vacuum connections must be checked.

It is advisable to install the electrical circuit of the purification system under a UPS unit. The total power consumption is about 100 W and the UPS unit will prevent the system from stopping in case of electrical power failure.

NOTE: all the CF flanges used in the purification unit have metallic gaskets. Once the CF flange is open the metallic gasket must be replaced with a new one. Be careful not tot tight too much the CF flange, in order to avoid the risk of damaging the metallic gasket.

For unit port list, please refer to attached drawing CTO507.

1. Connect the vacuum pumping unit either to *G* port (CF40 flange), via ad-hoc fittings (a vacuum valve should be installed on the fittings in order to able to remove the pump after the pumping operations) or to V8 valve, via KF16 flange.
2. Pump vacuum inside the pure argon circuit and the cryostat, down to level better than $1x10^{-3}$ mbar.
3. Open valves V7, V6 and V5 and pump vacuum inside the purification cartridges to level better than $1x10^{-3}$ mbar. **NOTE: Valve V4 must remain closed at this stage.**
4. **NOTE: Always remove the V5 and V6 valve handles when they are in open position, to prevent users from accidental closing of both V6,V7 and V4,V5 valves that could provoke liquid argon trapping and pressure increase inside the cartridge vessel. Purification vessels are not equipped with safety valves to avoid any source of molecular sieves pollution.**
5. Once vacuum level better than $1x10^{-3}$ mbar, vacuum insulation valve (to be supplied by user) can be close and pumping unit stopped.
6. The system is now ready for liquid argon filling operations (see next paragraph).

5. UNIT COOL DOWN AND RUN

Before starting cooling operation verify gas venting lines: it is advisable that all gas venting lines are conveyed, with flexible rubber pipe, to the exterior of the lab, in order to avoid excessive argon gas concentration inside the room.

5.1 Cool down

Once all the steps described in the previous paragraph PURIFICATION UNIT START UP have been done, the unit is ready for cooling down.

1. Connect liquid argon main reservoir to the purification unit via the flexible super-insulated vacuum line, supplied with the unit and install the cryogenic electro-valve *EV1* at line inlet, "ranger" side.
2. Switch on the Control Panel, to be able to monitor argon level inside the cryostat (*LT2*). After switching on the power cabinet the "Enable System" button have to be pushed in order to enable the system.
3. Open Liquid argon reservoir outlet valve.
4. Open EV1 (move the selector to "Manual" position) and V1 cryogenic valves, to feed cryostat cooling coil. At this stage cold argon gas comes out from the vent line called *R:* pay attention to the risk of cold burns.
5. After 5-10' from opening, and in any case if liquid argon reaches the *R* port, close V1 manual vale. The cryostat is cold and can be filled with liquid argon.
6. Close V7 valve, to prevent liquid argon from flowing inside the *oxysorb*® gas cartridge.
7. Open EV2 manually (by moving the valve selector on the control panel on "manual" position) to start filling the condenser cryostat as well.
8. Open V4 manual valve. Valve V2 can be opened, in the very start phase of filling operation, to allow high warm gas stream to flow out. Be careful: only open V2 when cryostat safety valve (port *C*) is already open. In order to avoid *C* port icing, with consequent o-ring sealing deterioration, always keep V2 valve open during liquid argon filling operations. Once liquid level approaches the nominal one (LT2 = 100%) close V2 valve, to prevent pollution to flow into the cryostat vessel. Be careful not to leave V2 open because this can provoke liquid argon pollution.
9. V3 manual cryogenic valve can be used to fill the argon cryostat by-passing the "liquid" *oxysorb*® cartridge: keep closed V4 valve and open V3 valve instead. Valve V2 can be opened, in the very start phase of filling operation, to allow high warm gas stream to flow out. Be careful: only open V2 when cryostat safety valve (port *C*) is already open. In order to avoid *C* port icing, with consequent o-ring sealing deterioration, always keep V2 valve open during liquid argon filling operations. Once liquid level approaches the nominal one (LT2 = 100%) close V2 valve, to prevent pollution to flow into the cryostat vessel. Be careful not to leave V2 open because this can provoke liquid argon pollution.
10. Once the desired argon level is reached (LT1 = 80%, LT2 = 100%), close EV1 and EV2 automatic valves (by moving back the valve selector to "0" position).
11. Close V3 and/or V4 valve, according to the filling procedure followed. **NOTE: Always check, at this stage, that V5 valve handle has correctly been removed, with the valve in open position, to prevent users from accidental closing of both V4 and V5 valves that could provoke liquid argon trapping and pressure increase inside the cartridge vessel. Purification vessels are not equipped with safety valves to avoid any source of molecular sieves pollution.**
12. Open V7 valve to allow gas flow through the "gas" *oxysorb*® cartridge. The system is ready for run.

13. **NOTE: verify that V5, V6 and V7 manual valves are open in order to prevent liquid argon to be trapped in the purification vessels. Purification vessels are not equipped with safety valves to avoid any source of molecular sieves pollution.**

5.2 Run

Once all the steps described in the previous paragraph Cool down have been done, the unit is ready to run.
The control cabinet must be powered and on.
In Table 1 the user interface controls are described:

Equipment	Description
Power On Lamp	Gives indication of "Applied Power" to the electric panel
System Enable Lighted Button	Auxiliary Circuits actuation button
Fault Lamp	Gives indication of system malfunctions. The fault description text is displayed on the operator panel (the information is sent out also through potential free contact on the panel strip)
Reset Button	Alarms reset. Must be pressed for reactuating the system after an alarm
EV1 Selector	Allows EV1 valve control
EV2 Selector	Allows EV2 valve control - to activate the automatic filling cycle, set both selectors on "Automatic"
RS-485 Connector	RS-485 Interface for PC connection for data acquisition. A RS-485 / RS-232 converter is available as System complement. Also a LabVIEW file .VI for data acquisition is supplied.

Table 1. Control panel switch description.

The unit is supplied with pre-set working parameters.

Equipment	Description	Standard Setting
Set Delay EV2 On Auto xxx min	Sets delay time in minutes from opening of EV1 valve and EV2 valve during the automatic filling cycle. The delay allows the proper cold down of the liquid argon adduction line	0 min
LT1 Off xxx.x % LT1 On xxx.x %	LT1 Off is the level of automatic filling stop LT1 On is the level of automatic filling start	80% 70%
LT1 Max xxx.x % LT1 Min xxx.x %	Set LT1 maximum level alarm Set LT1 minimum level alarm	90% 60%
LSH1 Delay setting xxx sec	Set the delay time of the extra level sensor operation (1)	10 s
LSH1 xxx.x K Threshold	Sets the trip temperature of the Extra-level sensor (1)	90 K
Max Time Filling Operation xxx min	Sets the maximum time for automatic filling. If that limit is exceeded, the system will lock and flags FAULT (1)	15 min
LT2 Offset xxx.xxx % LT2 Mul xxx.xxx	The LT2 value comes scaled second the following equation: LT2 = (LT2 + Offset) * Mul	-22,610 2,055

Table 2. Control panel pre-defined settings.

For more details concerning the PLC programming, please refer to Electrical Plant instruction manual.

The PLC display installed in the front panel of the control cabinet is the main user interface. Using the scroll arrows on the right side of the LCD display, all the working signals are displayed:

Displayed Text	Description	Actions
System Disabled	Shown at system turn-on or after emergency button operation	Reset the emergency button and press System Enable button
PT1 xx.x bar PT2 xx.x bar	Process Variable PT1 and PT2 Visualization	-
TT1 xxx.x K LSH1 xxx.x K	Process Variable TT1 and LSH1 Visualization	-
LT1 xxx.x % LT2 xxx.x %	Process Variable LT1 and LT2 Visualization	-

Table 3. User interface variable list.

The purification unit has been designed to work either in manual or automatic mode. The choice can be done using the two EV selector in the front panel. Moving the selector to “manual” position will open the corresponding valve.

To start the unit in automatic mode just move the two EV selector to “automatic” position.

The unit will automatically start the condenser filling operation, by opening the EV1 and EV2 valve. Once the set level is reached the EV will automatically close.

With liquid argon nominal level in the condenser, the argon gas that evaporates from the main cryostat and that purifies through the *oxysorb*® cartridge, is re-condensed and drained into the main vessel again.
The process is automatic.

NOTE. Be careful: always provide that a sufficient liquid argon reserve is present and connected to the unit feed line via EV1 automatic valve, otherwise the unit will automatically stop once run out of argon in the condenser and the argon purification process will stop.

5.3 STOP procedure

For a system safe stop, the following procedure has to be followed:

1. From the control panel, move the EV selector in "off" position.
2. Before disconnecting the cryogenic feeding lines, be sure that the V1, V2, V3 and EV2 valves are correctly closed.
3. Before opening the liquid argon cryostat be sure that no liquid argon is left inside the cryogenic circuits. To help liquid argon to evaporate an argon gas line, or dry nitrogen gas line, can eventually be connected to the cryostat cooling coil, via V1 valve and dry warm gas can be flushed until the LT1 and LT2 sensors show 0% level.
4. Once no liquid argon is left inside the unit, before opening the cryostat, close V5 and V7 valves, in order not to let humid air to contaminate the molecular sieves.
5. While opening the top cryostat cover or any other CF port, be careful not to damage the flange knife, to always guarantee good sealing.

5.4 General remarks

The argon purification process is a delicate one. Small leaks on the unit can prevent the purification process from succeeding. Although safety devices are needed in a cryogenic system and can not be avoided, every safety valve is a potential source of pollution for the unit. This is the main reason why no safety valves have been installed on the two purification cartridges.
For correct unit operation, carefully follow these recommendations:

- Be careful to never let air inside the cryogenic lines when in operation.
- Never put the purification cartridges in direct contact with air. If, for any reason, one or both the purification cartridges have to be removed:
    - Be sure that no argon is left inside the lines;
    - Execute a system purification pumping down, following what described in paragraph 4.
    - Once good vacuum level is reached inside the unit, break the vacuum with dry nitrogen gas up to cryostat working pressure (1,49 bar a) and tightly close the

insulation valves mounted on the outer vessel in order to leave a small inert gas overpressure inside the purification units.
    - Disconnect the purification cartridges via the VCR couplings.
- Periodically inspect the CF flanges in order to promptly detect potential leaks.

6. TECHNICAL DATA

The liquid argon cryostats are designed according the following:

Design pressure	1.49 bar (0.49+1 annular chamber vacuum)
Working pressure	<0.49 bar (+1 annular chamber vacuum)
Test pressure	0.7 bar
Design temperature	-195/+50 °C
Working temperature	-195/+50 °C
Fluid	Argon
Density	1.394 kg/l
Evaporation temperature	-185.87 °C
Physical status	Liquid/gas
Empty weight	800 kg

7. EUROPEAN DIRECTIVES

All these equipments have been designed, manufactured and tested according to European Directive 97/23/CE concerning pressure vessels (also called PED – Pressure Equipment Directive) and integrated in the Italian laws with the Decreto Legislativo n° 93 del 25/02/00.
More in details:

- The system must be considered as “stand-alone” equipment, according to PED 97/23/CE.
- In case the system will be integrated into a more complex and bigger cryogenic plant, will be customer responsibility to re-certify the complete system according to PED.
- In case modifications will be operated on the system, the customer will have to respect PED directive.
- The system class, according to type and involved fluid, is described in atr.3 par.3 of the above mentioned PED directive; therefore the application of no “modules” is required.
- According to PED the system CANNOT be marked “CE”.
- The safety valves have been dimensioned in the extreme case of external fire.
- The system can not withstand a fire accident: it is customer responsibility to protect the equipments.

List of applied codes:

- Raccolta VSR ISPESL edizione 1999 revisione 1995 (pressure vessels code)
- Raccolta M ISPESL edizione 1999 revisione 1995 (materials)
- Raccolta S ISPESL edizione 1999 revisione 1995 (welds)
- EN 13445-3 (pressure vessels code)
- Direttiva Europea 97/23/CE (PED) e relativo D.L. n° 93 del 25/02/00
- UNI EN 287 del 30/11/93 (welders qualifications)
- UNI EN 288 del 30/11/93 (welding procedure qualifications)
- UNI EN473 del 31/07/93 (non destructive test qualifications)
- D.M. 16/01/96 circolare n° 156AA.GG./STC del 04/07/96 (snow, wind)
- Ordinanza 3274 del 20/03/2003 (earthquake)
- CNR-UNI 10011 Giugno 1988 (head loads)
- Welding Research Council Bullettin 107 Marzo 1979 (mechanical loads on end caps and ports)
- Welding Research Council Bullettin 297 Settembre 1987 (mechanical loads on vessels)

8. INSTALLATION

For system handling and positioning adequate lifting equipments must be used, according to dimensional and load data supplied by CRIOTEC IMPIANTI.

9. GROUNDING

The metallic frame of the system must be electrically grounded and connected to the ground network of the lab.
For this operation use the dedicated connection points foreseen on the system.

10. SAFETY

People working in the vicinity of the cryostat and dealing with cryogenic fluid handling or cryogenic cold temperatures, must be trained on safety and health risks according to local safety laws (Italian law: D.L. 626 del 19/09/1994).
Personnel working on the unit must be quipped with dedicated tools and adequate Individual Protective Device according to relevant risks:

- Accident prevention shoes;
- Cotton overall and clothes;

Moreover, for cryogenic accident prevention, the following Individual Protective Device must be used:

- Protective helmet;
- Cryogenic gloves;

- Protective glasses;

10.1 General information

For correct risk identification, first aid information, fire instructions, accidental fluid leakages and any other recommendations and instructions the user shall refer to product technical datasheets and other documents that may help for a correct system use.

10.2 Maintenance

Cryogenic fluid handling and flow regulation as well as specific maintenance of cryogenic and pressure equipments must be done by CRIOTEC Impianti personnel or other qualified personnel.

11. RISK PREVENTION

CRIOTEC IMPIANTI s.r.l can not be considered responsible for any accident provoked by system misuse or lack of maintenance.
Present recommendations are for informative purpose only and must never replace Official National laws and directives issued on the subject.
Safety in cryogenic fluids handling mostly depends on fluid properties knowledge and on the respect of some basic common-sense precautions.

11.1 General recommendations

General recommendations related to the use of all cryogenic fluids, regards:
- Extremely low temperatures;
- Large gas volume production from small liquid inventory evaporation;
- Cold vapour accumulation in the lower part of the area.

Most common hazards are:

.a Skin exposition to extremely low temperature that can cause cold burns;
.b Prolonged exposition to cold vapours can cause hypothermia;
.c Cold vapour inhalation can damage lungs;
.d Cryogenic liquid and vapour can damage eyes;
.e Contact with cold surfaces can cause skin sticking to the surfaces and skin ripping when detached;
.f Cryogenic vapour release can cause asphyxia as a consequence oxygen concentration decreasing;
.g Liquid oxygen release increase the risk of fire;

11.2 Risk prevention

- Always wear overall and adequate clothes for cryogenic temperature;

- Always wear protection glasses;
- Always wear cryogenic gloves;
- Be careful when introducing cold objects into a cryogenic bath: turbulent boiling cal lead to harming liquid drops projection;
- Always use adequate tools to handle object into a cryogenic liquid;
- Provide that in the working room there is sufficient air ventilation;
- Never drop cryogenic liquid in small places, to avoid vapour cloud formation and asphyxia;
- Always keep in mind that cold vapour can accumulate in lower places of the room.

12. FIRST AID

In case of cold burns accident:

- Abundantly rinse injured part with warm water;
- Do not expose injured part to direct heating source;
- In case of freezing symptoms or severe lesions to lungs of eyes, immediately ask for medical assistance; waiting for assistance cover the injured parts with soft clothes and keep the injured people in warm and quiet place. Never give alcohol to drink to the injured person.
- In case of asphyxia provide that:
    - the rescue team must be equipped with oxygen masks;
    - injured people is immediately taken out from the dangerous zone;
    - immediately intervene with artificial respiration;
    - immediately ask for medical assistance.

13. ARGON TECHNICAL DATASHEET

13.1 PRODUCT IDENTIFICATION

Product name: Liquid Argon
Chemical formula: Ar

13.2 COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	Argon
Chemical Family	Inert rare gas
CAS No.	7440-37-1

UN No.	1951
ERG No.	120
Hazchem Warning 2	C Non-flammable gas

13.3 HAZARDS IDENTIFICATION

Main Hazards. All portable Cryogenic Containers (PCC's) containing cryogenic liquids must be regarded as pressure vessels at all times. Excessive exposure to heat could cause the internal pressure to increase significantly with the consequent violent rupturing of the vessel. Due to its extremely low boiling point, -186°C, extreme care must be taken when handling liquid argon, otherwise frostbite can occur. Argon does not support life. It can act as a simple asphyxiant by diluting the concentration of oxygen in air to below the levels necessary to support life.

Adverse health effects. Inhalation of argon in excessive concentrations can result in dizziness, nausea, vomiting, loss of consciousness and death.

Chemical Hazards. At the temperature of liquid argon, ordinary carbon steels, and most alloy steels, lose their ductility, and are therefore considered to be unsafe for liquid argon service. Satisfactory materials for use with liquid argon include Type 18-8 stainless steel, and other austenitic nickel-chromium alloys, copper, Monel, brass and aluminium. Argon is extremely inert and forms no known chemical compounds.

Biological Hazards. Contact between the skin and liquid argon, or uninsulated piping, or vessels containing it, can cause severe cold burn injuries.

Vapour Inhalation. As gaseous argon acts as a simple asphyxiant, death may result from errors in judgement, confusion, or loss of consciousness which prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur in seconds without warning.

Eye Contact. Can cause severe cold burn injuries.

Skin Contact. Frostbite can occur from contact with liquid argon.

Ingestion. Severe cold burn injuries would occur.

13.4 FIRST AID MEASURES

Prompt medical attention. is mandatory in all cases of overexposure to Argon. Rescue personnel should be equipped with self-contained breathing apparatus. In case of frostbite from contact with liquid argon, place the frost-bitten part in warm water, about 40 - 42°C. If warm water is not available, or is impractical to use, wrap the affected part gently in blankets. Encourage the patient to exercise the affected part whilst it is being warmed. Do not remove clothing whilst frosted. Conscious persons

should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be removed to an uncontaminated area, and given mouth-to-mouth resuscitation and supplemental oxygen.

Eye Contact. Immediately flush with large quantities of tepid water, or with sterile saline solution. Seek medical attention.

Skin Contact. See above for handling frostbite.

Ingestion. Seek medical attention.

13.5 FIRE FIGHTING MEASURES

Extinguishing media. As Argon is an inert gas, it does not contribute to the fire, but could help with the extinguishing by reducing the oxygen content of the air by dilution to below the level to support combustion.
Specific Hazards. Argon does not support life. It can act as a simple asphyxiant by diluting the concentration of oxygen in the air below the levels to support life.
Emergency Actions. If possible, shut off the source of excess Argon. Evacuate area. Prevent liquid argon from entering sewers, basements and workpits. Keep the PCC, tanker or any other cryogenic vessel cool by spraying with water if exposed to a fire, or source of excessive heat. If the tanker has overturned, do not attempt to right or move it. CONTACT THE NEAREST AFROX BRANCH.
Protective Clothing. Self-contained breathing apparatus. Safety gloves and shoes, or boots, should be worn when handling containers.
Environmental precautions. Argon is heavier than air and could form pockets of oxygen-deficient atmosphere in low-lying areas.

13.6 ACCIDENTAL RELEASE MEASURES

Personal Precautions. Do not enter any area where argon has been spilled unless tests have shown that it is safe to do so.

Environmental precautions. Argon itself does not pose a hazard to the environment. However, because of the extreme cold of the liquid, damage to the ecology can occur in the immediate environs of the spill.

Small spills. Shut off the source of escaping argon. Ventilate the area.

Large spills Evacuate the area. Shut off the source of the spill if this can be done without risk. At the source dangerous cold conditions could exist. Restrict access to the area until completion of the clean-up procedure. Ventilate the area using forced-draught if necessary. Frost and vapourising liquid indicates extreme risk of cold condition.

13.7 HANDLING AND STORAGE

When liquid argon is held in any closed vessel or space, there must be an appropriate pressure relief device because of the very large pressure increases that can occur as the liquid argon is vapourised. Liquid argon must also be handled with all the precautions required for safety with any cryogenic fluid. Keep out of reach of children.

13.8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Hazards. As gaseous argon is a simple asphyxiant, avoid any areas where spillage has taken place. Only enter once testing has proved the atmosphere to be safe.
Engineering control measures. Engineering control measures are preferred to reduce exposure to Oxygen-depleted atmospheres. General methods include forced-draught ventilation, separate from other exhaust ventilation systems. Ensure that sufficient fresh air enters at, or near, floor level.
Personal protection. Self-contained breathing apparatus should always be worn when entering area where oxygen depletion may have occurred. Safety goggles, gloves and shoes or boots should be worn when handling containers.

Skin. Wear loose-fitting overalls, preferably without pockets.

13.9 PHYSICAL AND CHEMICAL PROPERTIES PHYSICAL DATA

Chemical Symbol	Ar
Molecular Weight	39,948
Boiling point @ 101,325 kPa	-185,9°C
Relative Density of vapourised liquid (Air=1)	1,380
Critical temperature	-122,29°C
Latent heat of vapourisation @ boiling point	160,7 kJ/kg
Colour	Pale blue
Odour	None

13.10 STABILITY AND REACTIVITY

Conditions to avoid The dilution of the oxygen concentration in the atmosphere to levels which cannot support life.
Incompatible Materials. Due to the extremely low boiling point, -186°C, extreme care must be taken when handling liquid argon, otherwise frostbite can occur, as well as embrittlement of many materials such as plastic and steel.

Hazardous Decomposition Products –None.

13.11 TOXICOLOGICAL INFORMATION

Acute Toxicity. No known effect
(For further information see Section 3. Adverse Health Effects).

13.12 ECOLOGICAL INFORMATION

Argon is heavier than air and can cause pockets of oxygen depleted atmosphere in low-lying areas. It does not pose a hazard to the ecology. Liquid contact with living creatures and plant life could cause severe damage.

13.13 DISPOSAL CONSIDERATIONS

Disposal Methods. Small amounts may be blown to the atmosphere under controlled conditions. Large amounts should only be handled by the gas supplier.
Disposal of packaging. The disposal of containers must only be handled by the gas supplier.

13.14 TRANSPORT INFORMATION ROAD TRANSPORTATION

UN No.	1951
ERG No.	120
Hazchem warning	2C Non-flammable gas

SEA TRANSPORTATION

IMDG	1951
Class	
Packaging group	
Label Non-flammable gas	

AIR TRANSPORTATION

ICAO/IATA Code	1951
Class	2.2
Packaging group	
Packaging instructions	
- Cargo	202
- Passenger	202
Maximum quantity allowed	
- Cargo	500 kg
- Passenger	50 kg

13.15 REGULATORY INFORMATION

EEC Hazard class	Non-flammable
Risk phrases	R21 Harmful in contact with skin
	R35 Causes severe burns
	R41 Risk of serious damage to eyes
	R44 Risk of explosion if heated under confinement
	R45 May cause cancer
Safety phrases	S2 Keep out of reach of children
	S9 Keep container in a well-ventilated place
	S12 Do not keep the container sealed
	S15 Keep away from heat
	S36 Wear suitable protective clothing
National Legislation:	None

Refer to SABS 0265 for explanation of the above.

13.16 OTHER INFORMATION

Bibliography

Compressed Gas Association, Arlington, Virginia
Handbook of Compressed Gases - 3rd Edition
Matheson. Matheson Gas Data Book - 6th Edition
SABS 0265 - Labelling of Dangerous Substances

13.17 EXCLUSION OF LIABILITY

Information contained in this publication is accurate at the date of publication. The company does not accept liability arising from the use of this information, or the use, application, adaptation or process of any products described herein.

14. LAYOUT

See attached drawing.