

**SAFETY DISTANCES AROUND LIQUID OXYGEN STORAGE TANKS**  
**(in the absence of a protection wall)****FRONT PAGE**

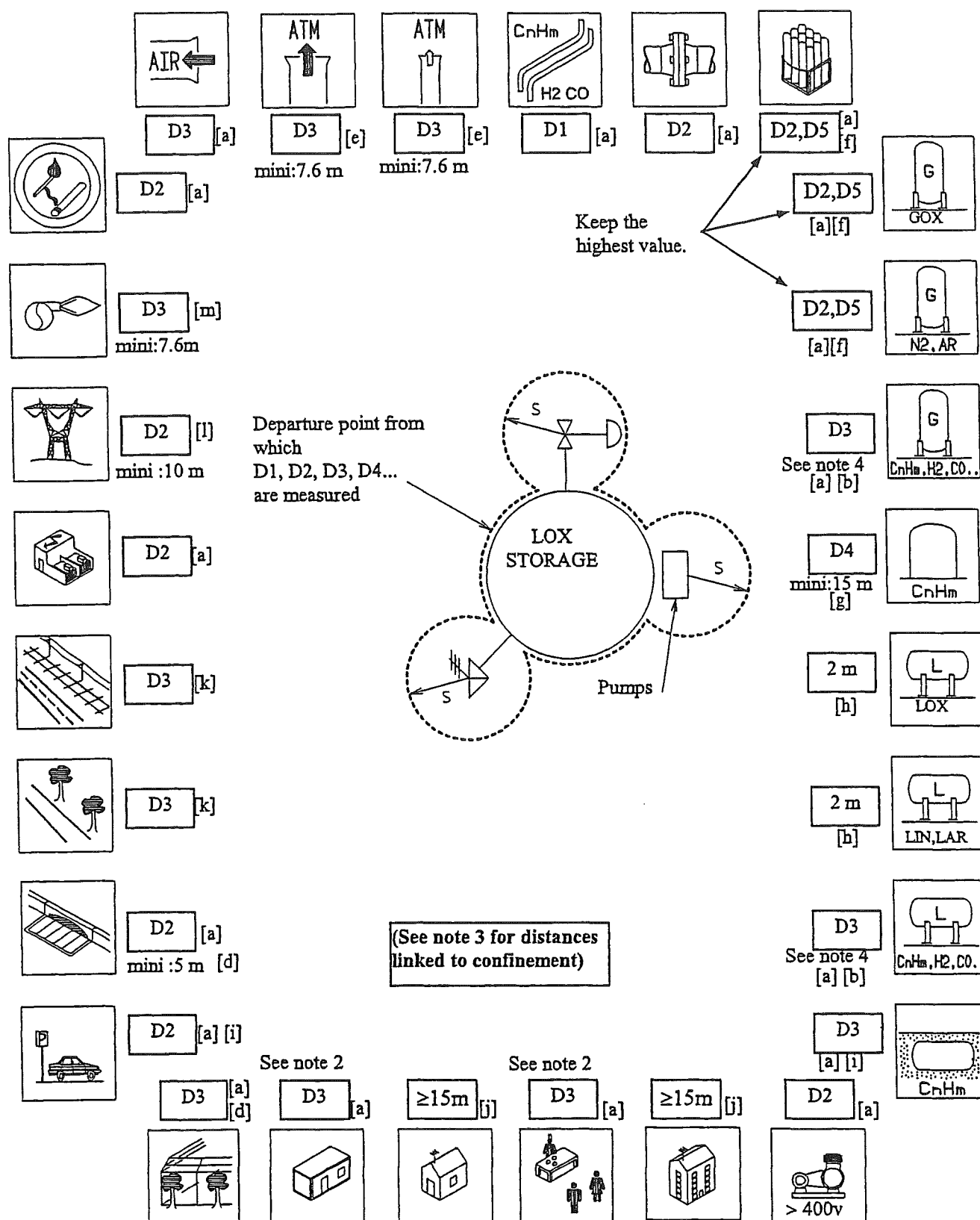
Rev.	Date	Supervis.	Appr.	Modifications
0	10.09.76	Hezard		Original Issue
a	21.02.78	Hezard		Remade
b	18.11.88	Garcia		Updated
c	15.03.97	Le Goas		Updated
d	03.07.97	Le Goas		Reaffirmed under Microsoft® Word
e	10.06.98	Sagot		New layout, adaptation to comply with regulations
f	25.08.98	Sagot		Modified D5 curve in accordance of CGA 17/85
g	07.06.04	F. Bachelier		Precedence principle of local rules over Air Liquide practices
h				
i				
j				
k				
l				
m				
n				
p				

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## SAFETY DISTANCES AROUND LIQUID OXYGEN STORAGE TANKS

(in the absence of a protection wall)





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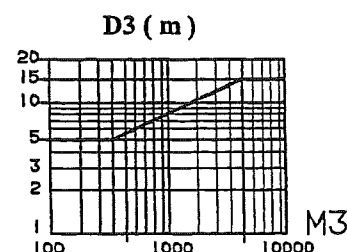
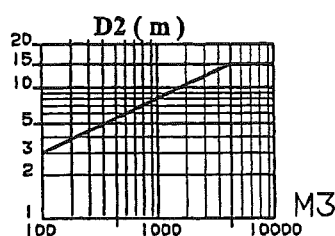
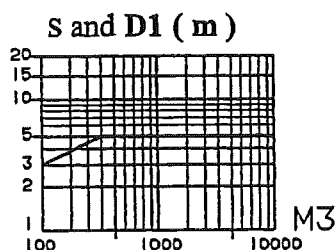
**– General**

- For key to symbols and supplementary constraints due to the risk study refer to:  
**AL-GR.204.40.**
- For distances around retention pits refer to **AL-GR.204.48.**
- The distances are in conformity with the prescriptions of **IGC.16/85 ; IGC.21/85 ; NFPA-50;** French legislation; (**CGA.P12 § 6.6.2** refers to **NFPA-50** rules) and **AIR LIQUIDE** rules. Even if national regulations authorize lower distances, the values indicated in this document must be considered as a minimum requirement.
- In the presence of a protection wall with a fire resistance of at least 2 hours. (cf. **NFPA** note **A.2.2** or decree of **10/03/97 § 2.1**), the values specified in this document are no longer mandatory.
- For the layout of **LOX** pumps and pressure relief valves, the requirements of **AL-SE.350.05** and **AL-GR.221.80** must be respected.

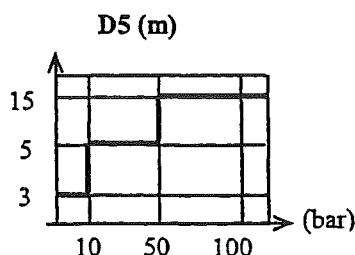
**Local rules, if more restrictive, supersede the practices listed below.**

**– Note 1:**

- **S ; D1 ; D2 ; D3** values depending on the **LOX** storage tank volume:



- **S** = Distance allowing to define the contour (—) of the "departure point" area, (from which **D1 ,D2 ,D3 ,D4 ...** will be measured). Value **S** is arrived at on the basis of all points where liquid oxygen leakage may occur in normal operation.
- **D4**: High-risk installations: distances according to national regulations (with a minimum of 15m), and / or values of specific risk study.
- **D5**: Value depending on gaseous storage pressure:





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– **Note 2:**

- For the USA, the NFPA imposes a minimum of 7.5m for slow burning materials and a minimum of 15m for fast burning materials.
- For constructions with an opening in close vicinity to the storage facility, even if the access is not much frequented (e.g.: MODIN®), the door must be at a at least 3 m away from the departure point (cf. NFPA-50.App A.1.2)

– **Note 3:**

- Should the natural ventilation of the storage facility be hindered by obstacles (buildings, walls...), a free space of 11m and 23m in 2 perpendicular directions is required (cf NFPA A.2.2).

– **Note 4:**

- As far as combustible or flammable gas storage facilities are concerned, the greatest distance between D3 and the values indicated in the table below are to be taken (extracted from NFPA-50 §2.2.6)

Storage	Quantity	Minimum Distance
H <sub>2</sub> gas	any	AL-GR.204.45
H <sub>2</sub> liquid	any	AL-GR.204.46
CnHm,Co...gaseous	≤ 708 m3	7.5m
	> 708 m3	15 m
CnHm,Co...liquid	≤ 3785 l	7.5m
	> 3785 l	15 m

– **Explanatory Notes:**

AL decisions correspond to identifiable risks which, as far as we know, are not governed by any regulation or for which specific recommendations by a recognized official body do not exist.

[a] IGC 21.85

[b] NFPA 50

[c] CGA P12

[d] French legislation - Decree of 10/03/97 - LOX storage facilities < 200 t.

[e] AL decision: In the same vein as IGC.21, group 3, with a minimum corresponding to the value indicated by NFPA 50 for flammable and combustible liquids.

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[f] AL decision: Identification of the risk related to the proximity of vessels under high gaseous pressure. The empirical correlation of distance/pressure indicated in the graph may be subject to modification, depending on the results of the risk study carried out for a given installation (e.g. taking into account the volume).

[g] Based on the NFPA 50 for volumes  $> 4 \text{ m}^3$ , a minimum distance of 15m was set, AL decided to apply this to all volumes.

[h] AL decision: No danger identified in this case, the recommended distance corresponds to a minimum maintenance and safety zone (liquid leakage..).

[i] AL decision Follow IGC recommendations; NFPA 50 indicates a fixed value, independent of the LOX volume.

[j] AL decision: Following the example of the NFPA 50, which imposes at least 15m for certain buildings (see note 2).

[k] AL decision: Following the example of the IGC, in conformity with the distance related to the property boundary.

[l] AL decision: Following the example of the IGC, but with a minimum distance of 10m to minimize the risk of direct contact between a HV power cable and the LOX storage facility in the case of rupture.

[m] AL decision: The thermal power of a burner or furnace was classified in the same category as hydrocarbon risks, such as defined by IGC, and minimum imposed by NFPA.

## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules

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Rev.	Date	Author	Signature	Modified paragraphs
0	07/10/97	L.Greter		Edition Originale / Original Issue
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## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules

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## 1 SCOPE

The present specification concerns the installation of liquid oxygen Process centrifugal pumps with a power of less than 200 kW and a MWP of  $\leq 50$  bar.gauge.

It defines the means to be implemented to protect the operators against potential risks related to the pumps and pump equipment.

## 2 GENERAL POINTS

Centrifugal pumps for LOX shall be in accordance with the following requirements :

- All pumps, irrespective of flow rate and pressure, shall be of the high performance type (definition in IGC 11/82 document).
- Have an automatic deconcentration system to avoid CnHm buildup, when pumps are kept cold during shutdown of units with "on call" personnel.
- Have an anti-cavitation protection.
- Use AIR LIQUIDE-authorized lubricants (note that oxygen compatibility of greases is limited and that it is essential to avoid their contact with oxygen).

In addition to the above, vertical labyrinth process pumps shall be equipped with the following systems :

- Safety system to avoid LOX leakage at the labyrinths (detection of leak of seal gas and low temperature detection at labyrinths)

## Protection and safety rules

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## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules

The protection of pumps of the module type is ensured by the lantern. The labyrinths are on the low pressure circuit on the pump suction side.

#### NOTE 2: Leak detector on the casing

Leakage inside the casing may in particular be caused by :

- wear of a flange joint,
- deficient welding,
- insufficient tightening,
- rupture of a hose.

If not detected, such an incident may have serious consequences :

- fracture of the casing,
- spilling of cryogenic liquid inside the casing.

As a consequence of modern operating conditions (less staff, units with "on call" personnel), visual control (patrol inspections) has a tendency to disappear. This fact must be taken into account.

In the case of an unit with "on call" personnel, it must be considered that an internal leak may only be detected after 48 hours (less than one week-end).

To avoid this risk, we recommend the installation of :

- probes of the PT 100 type beneath the casing, with the following action:
  - in units with permanently present staff (shift-work type), activation of an alarm on the TSL.
  - in units with "on call" staff, activation of an alarm on the TSL.

If the pump is not in operation: closure of the automatic suction valve and interdiction to start.

If the pump is in operation and if the TSL is in addition equipped with a cavitation alarm: disactivation of the pump with interdiction to start and closure of the suction control valve.

The above-mentioned devices concerning units with "on call" staff ensure the protection of the installation against risks caused by the rupture of a hose. For this, it is presumed that a control valve is installed.

The question whether a control valve will be installed or not depends on the liquid capacity contained upstream the suction valve liable to spill to the ground (less the vaporized quantity) and on the type of supervision during plant operation ("on call" staff or staff present on the site).

**NOTE 3:** Vent for seal gas + Process gas mixture : NPS 1".

Height above ground : about. 4 m for  $Q \leq 15 \text{ Nm}^3/\text{h}$ .

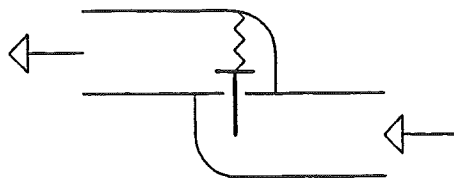
**NOTE 4:** System of evacuation in the case of liquid entrainment through the labyrinths (seat gate valve).

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## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules



Seat gate valve

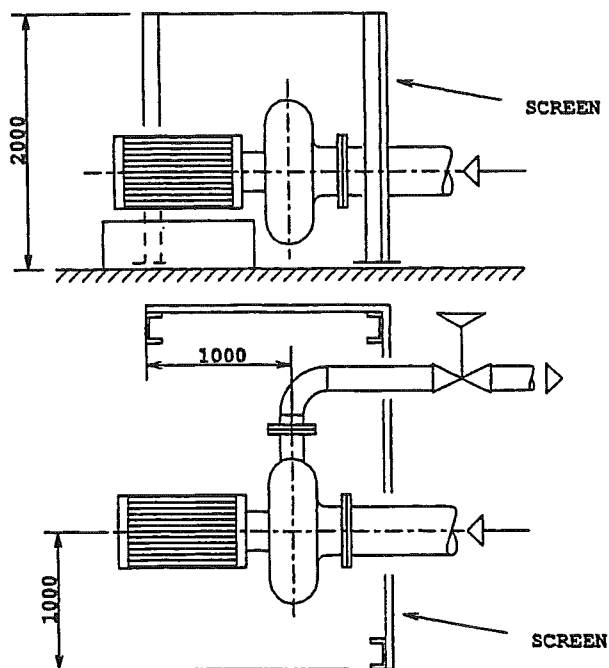
22180GRb

### 3.1.2 Pumps without thermal-insulated casing

A screen shall be provided to protect the operator against ejection of liquid in the following cases :

- Pump discharge at pressures equal to or above 30 eff. bar.
- Pumps with a sealing system (mechanical seal or labyrinths) submitted to a pressure above or equal to 11 bar.gauge.
- Pumps with suction or discharge flanges in conformity with the following:  $PD^2 \geq 3000$  or  $PD \geq 280$

with  $D = ND$  of the flange in cm and  $P =$  Maximum working pressure in bar gauge (Pressure at start of relief valve opening).



22180GRc

## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules

### 3.2 Suction filter

A conical filter consisting of a grid and a wire mesh shall be installed on the suction pipes of the pump.

- The filter will be permanently installed, unless special dispensation.
- The filtering fineness shall be 300 microns.

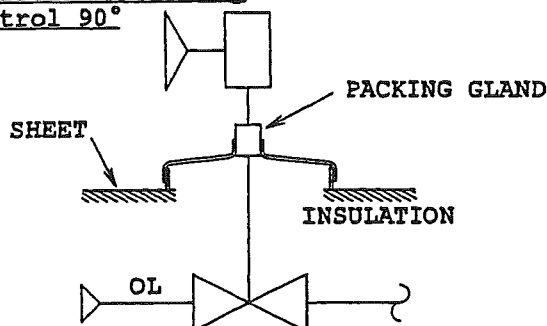
### 3.3 Safety system on liquid oxygen cryogenic valves

#### 3.3.1 Installation inside cold box

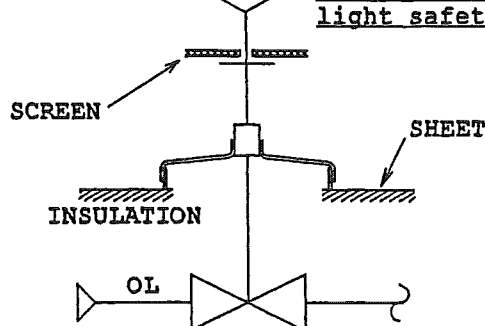
The only supposed risk for the operator : the stuffing-box of the valve.  
Two types of protection are recommended :

- Safety actuation by manual control 90°(see case "a" of 22180GRd).
- Protection with light safety screen (see case "b" of 22180GRd).

(a) Safety actualisation by manual control 90°



(b) Protection with light safety screen



22180GRd

**Rule:** In case (b), provide a protection for the operator when  $PD^2 \geq 3000$  (see notes).

#### 3.3.2 Installation outside cold box

**Piping and valve:**

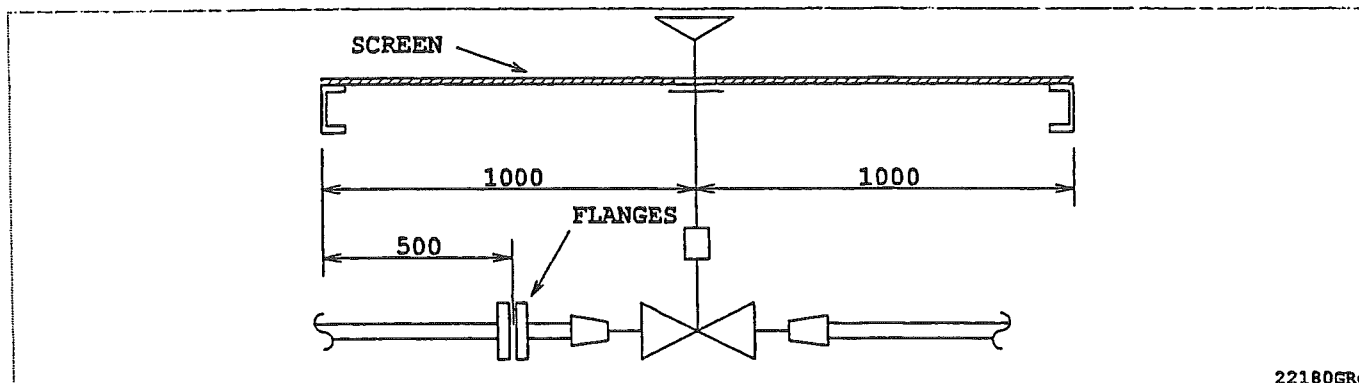
**Rule:** Provide a protection screen if  $PD^2 \geq 3000$  or if  $PD \geq 280$  (see notes).

If the piping is completely welded, take  $D = ND$  of the valve.



## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules



22180GR

### 3.3.3 Recycling by-pass

- Provide a fire protection screen if the first elbow downstream the pressure reducing valve is located opposite a pressurized element.
- Provide a straight length of 10 D minimum downstream the pressure reducing valve.

### 3.3.4 Piping accessories

This concerns for instance drain pipes.

Provide a screen if  $PD^2 \geq 3000$  or if  $PD \geq 280$  (see notes).

Example: For pipes submitted to a pressure of 40 bar, no protection is necessary up to ND 80.

Notes:  $D = ND$  valve in cm.  $P = MWP$  (= pressure at start of relief valve opening)

## 3.4 Safety system on motor bearing cooling system on pump side

Temperature control is interlocked with the startup of the Process pump and acts upon the heating system at shutdown.

## 3.5 Safety system on seal gas circuit

Make provision for an alarm and tripping in the case of :

- leak of seal gas flow
- low temperature at labyrinths.

Shutting down the pump and closing the suction valve in those cases.

## 3.6 Dimensioning of LOX pressure relief valves

Determine a set pressure that differs from the service pressure, so as to prevent the column or tank from being emptied in the event of non-closure of the relief valve.

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## HP LIQUID OXYGEN CRYOPUMPS

### Protection and safety rules

If a flow rate pressure relief valve is installed, it shall be taken into account for calculation of:

- the flash
- the back-pressure of the header pipe.