

# SAFETY

# Accident prevention results from safety awareness



## **BELIEF**

*All accidents  
can be avoided.*

*Zero accident  
is possible.*

## **CONDITION**

*Know your  
business.*

*Be aware of  
the hazards.*

## **BEHAVIOR**

*Learn, think  
and act in such  
a way as to  
avoid accidents.*

# PERSONAL PROTECTION EQUIPMENTS

PERSONAL SAFETY EQUIPMENT IS ESSENTIAL TO PROTECT YOU AGAINST SPECIFIC HAZARDS :

WRAP-AROUND GOGGLES



GLOVES



HEARING PROTECTION



AIR MONITOR



SAFETY HARNESS



CHEMICAL-PROOF CLOTHING



# BASIC RULES

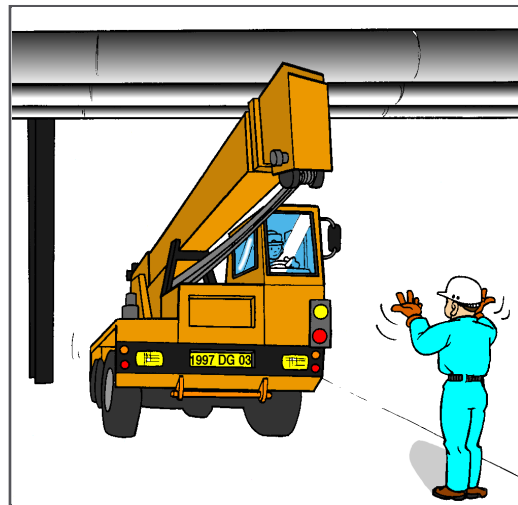
**YOU NEED PERMIT  
FROM YOUR  
EMPLOYER  
TO OPERATE  
MOBILE UNITS**



**THE EQUIPMENT MUST BE SUITABLE  
AND IN GOOD CONDITION**



**BE CAREFUL  
WHEN DRIVING  
UNDER PIPE  
RACKS**



HAVE A GUIDE  
DIRECT YOU,  
IF NECESSARY

**TRANSPORT GAS CYLINDERS  
IN SPECIALLY DESIGNED,  
VENTILATED VEHICLES**

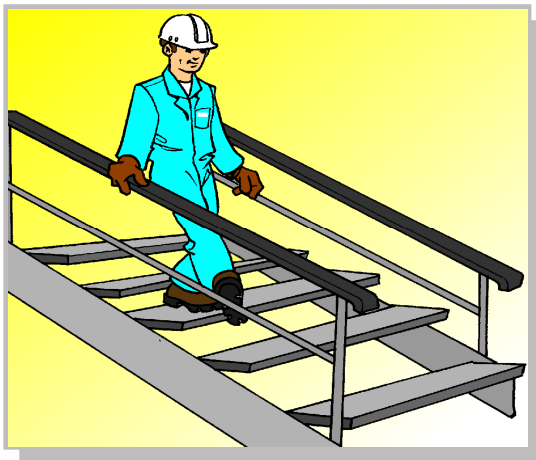


# BASIC RULES



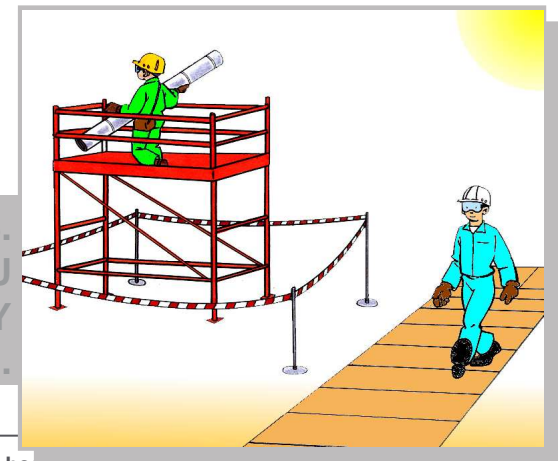
DO NOT RUSH, DO NOT RUN...

DO NOT ENTER WORK AREAS WHERE YOU HAVE NO ASSIGNMENT. AUTHORIZATION IS REQUIRED TO SOME RESTRICTED-ACCESS AREAS...



ALWAYS HOLD THE HANDRAIL WHEN USING A STAIRWAY...

STAY OUT OF CORDONED-OFF AREAS. THEY ARE THERE TO PROTECT YOU AGAINST HAZARDS WHICH MAY NOT BE VISIBLE TO YOU...



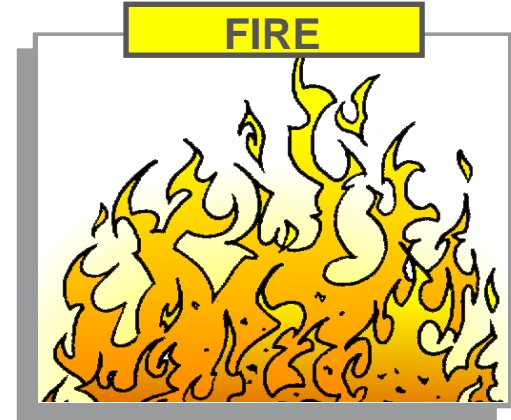
# MAIN RISKS OF GAS

All the gases produced or used at AIR LIQUIDE facilities can be dangerous.  
The presence of these gases is the main hazard related to our business.

## ASPHYXIA



## FIRE



## POISONING



!  
MAIN  
HAZARDS  
OF GASES

## EXPLOSION



Possibles causes :  
- LEAKS  
- PURGES  
- BLOWING  
- INERTING  
- LEAK TESTING

# MAIN RISKS OF GAS

## COMBUSTIBLE OR INFLAMMABLE GASES

Examples :  
HYDROGEN  
NATURAL GAS  
BUTANE  
PROPANE  
CARBON MONOXIDE (CO)



THEY BURN  
THEY EXPLODE

## OXIDIZING GASES

Examples :  
OXYGEN  
AIR



THEY SUPPORT  
AND ACCELERATE  
COMBUSTION

## NEUTRAL OR INERT GASES

Examples :  
NITROGEN  
ARGON  
CARBON DIOXIDE (CO<sub>2</sub>)



THEY DO NOT  
SUPPORT LIFE  
AND CAN CAUSE  
DEATH BY  
ASPHYXIATION

## TOXIC GASES

Examples :  
CARBON MONOXIDE (CO)  
AMMONIA  
CHLORINE  
PHOSGENE



THEY ARE TOXIC  
AND CAN CAUSE  
DEATH BY  
POISONING

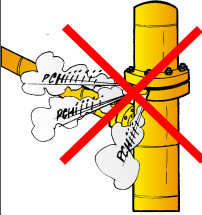

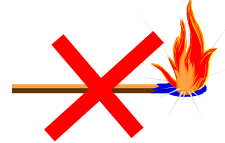

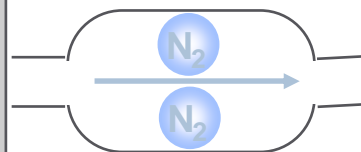
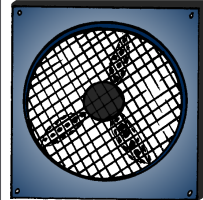



# MAIN RISKS OF GAS

## CHARACTERISTICS



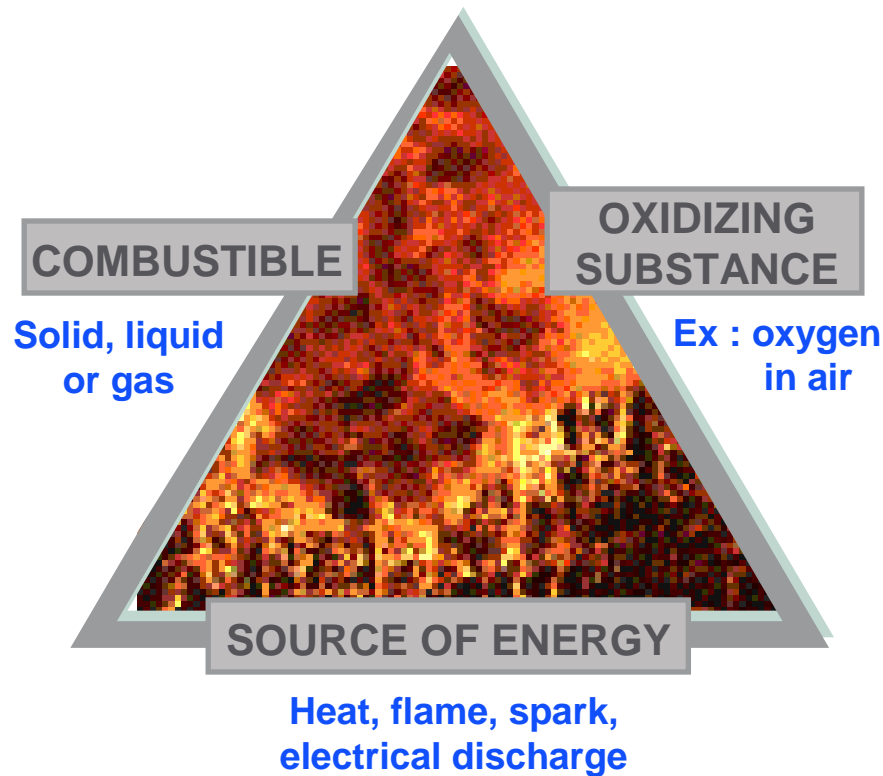
**GAS WHICH CAN BURN OR EXPLODE IN THE PRESENCE OF AN OXIDIZING SUBSTANCE (ex : air) AND A SOURCE OF ENERGY.**

## SAFETY PRECAUTIONS

 <p>No leaks</p>	 <p>No source of heat</p>	
 <p><b>DETECTION</b> Alarm sounds if <math>C &gt; 25\%</math> LEL</p>	 <p>INERTING</p>	 <p>AIR</p>
 <p><b>IDENTIFICATION</b> of pipes and storage areas</p>	 <p>Purge gases vented outside</p>	 <p>Specific electrical equipment</p>

# COMBUSTION

COMBUSTION IS POSSIBLE  
IF THE FIRE TRIANGLE IS COMPLETE



EXPLOSIVE LIMITS  
OF COMBUSTIBLE GASES IN AIR  
in the presence of a source of energy

0% of combustible gas in air

NO IGNITION

LEL : Lower Explosive Limit



UEL : Upper Explosive Limit

NO IGNITION

100% of combustible gas  
in the atmosphere

# METHANE AND PROPANE

METHANE (CH<sub>4</sub>)  
PROPANE (C<sub>3</sub>H<sub>8</sub>)

## DETECTION

Colorless, purposely odorized

## SPECIFIC GRAVITY / AIR

Methane → s.g. = 0.55

Propane → s.g. = 1.54



## EXPLOSIVE LIMITS





Methane → LEL = 5%    UEL = 15% in air

Propane → LEL = 2.4%    UEL = 9.5% in air



Dangerous product of combustion (CO<sub>2</sub>) !

## SPECIFIC PRECAUTIONS

-  Use only synthetic rubber.
-  Check valves.
-  Excess flow valves.
-  Detection by means of a portable device (explosimeter)

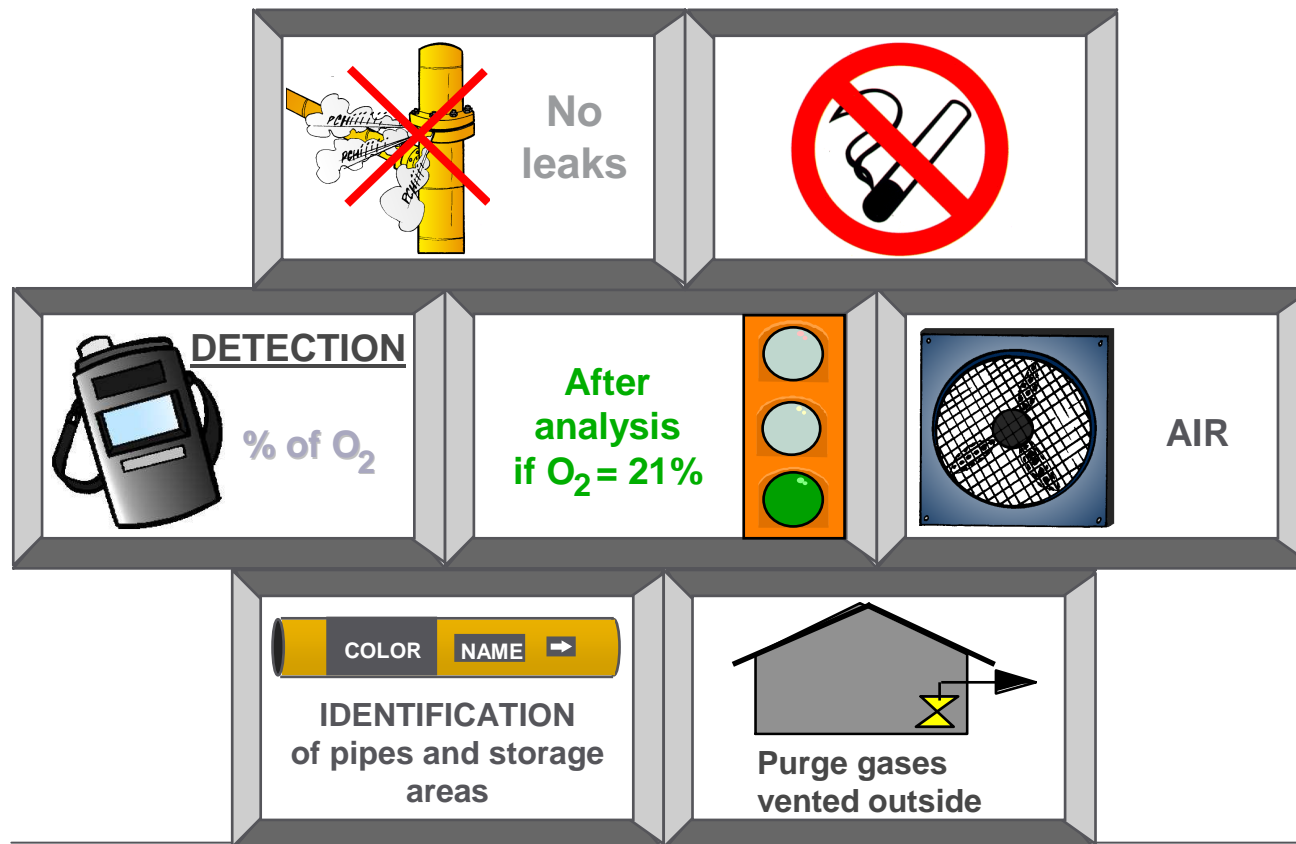
# METHANE AND PROPANE

## CHARACTERISTICS

**THESE GASES PERMIT AND SUPPORT COMBUSTION**



## SAFETY PRECAUTIONS



# OXYGEN

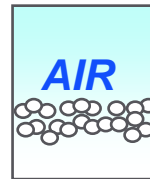
OXYGEN O<sub>2</sub>

## DETECTION

Colorless, odorless, tasteless

## SPECIFIC GRAVITY / AIR

s.g. = 1.1



## NORMAL PERCENTAGE BY VOLUME IN AIR







21%

## EFFECT OF OXYGEN-RICH ATMOSPHERE ON COMBUSTION

- ➔ Ignition of combustibles is easier.
- ➔ Flames are much hotter and spread faster.

% of O <sub>2</sub> in air	Effect on combustion
25%	ACCELERATED COMBUSTION
30%	VIGOROUS COMBUSTION
50%	INSTANTANEOUS COMBUSTION / EXPLOSION

## SPECIFIC PRECAUTIONS

-  Detection with alarm if the air contains more than 25% oxygen.
-  No grease, no oil.
-  No particles.
-  Clean and fire-resistant clothing.
-  Controlled flow and slow operation of equipment.
-  Clean floors made of non-combustible materials.

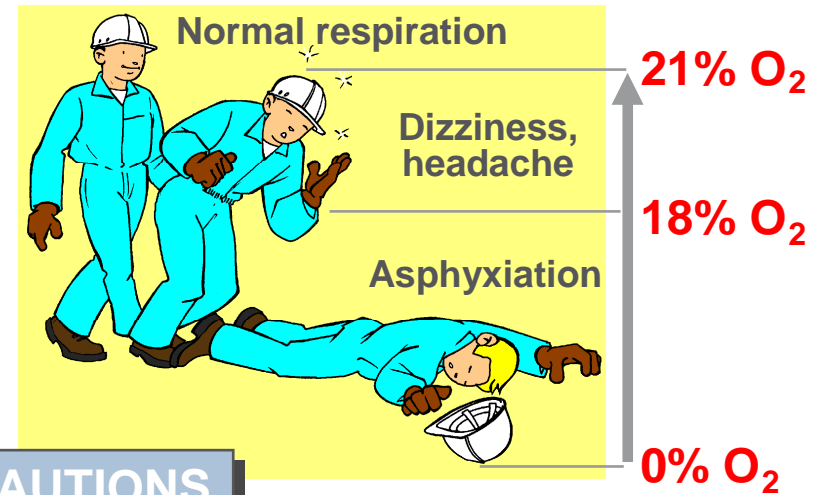
# OXYGEN

## CHARACTERISTICS

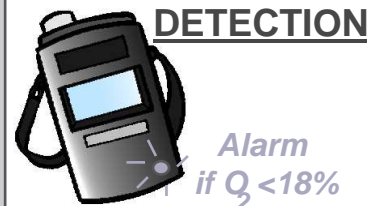


**GASES WHICH DO NOT SUPPORT LIFE.  
IN THE PRESENCE OF THESE GASES :**

- ➔ **DISPLACEMENT OF O<sub>2</sub> IN AIR,**
- ➔ **OXYGEN-POOR ATMOSPHERE,**
- ➔ **ASPHYXIATION.**



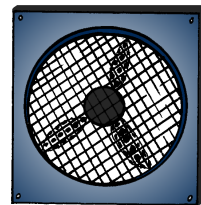
## SAFETY PRECAUTIONS



After analysis  
if O<sub>2</sub> = 21%

OR

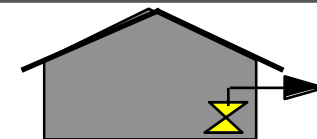
If O<sub>2</sub> < 18%



AIR



IDENTIFICATION  
of pipes and storage  
areas.



Purge gases  
vented outside

# OXYGEN

## GAS CYLINDERS MUST BE :



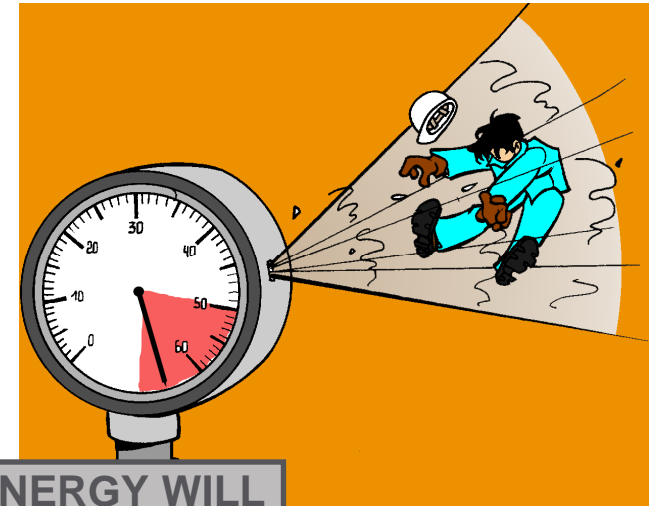
- ➔ Secured in an upright position (they must never be stored lying down !).
- ➔ Stored outdoors and segregated (combustible, oxidizing, neutral and toxic) to avoid any grouping of incompatible gases together. Away from flames.
- ➔ Tightly closed after use.
- ➔ Returned empty with the valve closed and the cap secured.
- ➔ Filled only by a certified Air Liquide plant.
- ➔ Transported only in specially-fitted vehicles.

- Follow the Regulations concerning the quantities stored.
- Clearly identify the gases (label or tag with composition).
- Never tamper with connectors and distribution networks.

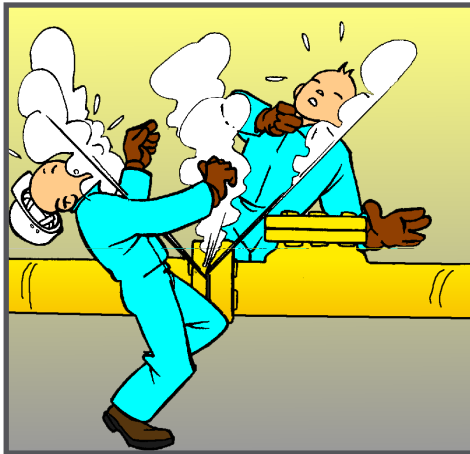
# PRESSURE

THE RISK INHERENT IN PRESSURE VESSELS  
STEMS FROM THE QUANTITY OF STORED ENERGY  
USED TO PRESSURIZE THE FLUIDS CONTAINED.

THIS ENERGY MAY BE CONSIDERABLE !



IN THE CASE OF A RUPTURE, THIS ENERGY WILL  
CAUSE A SUDDEN EXPANSION OF THE FLUID



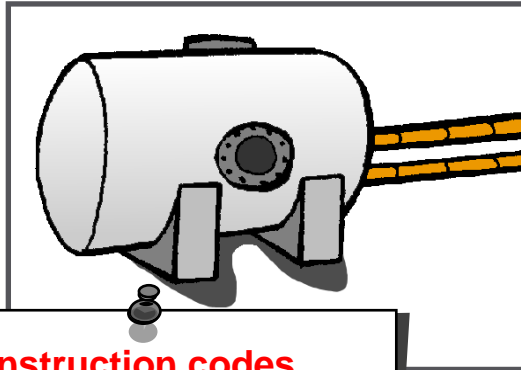
LEAK AND BURSTING



EXPLOSION

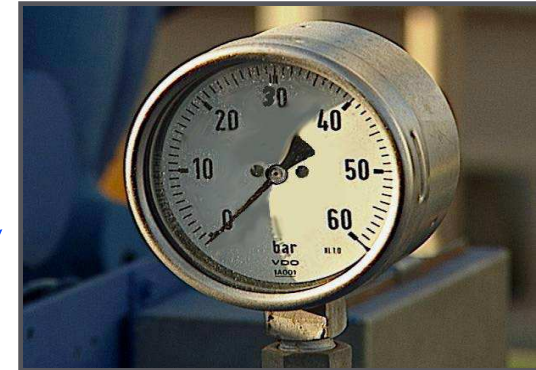
# PRESSURE

**PIPING AND CONTAINERS  
MUST COMPLY WITH  
CURRENT REGULATIONS**



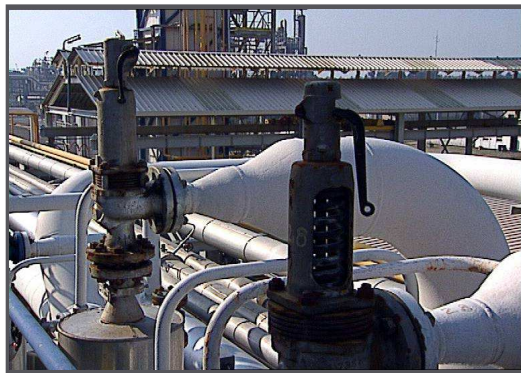
- > Construction codes
- > Periodic requalifications
- > Tests

**ALWAYS MAKE SURE THAT  
THERE IS NO PRESSURE BEFORE  
UNDERTAKING ANY WORK**



## SAFETY PRECAUTIONS

**SAFETY DEVICES**



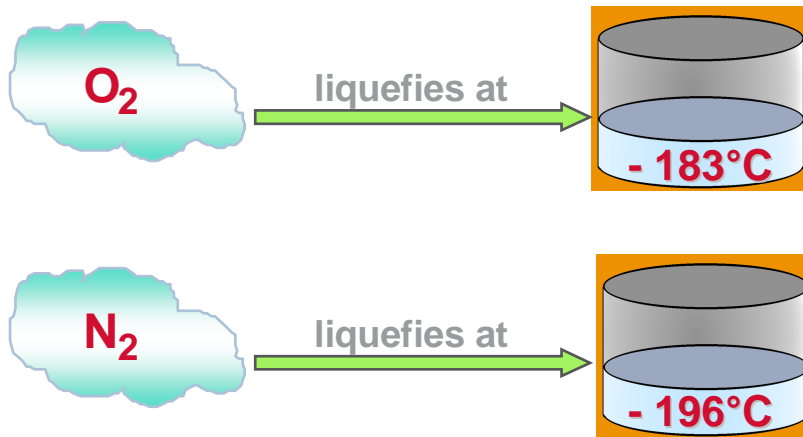
**FOLLOW OPERATING  
PROCEDURES**



IMMEDIATELY REPORT  
ANY IDENTIFIED DEFECT  
NOTED ON A PIECE  
OF EQUIPMENT,  
A PIPE OR A SAFETY DEVICE.

# COLD

OUR PROCESSES REQUIRE GAS COOLING AND LIQUEFACTION



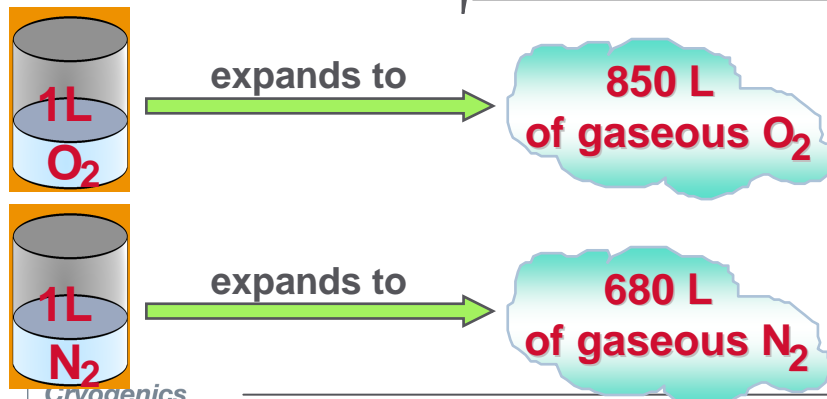
H  
A  
Z  
A  
R  
D  
S



CRYOGENIC  
BURNS

EMBRITTLMENT  
OF CERTAIN  
MATERIALS  
(carbon steels,  
plastics...)

LIQUEFIED GASES ARE EASIER TO STORE



H  
A  
Z  
A  
R  
D



CRYOGENIC  
FOG  
from purges,  
leaks, or high  
concentrations  
in air.

# COLD

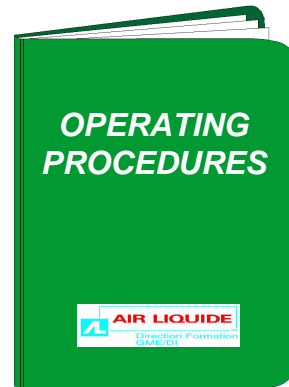
## SAFETY PRECAUTIONS

TO PROTECT AGAINST  
BURNS AT INSTALLATIONS  
HOLDING CRYOGENIC  
LIQUIDS, ALWAYS WEAR :



- WRAP-AROUND GOGGLES
- CRYOGENIC GLOVES
- SAFETY SHOES OR BOOTS

TO AVOID BRITTLE  
FRACTURE OF PIPING  
DUE TO LOW  
TEMPERATURES :



- CONFORMANCE TO PROCEDURES
- SAFETY EQUIPMENT IN OPERATING CONDITION
- PROPER MATERIALS

TO AVOID FALLS  
AND BURNS CAUSED  
BY CRYOGENIC FOG :

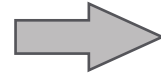


NEVER WALK  
THROUGH  
A CRYOGENIC FOG

# CONFINED SPACES

## DEFINITION :

AREAS OR STRUCTURES WITH POOR NATURAL VENTILATION WHERE THE ATMOSPHERE MAY BE DANGEROUS (sumps, cold boxes, vats...)



ASPHYXIA



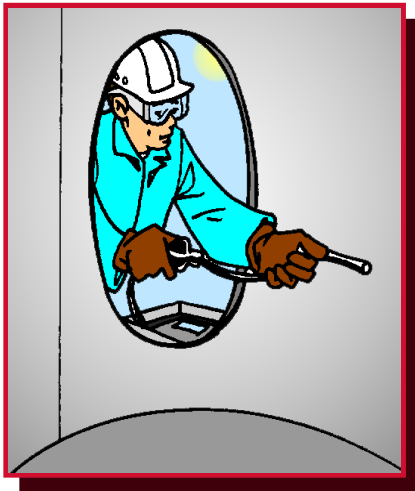
POISONING



EXPLOSION

## SAFETY PRECAUTIONS

There are specific procedures for performing work in confined spaces, for example :



ANALYSIS OF  
ATMOSPHERE



- SPECIFIC PROTECTION EQUIPMENT  
- PERMANENT WATCH GUARD IN THE ENTRANCE



AIR  
VENTILATION

# PERLITE

## 2 DEATH-HAZARDS OF DEATH !

THEY ARE VENTILATED WITH NITROGEN

IF THEY CONTAIN PERLITE

**RISK OF ASPHYXIATION**



**LOCK-OUT/TAG-OUT OF THE NITROGEN SUPPLY**



**CONSTANT MEASUREMENT OF % OF O<sub>2</sub>**

**VENTILATION WITH FRESH AIR**



**YOU CAN DROWN IN PERLITE**

**CONSTANT SUPERVISION BY A CO-WORKER**

**HARNES  
MASK  
WRAP-AROUND GOGGLES**

Filling or emptying perlite

# OTHER PRODUCTS

**CERTAIN DANGEROUS PRODUCTS ARE USED AT OUR FACILITIES OR CONSTRUCTION SITES, for example :**

- **SULFURIC ACID**
  - **CAUSTIC**
  - **JAVEL**
  - **TRICHLOROETHYLENE AND SOLVENTS**
  - **CORROSION INHIBITORS**
- } used primarily for water treatment

## LEARN TO RECOGNIZE THE SYMBOLS OF THESE PRODUCTS



I. IRRITANT

**CORRODES**  
**ITCHES**



CORROSIVE

**POISONS**



N. NOXIOUS



TOXIC

## READ THE LABEL CAREFULLY



C. CORROSIVE

### LABOROP

12, rue de Versailles  
75001 PARIS  
Tél : 01 42 12 12 12

### 95% SULFURIC ACID CAUSES SEVERE BURNS

- Wear appropriate protective clothing, gloves and eye protection.
- Never pour water into this product.
- In case of contact with eyes, flush immediately with water and seek medical advice.
- In case of accident or if you feel ill, seek medical advice immediately (if possible, show the label to the physician).

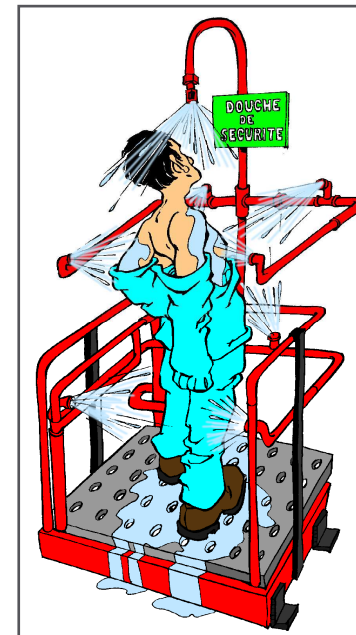
# OTHER PRODUCTS

**WEAR APPROPRIATE PROTECTIVE EQUIPMENT**

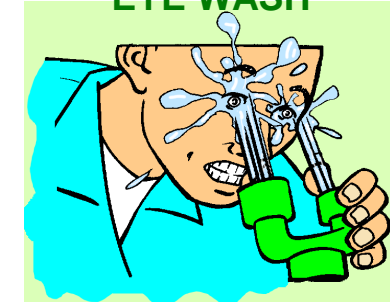


**IN CASE OF CONTACT WITH A DANGEROUS PRODUCT:**

**IMMEDIATELY FLUSH THE CONTAMINATED AREA WITH COLD WATER FOR AT LEAST 15 MINUTES...**



**USE AN EYE WASH**

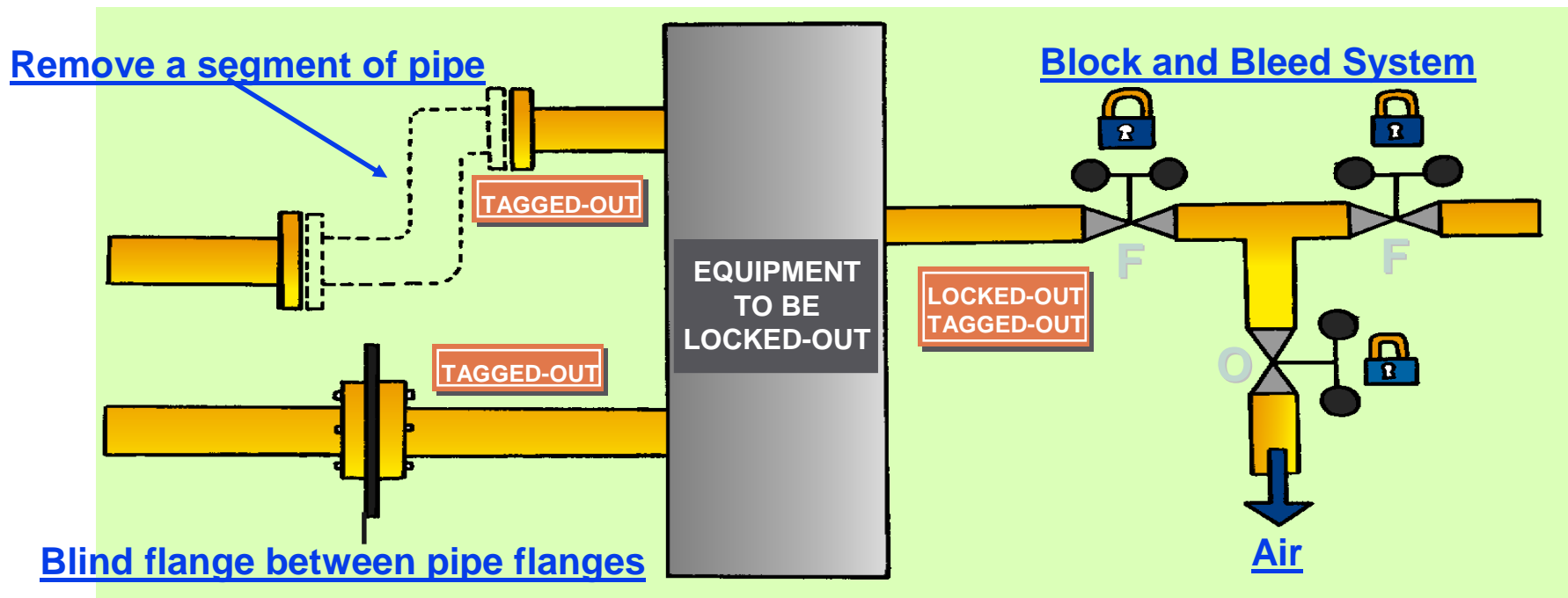


**When undertaking very risky work, a co-worker must watch constantly with a fire hose.**

# LOTO

## WRITTEN PROCEDURE FOR LOCKING-OUT / TAGGING-OUT OF GAZ SYSTEM :

- ▶ Shut down the equipment; depressurize.
- ▶ Purge all liquids, derime, inert, ventilate with air, check.
- ▶ Isolate all process circuits and utilities around the work area mechanically and visibly :



- ▶ Numbered diagram indicating the points of disconnect.
- ▶ Each point of disconnect to be lagged.
- ▶ Frequent analysis of air in locked-out / tagged-out area.

# EAR PROTECTION

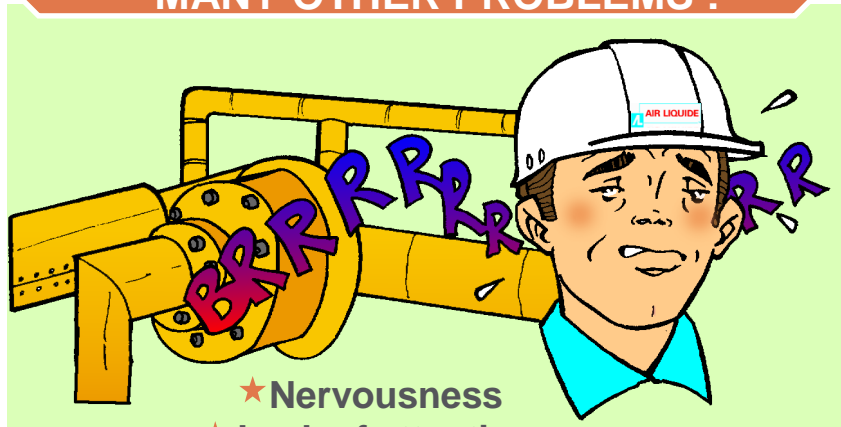
**NOISE DESTROYS THE CELLS  
IN THE INNER EAR AND CAUSES  
DEAFNESS.**



*In the present state of advancement  
of medicine, this type of deafness  
cannot be corrected with hearing aids.*

**THIS TYPE OF DEAFNESS IS IRREVERSIBLE !**

**NOISE CAN CAUSE  
MANY OTHER PROBLEMS :**



- ★ Nervousness
- ★ Lack of attention
- ★ Loss of concentration
- ★ 20% increase in fatigue



**INCREASE IN PROBABILITY  
OF ACCIDENTS**

**WEAR YOUR HEARING  
PROTECTION**



**EARMUFFS**



**EAR PLUGS**

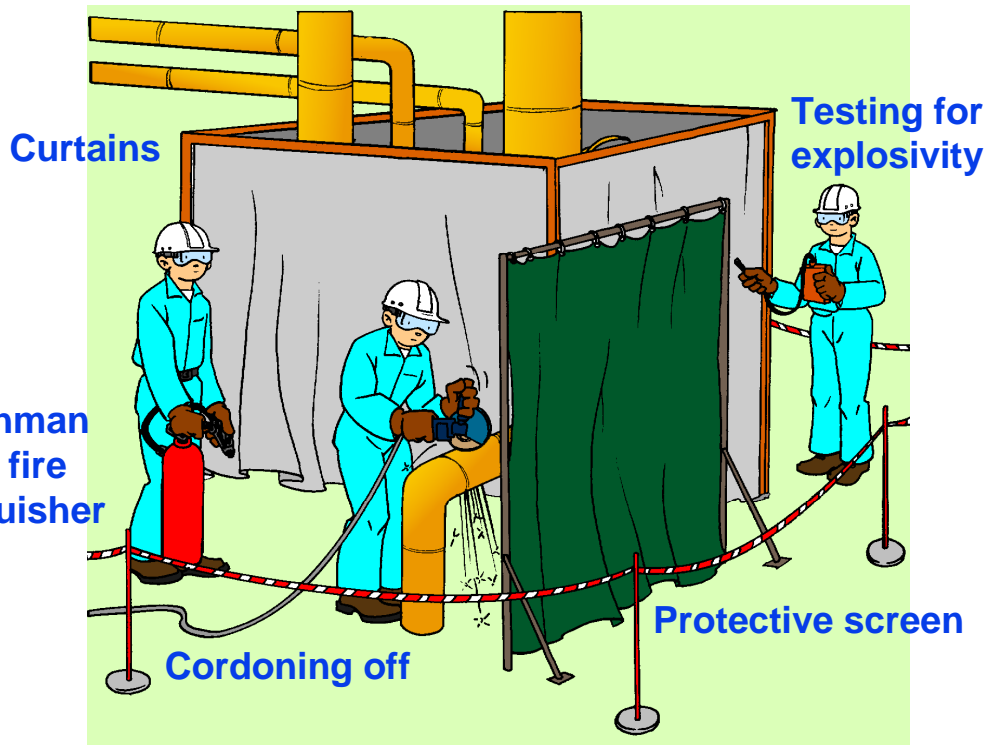
**RECOMMENDED** for noise levels of **85 dB(A)** and up.

**MANDATORY** for noise levels of **90 dB(A)** and up.

# WELDING



**THE HAZARDS :**  
- FIRE, EXPLOSION,  
- BURNS,  
- PROJECTION OF PARTICLES  
INTO THE EYES.



**WEAR THE APPROPRIATE PROTECTIVE EQUIPMENT**



**ANY WORK THAT POSES A FIRE HAZARD MUST BE DONE AS AUTHORIZED AND IN ACCORDANCE WITH THE SAFETY PRECAUTIONS INDICATED IN THE WORK PERMIT.**

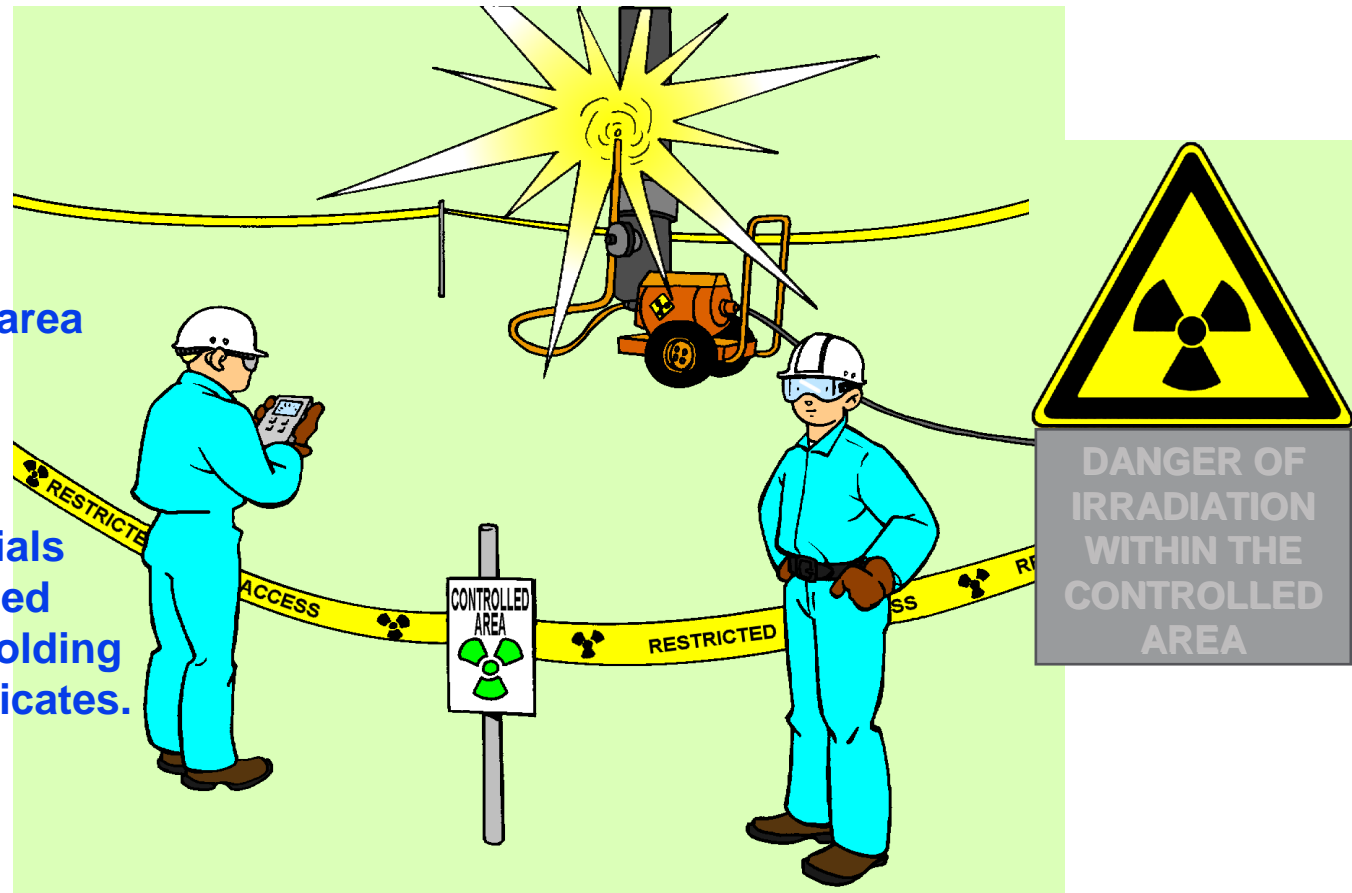
# IRRADIATION

## THE HAZARDS :

Ionizing radiation which if it penetrates the organism may cause :  
---> SKIN DISEASES, BONE DISEASES, EYE DISEASES, LUKEMIA, CANCER...

Controlled,  
cordoned off  
and identified work area

Radioactive materials  
can only be handled  
by qualified people holding  
the appropriate certificates.

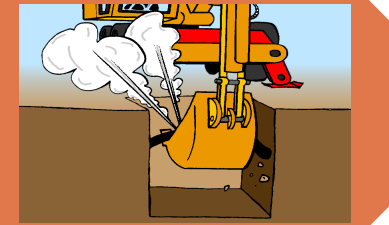


**ENTERING A CONTROLLED AREA IS STRICTLY PROHIBITED**

# EXCAVATION

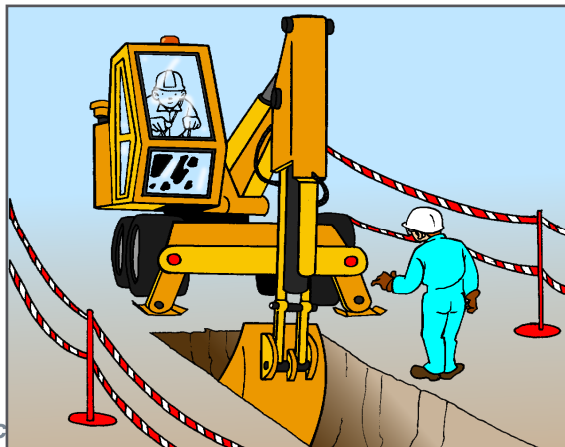
## THE HAZARDS :

- Electrical or instrumentation conduits may be damaged.
- A gas pipeline may be punctured.
- Someone may fall into a trench and be buried there.



**1** Concerted effort to determine the type of terrain and the location of networks (localizing, mapping).

**2** The area must be cordoned off. Constant supervision of equipment at work.



**3** Digging must be done with manual tools within 50 cm of where conduits or pipelines are supposed to be located.



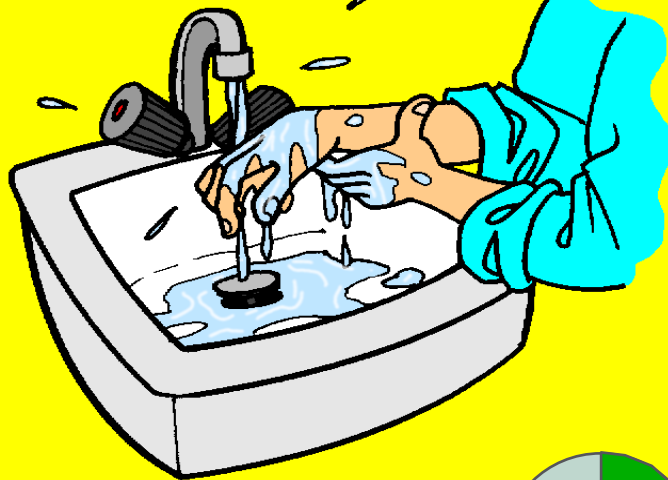
**4** Shoring is required at depths of 1.3 m or more.



# BURNS

FOR ANY TYPE OF BURN :

- CHEMICAL
- HEAT
- CRYOGENIC



Flush thoroughly  
with cold water  
for at least 15 minutes.

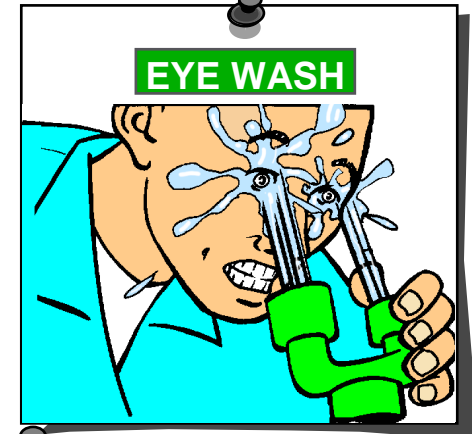
15'

USE ANY MEANS  
AVAILABLE NEARBY

SHOWER



EYE WASH



FIRE HOSE

