SAFETY TRAINING OF EMPLOYEES

AIGA 009/04

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1 Introduction

In the gases industry, accidents can and unfortunately do occur at all stages of manufacturing and handling i.e. production, cylinder filling and handling, maintenance and distribution.
Accidents records and statistics show that newly hired and inexperienced employees are more prone to accidents than others. Data that focus not on age but on length of service give similar results and confirm that the frequency rate of work accidents decreases with length of service. But statistics fail to explain why so many accidents occur with new employees.
Regulations, being generic by nature, do not provide sufficiently detailed guidelines as to the content of the training required in a specific industry. This document collates and shares the vast experience acquired by the industry in training new employees.

2 Scope and purpose

This document is intended to serve as a guideline for managers to develop their own training programs.

2.1. Scope

The document aims at offering answers to the following questions for employee safety training:

- Which topics must be included in the training?
- Which key messages should be delivered as part of each topic?
- How to arrange a consistent training schedule?

This document mainly deals with the common industrial gases, namely oxygen, nitrogen, hydrogen, argon and acetylene.
It also deals with basic safety rules, the use of hand tools and portable power tools, chemicals and solvents, safe procedures and safety instructions related to the use of fork lift trucks, electricity, fluid pressure, fire and protective devices, cylinders handling, etc.
This document is not a design or operating procedures reference document.

2.2. Purpose

It should be borne in mind that the newly hired or reassigned INDIVIDUAL has everything to learn about the specific details of his/her JOB, the hazards of the materials he/she will be handling and the TOOLS at his/her disposal. Lacking experience and training, he/she is vulnerable to all the risks involved.
An employee can also be affected by the unfamiliar work environment of a new job which includes both the physical factors such as noise and heat, as well as the new relationships he/she must establish with his/her colleagues and superiors.
The arrival of new employees is a unique opportunity for management to help them understand the work environment and ensure rapid and safe integration. This responsibility must be accepted by management.
A sound training programme helps to create relations of trust which are beneficial to the safety awareness of a new employee.
Although the publication is primarily intended on training of new employees, it will also have its usefulness to re-train experienced employees.
This document aims at helping the Plant Manager to select the proper safety training material when having the first contact with the new employee before the starts work. Selected material could be used to write a training programme for an existing employee who is being transferred to a new job or just to periodically refresh employees' knowledge on basic Safety rules and practices.

3 Guidance notes

3.1. Checklists and leaflets

The document consists of a Safety Training Checklist and leaflets which contain information which must be known by the new employee and, therefore, includes data on product and equipment characteristics, hazards and precautions.

3.2. Training program

Before receiving the new employee, the Plant Manager (or equivalent) prepares a written training programme consistent with the function of the new employee. He/she should do this using the Safety Training Checklist and selecting the leaflets appropriate to the employee's job – a guide to selection of leaflets is given in 3.5. (non-selected items are identified as Non Applicable). Manufacturer's instruction booklets and in-house safety documentation constitute another source. The trainee should be given a copy of the checklist, the appropriate leaflets and other materials as selected by the manager.
The program should include the names of all persons responsible for initiating actions, together with dates, time and location for each

separate activity.

3.3. Training records

Records of training should be kept. This will include a copy of the checklist signed by the trainee to acknowledge that he/she has received and understood the training.

3.4. Training process

It is not sufficient just to hand over written material to the trainee. Each document must be explained to him/her by the trainer, manager or supervisor and worked through to give the trainee the best opportunity to understand it. The written material should be supplemented by the use of suitable videos and slides.
The understanding of the trainee should be checked during the training and after it has been completed. When possible, simple written comprehension tests should be performed.
There should be a follow up within a suitable period of time to ensure that the essential safety points have been remembered.

3.5. Program selection

The leaflets appropriate for each job are given below – see the contents list for titles -:

- Liquid handling : 1, 2, 4, 11, 13, 14, 16, 22.
- Fork Lift Truck : 1, 8, 9, 10, 12, 16, 20.
- Cylinder handling : 1, 8, 9, 10, 12, 16.
- Cylinder filling : 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 16.
- Operating Air Separation Unit : 1, 2, 4, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22.
- Transport bulk liquid gases : 1, 2, 4, 5, 11, 13, 14, 16.
- Transport cylinders : 1, 3, 5, 8, 9, 10, 12, 16.
- Maintenance Air Separation Unit : 1, 2, 4, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22.
- Maintenance HP cylinders : 1, 2, 3, 4, 5, 8, 14, 16, 17, 18, 19, 21.
- Maintenance customer installations : 1, 2, 4, 6, 7, 8, 9, 11, 13, 22.
- Operating acetylene plants : 1, 7, 9, 13, 14, 15, 16, 20, 22.
- Maintenance acetylene cylinders : 1, 7, 9, 14, 15, 16, 17, 20.
- Maintenance acetylene plants : 1, 7, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22.
- Maintenance filling plants : 1, 2, 3, 4, 5, 11, 12, 13, 22.

4 Checklists and certificates

4.1. Safety training checklist

The safety training checklist is a document designed to be used by the employee's immediate manager to serve as training plan, record and feedback document. When possible, the senior manager and the safety adviser should be involved in approving the training programme and in monitoring progress. **Appendix A** presents a model template.

4.1.1. Scope

The checklist is not a training manual and sections which request specific training should only be completed when the relevant training has been delivered.
The checklist shown in this document is only a basic model which is not exhaustive and may be varied according to the needs of particular installations and employees.

4.1.2. Use

The manager responsible for the overall training programme must complete the first column on the right hand side of the check list by inserting against each item the name of the person responsible for carrying out that item of training or, if not applicable, mark N/A. Items can be added at the manager's discretion and to suit specific needs.
Completion of the safety training checklist and delivery of the "Safety Qualification Certificate" (see hereafter) is not a substitute for job training, nor does it constitute a record that an employee has been trained to perform the job(s) for which he/she has been recruited. Therefore, separate records of training in all aspects of an employee's job must be kept in his/her training file in addition to the safety training records.
The safety-training checklist has been divided into 7 sections but neither these sections nor the order of the items in a section constitute a priority list.
When an employee changes job, he/she will need to be trained accordingly and the appropriate sections of the checklist should be used. This "new' training session need be documented as requested above.
The safety-training checklist does not make any reference to the testing of employees' knowledge and skills. This is deliberate, as practices vary widely between companies and

countries. Statutory testing – as for welders – has still to be carried out and recorded separately.

4.2. Certificates

Two certificates are part of the training process. Model templates are in **appendix B.**

4.2.1. Induction Training Certificate

This Induction Training Certificate documents that the new employee has been provided with basic information and Personal Protective Equipment before being allowed to report at his workplace.

4.2.2. Safety Qualification Certificate

The Safety Qualification Certificate, when completed and signed as requested, documents that the employee has received specific training in all matters relating to Safety, as well as safety information relating to his/her job and the materials which he/she will be handling. It is the responsibility of the employee's immediate manager to see that the form is completed in every detail and filed in the appropriate manner.

5 Safety leaflets

There are 22 leaflets covered in **appendix C** :

1. Basic rules for safety and good housekeeping.
2. Oxygen.
3. Nitrous oxide.
4. Inert gases (nitrogen and argon).
5. Carbon dioxide.
6. Hydrogen.
7. Acetylene, calcium carbide, lime sludge and purifying materials.
8. Cylinders for compressed gases.
9. Acetylene cylinders.
10. Loading and transporting cylinders.
11. Cryogenic liquid spills and vapour clouds.
12. Forklift trucks.
13. Critical safety systems – alarm & tripping devices.
14. Pressure.
15. Electricity.
16. Fire.
17. Hand tools.
18. Portable electric tools.
19. Portable pneumatic tools.
20. Chemicals.
21. Solvents.
22. Work Permit.

The safety leaflets summarize the basic operational safety knowledge which needs to be known by employees working in the gas industry.

Refer to 3.5 for the various combinations of leaflets which define the scope of safety training for a variety of specific jobs.

Each leaflet addresses a specific topic as briefly described in its headline.

Each leaflet is wearing a dedicated page numbering identification and the various items and instructions, which compose a leaflet, are identified by an item number.

	Training completed	
Trainer or N/A	Signature of trainer	Date

1. SAFETY EQUIPMENT

1.1. Has the appropriate Personal Protective Equipment been given to the employee ?

- appropriate work clothes
- safety boots/shoes
- gloves
- eye protection
- hearing protection
- hard hat

1.2. Have the rules regarding wearing of personal protective equipment been explained?

1.3. Does employee know that special protective clothing (impermeable gloves, apron or suit, boots, goggles, face shield) must be worn when work is being done on caustic/acid installations or with solvents and where it can be obtained ?

1.4. Does employee know that clothing contaminated with caustic or acid has to be removed carefully ?

1.5. Has employee been told that damaged or unserviceable personal protective equipment must be replaced and that any damage to safety equipment must be reported to his/her supervisor ?

1.6. Has employee been told that emergency equipment must not be used for routine jobs ?

1.7. Has employee been shown where emergency showers and eyewash devices are located and how to use them?

1.8. Does employee know why showers and eyewash bottles are provided in some plant areas and the importance of preventing their misuse ?

1.9. Has employee been told that it is dangerous to wipe his/her eyes or face with hands which may have come into contact with chemicals or solvents?

	Trainer or N/A	Training completed	
		Signature of trainer	Date
1.10 Does employee know where self-contained breathing apparatus, canisters and safety harness are kept and that they can only by used by trained personnel ?			

2. HAZARDS

	Training completed	
Trainer or N/A	Signature of trainer	Date

2.1. Have all specific documents relevant to the job been given to employee ?

2.2. Have the Work Instructions which concern employee's particular work and general matters been pointed out to him/her ? Has employee read and understood them ?

2.3. Has the meaning of all relevant safety signs been explained ?

2.4. Is employee aware of the precautions to be taken when handling or working with :

- i Gaseous and liquid oxygen, nitrogen and argon ?
- ii Nitrous oxide, carbon dioxide
- iii Hydrogen ?
- iv Dissolved Acetylene (DA) ?
- v Caustic materials, acids, solvents (i.e. acetone), calcium carbide, carbide sludge, purifying materials, molecular sieves, insulation materials,...?

Any relevant safety booklets should be used at this stage.

2.5. Does employee know the hazards associated with :

- I Oxygen plus oil, grease or other flammable or organic substances ?
- ii Acetylene or hydrocarbons in liquid oxygen (air separation plants only) ?
- iii Liquid oxygen spillages on black top(asphalt)...?
- iv Oxygen deficiency which can be created by spillage or venting of nitrogen or argon in confined spaces?
- v Oxygen enrichment due to spillage or venting ?
- vi Improper use of plant utilities, such as steam and compressed air ?

2.6. Does he/she know that hot work, including the use of naked flames may only be carried out in certain specified areas which have been pointed out to him/her, or after the issue of the appropriate Work Permit ?- see Leaflet 22 -.

2.7. Does employee fully understand hazards associated to flames / sparks... and that smoking is only allowed in certain areas which have been pointed out to him/her?

	Training completed	
Trainer or N/A	Signature of trainer	Date

2.8. Does employee know that he/she must not bring matches, transistor, radios or other unapproved electrical devices, lighters or smoking materials within the boundary of DA and hydrogen storage and production areas ? (DA = Dissolved Acetylene).

2.9. Is employee aware of the instructions for action in case of fire... ?

i Does employee know the location of fire extinguishers, hydrants and hoses?
ii Has employee been given a demonstration of the use of appropriate fire extinguishers and hoses ?
iii Does employee know the location and sound of the fire and evacuation alarms ?

2.10 Have instructions been given in emergency procedures relevant to employee's job and does employee know the position of emergency stop buttons and emergency shut-off valves ?

2.11 Has the site emergency plan been explained including employee's particular role ?

2.12 Does employee know his/her meeting point in case of emergency ?

2.13 Record here when present at a site emergency drill or training session.

2.14 Does employee know how to identify the contents of cylinders by :

a the written word (label) ?
b colour code ?
c valve type ?

2.15 Have the dangers of filling damaged cylinders been explained to him/her ?

2.16 Have the dangers of overpressurizing cylinders been explained ?

2.17 Have the dangers of allowing an out of standard cylinder to be despatched been explained (i.e. empty, uncapped, incorrect labels,...) ?

	Training completed	
Trainer or N/A	Signature of trainer	Date

2.18 Has the procedure for reporting safety hazards been explained to employee ?

2.19 Has employee been instructed to report gas leaks on equipment and faulty connections ?

2.20 Does employee know what to do when cryogenic transfer hoses and/or high pressure filling hoses rupture ?

2.21 Does employee know the dangers of continued exposure of hands and other parts of the body to solvents ?

2.22 Does employee know that there are approved skin cleansers, and where to find them ?

2.23 Is employee aware of the role he/she is expected to play in housekeeping of the area or section in which he/she works and the importance of it in prevention of accidents?

3 . WORK PERMIT

	Trainer or N/A	Training completed	
		Signature of trainer	Date
3.1. Does employee know how the Work Permit system operates ?			
3.2. Is employee aware of when Work Permits must be used ?			
3.3. Have the signing on and signing off procedures concerning permits been explained to employee and has he/she been instructed on what to do if the job is interrupted, or handed over to someone else ?			
3.4. Has employee been instructed to observe permit “special precautions” and “protective clothing” requirements, during the validity period of the permit ?			
3.5. Is employee aware that under certain circumstances a permit could be necessary in a workshop ?			
3.6. Has employee been instructed in lock out and tag out techniques (electrical, mechanical and pipework) and their importance ?			
3.7. Does employee appreciate that when special precautions are called for, the person who has taken over is authorized to carry out ONLY the job described unless further authority approval has been obtained?			
3.8. Is employee aware of the special precautions which must be taken when it is necessary to enter a confined space? And how to recognize a confined space ?			
3.9. Is employee aware of any special arrangements which exist for isolating electrical systems ?			

	Training completed	
Trainer or N/A	Signature of trainer	Date

4 . MECHANICAL & ELECTRICAL HAZARDS

4.1. Has employee been instructed in the proper methods of breaking into lines ?

4.2. Does employee know where low voltage hand tools should be used ?

4.3. Does employee know the rules governing the use of standard voltage hand tools ?

4.4. Is employee familiar with the hazards associated with soldering, welding and flame-cutting and the correct precautionary measures ?

4.5. Does employee know that he/she is required to wear additional eye protection for certain tasks and/or in certain locations and have these tasks and locations been explained to him/her?

4.6. Does employee know that special precautions are required for working on roofs or in excavations ?

4.7. Have rules relating to the use, care and return of ladders and lifting equipment been explained ?

4.8. Has employee been told that access to fire equipment, emergency exists and electrical switchboards must be kept clear at all times ?

4.9. Has employee been instructed how to handle cylinders and other heavy objects correctly ?

4.10 Does employee understand that only trained personnel can use cranes and lifting equipment ?

4.11 Is employee aware that only qualified electricians can carry out electrical repairs, even though apparently trivial ?

5 . TRAFFIC HAZARDS

5.1. Has employee been told that a speed limit exists for all vehicles in the factory ?

5.2. Has employee been told that only trained and authorised personnel are allowed to drive or operate forklift trucks ?

5.3. Has employee been told that riding as a passenger on a forklift truck or the back of a lorry is forbidden ?

5.4. Has employee been advised to keep clear from vehicles that might move without warning...?

5.5. Has employee been instructed to report all unsafe conditions at customer's premises as well as in the factory ?

5.6. Does employee know that he/she should use pedestrian walkways when they are available/identified ?

Trainer or N/A	Training completed	
	Signature of trainer	Date

	Training completed	
Trainer or N/A	Signature of trainer	Date

6 . FIRST AID AND INJURIES

6.1. Does employee know who is his/her department first-aider and where he/she is located ?

6.2. Does employee know that all injuries must be reported to his/her Supervisor and a record made in the Accident Logbook as soon as possible ?

6.3. Does employee know that if an injury occurs which necessitates his/her absence from work, he/she must, as soon as possible before the first day or shift of absence, inform his/her Supervisor?

6.4. Does employee know that, during absence from work, he/she may be requested to attend medical examination by an appointed Doctor ?

6.5. Does employee know that, on return to work, he/she may be required to be examined by an appointed Doctor ?

	Training completed	
Trainer or N/A	Signature of trainer	Date

7 . SAFETY ORGANISATION

7.1. Has the employee been given a copy of the Site Safety Policy ?

7.2. Has the Safety Policy been explained to employee ?

7.3. Has Safety organisation (Company and operating unit) been explained to employee ?

7.4. Does employee know to whom he/she should address queries on Safety ?

7.5. Has employee been advised about the function of the Safety Committee ?

7.6. Has employee been advised about Safety Audits and inspections and the role he/she may be asked to play ?

COMPANY / SITE

"I N D U C T I O N T R A I N I N G C E R T I F I C A T E"

- Training of New Employees -

This form must be completed before the employee starts work :

Name : .....

Id. N° : .....

Job Title : .....

Department : .....

The above employee was instructed about the basic rules of safety and good housekeeping per leaflet 1.

The following documents were handed over :

- Safety Training Check List,
- Leaflet 1

Employee was provided with following pieces of personal protective equipment :

- Hard hat,
- Safety glasses,
- Safety shoes.

Date :

Names/Signatures :

Immediate Manager : ....

Employee : ....

Comments :

.....
.....
.....
.....
.....
.....

COMPANY / SITE

"S A F E T Y Q U A L I F I C A T I O N C E R T I F I C A T E"

- Training of New Employees -

This certifies that..... (Id. N°).....
was delivered Safety training as detailed in the sections 1 to 7 of attached Safety Training check list.

JOB / FUNCTION :..... Department : .....

Date/time job start :.....

Name/Signature of
immediate Manager : ..... Date :.....

Name/Signature of
Employee :..... Date :.....

COMMENTS BY SENIOR MANAGER (when applicable) :
.....
.....
.....
.....
.....
.....

Name/Signature :..... Date :.....

COMMENTS - SAFETY/TRAINING OFFICER (when applicable) :
.....
.....
.....
.....
.....
.....

Place this certificate with completed Safety training checklist on the employee's training file

BASIC RULES FOR SAFETY AND GOOD HOUSEKEEPING

SAFETY

1 Before dealing with the materials and products, ensure you have a basic knowledge of the properties and potential hazards of the materials and products you are dealing with.

2 Never use or be under the influence of alcohol or other drugs at work.

3 Drive safety. When in rest periods, remember not to drink alcohol or take drugs.

4 Company Safety Procedures : refer to... (insert name of procedures / Manuals, database, etc… as appropriate).

5 When accessing a site, respect signs, speed limit, authorized parking areas, walk-ways, security access procedures and registration. When leaving make sure that this is recorded.

6 Smoking is forbidden except in designated smoking areas

7 Do not waste paper, water, energy and other utilities and minimise the gas losses.

8 Wear personal protective equipment (safety shoes, appropriate work clothes, gloves, safety glasses (or goggles), hearing protectors and hard hat) where it is required.

9 Get skilled in handling safety equipment such as fire extinguishers, self contained breathing apparatus canisters, safety harness, emergency showers and eye wash devices.

10 Report deficiencies faulty equipment and unsafe conditions immediately.

11 Leave electrical work or repair to a qualified electrician. Do not open electrical cabinets.

12 Work tidily - maintain a high standard of housekeeping.

13 Learn how to lift loads correctly and always use the correct method. If an object is too heavy, use mechanical means or get help.

14 Do not start a job unless you have been trained to do it and know the correct procedure.

15 Report all injuries to the supervisor immediately and get first aid for even a minor cut or burn to reduce the risk of infection.

16 Worn or damaged tools should never be used. Take them to your supervisor who will have them repaired or will scrap them.

17 Learn how to stop machines quickly in the event of an emergency.

18 Learn what actions will be required of you in the event of an emergency.

19 Identify (your) emergency exits and where the fire fighting equipment is located. Identify (your) first aid trained persons.

20 Report immediately accidents or “near misses” (i.e. incidents which could have resulted in injury or equipment damage) to your supervisor.

21 Do not enter high voltage switch rooms unless authorised.

22 Use the checklist or operating procedure provided when starting up or shutting down

machines or plant.

23 If an electrically driven machine trips, refer to your supervisor before attempting to re-start.

24 Do not put yourself in front of the discharge port of a relief valve. It might open while you are there.

25 Close or open valves gradually. Rapid operation of a valve can lead to local compression and temperature rise. In the case of oxygen or acetylene this could cause an explosion. Also when changing cylinders, pressure reducer pressure setting valve must be released. Valves must not be forced open or closed using extension devices to increase torque.

26 Do not attempt any unauthorised modifications to plant or equipment. Any changes must be approved by the appropriate level of management.

27 Guards, safety valves and other protective devices are provided for your protection. They should not be removed or tampered with.

28 All fire and safety equipment must be kept clear of obstructions. It should not be removed or used except in case of actual emergency or authorised practice (drills).

29 Always use an approved cleaning compound to clean your hands or other parts of your body. Solvents should not be used as they can cause skin disease.

30 If compressed air is used to clean machines the hose should be fitted with a properly designed nozzle incorporating emergency shut-off.

31 Do not use compressed air for blowing dust off clothing.

32 If forklift trucks are operating in your working area be especially cautious near corners, doorways, tall stacks of goods. Walk in identified walkways.

33 Clothing must be free from oil or grease when working with oxygen. Clothes must be made of natural fibre or flame resistant fibres.

34 We are all responsible for each other's safety. If you see another person not complying with safety rules - e.g. not wearing personal protective equipment - point it out to the person.

IF IN DOUBT, ASK !
Do not take chances

GOOD HOUSEKEEPING

35 A cluttered workplace leads to accidents.

36 Aisles, passageways, doorways, emergency exits and access to safety equipment must be kept clear of obstructions.

37 Floors must be kept clear of oil, grease and any spillage of chemicals e.g. calcium carbide.

38 Platforms above ground level must be kept clear, both to allow safe movement and to prevent tools etc..., from falling on people below.

39 Waste material must be placed in the correct disposal place.

40 Tools and equipment must be taken back to in their correct storage point after use and not left lying around.

41 Chemical and lubricant containers should be kept in approved stores.

42 Oily rags must be placed in special closed containers.

43 Areas where liquid oxygen is handled must be kept particularly clean and free from oil and grease.

44 A job is finished only when everything is clean and in order.

SUBCONTRACTORS

Subcontractors working at the premises of your Company must respect the Safety, Health and Environment Protection rules and requirements. Report any deviation that you may identify.

OXYGEN

1 Oxygen is referred to as O_2. It is a colourless, odourless and tasteless gas, slightly heavier than air. The atmosphere normally contains 21 % oxygen. An increase above this figure is known as enrichment; a decrease below this figure is known as deficiency.

2 Oxygen is essential for life : if a person enters an oxygen deficient atmosphere he/she could collapse immediately and die if not rescued.

2.1. When liquid oxygen evaporates the gas produced is very cold and so is much heavier than air. Thus it can collect in areas below ground level such as pits and trenches where it may be slow to disperse.

2.2. Before entering areas and enclosed spaces in which an oxygen deficiency or enrichment could occur, make sure that the atmosphere has been tested to ensure that the oxygen content is 21 % (+/- uncertainty of measurement) and that causes for deviations from 21 % are identified and controlled.
Read the Work Permit - see leaflet 22 – and make sure it is valid (date, signature).

3 Oxygen is not flammable but is essential for combustion. Even a slight enrichment of the atmosphere may cause rapid combustion, while a high concentration of oxygen can cause burning at explosive rates. Conversely, if there is not enough oxygen a combustion will stop or not start.

3.1. In areas where oxygen enrichment can occur, do not smoke and do not use naked flames. If hot work (welding, flame cutting, soldering, grinding, etc...) has to be carried out, ensure that the atmosphere has been checked and confirmed as safe and obtain a Work Permit - see Leaflet 22 -.

3.2. Do not use oxygen for applications for which it is not intended. Do not use oxygen as a substitute for air, e.g.. for operating pneumatic tools, inflating tyres, starting diesel engines.

3.3. Make sure that all items such as tools, cleaning rags and clothes which may come into contact with oxygen are free of oil and grease. Clean them with approved solvents and remove all traces of solvents before exposing them to oxygen - see Leaflet 21 -.

3.4. If you have been in an oxygen-enriched atmosphere, ventilate your clothing in the open air for at least 15 minutes before smoking or going near to a source of ignition.

4 Only certain materials are suitable for use in oxygen service. Most materials will burn in pure oxygen, even if they cannot be ignited in air. Some organic materials, in particular oils, grease and materials contaminated with these substances can catch fire spontaneously in an enriched atmosphere. When ignited, metals burn in oxygen.

4.1. Check with your supervisor that the materials or substances which you use are approved for oxygen service.

5 Parts used for oxygen service must be labelled accordingly and preserved with adequate packaging.

6 Oxygen cylinders filling specific hazards and prevention measures :

6.1. Pollution of oxygen cylinders with moistures is hazardous as it causes corrosion which in turn may cause cylinders to burst when pressurized.

6.2. You must know how to stop the cylinder filling process in case of an emergency.

6.3. When not connected to the filling rack, cylinders must be capped and secured.

6.4. You must know the cylinders filling diagram (pressure, time, temperature) and the maximum allowed temperature of oxygen cylinders during filling.

6.5. Oxygen cylinders used for medical service are subject to specific rules that you must be instructed with.

7 Liquid oxygen storage specific hazards and prevention measures

7.1. Liquid oxygen is stored in registered pressure vessels ; there is an identification plate, you must know what the engraved information means. Tank pressure monitoring and control is critical, overpressure protections must be kept in good condition, operating instructions must be known, uncontrolled deviations must be reported.

7.2. Liquid oxygen storage requires specific regulations to be known and respected.

7.3. Storage area must be clean and free from oil and grease.

7.4. It is hazardous to overfill liquid storage tanks ; level in the tank must be monitored.

7.5. A liquid oxygen release in the atmosphere generates a deep cloud made of moisture condensation. Do not expose yourself to the cloud.

NITROUS OXIDE

1 Nitrous oxide is referred to as N_2O. It is, at room temperature and atmospheric pressure, a colourless gas with a barely perceptible sweet odour and taste. In cylinders nitrous oxide is liquefied with a pressure of approximately 50 bars at 20°C.

2 Nitrous oxide is heavier than air. Thus it can accumulate in areas below ground level such as pits and trenches where it may be slow to disperse.

3 Nitrous oxide is not toxic. When the gas is inhaled, it is inebriating (that is why it is also called “laughing gas”) and narcotic.

Inhalation of high concentrations may cause fatal asphyxiation as it displaces oxygen in air.

4 Nitrous oxide is not flammable, but has to be treated as an oxidising agent (like oxygen - see leaflet 2). Its oxidising power is much higher than air and almost 50 % of pure oxygen.

4.1 Make sure that all items such as tools, cleaning rags and clothes which may come into contact with nitrous oxide are free of oil and grease. Clean them with approved solvents and remove all traces of solvents before exposing them to nitrous oxide – see Leaflet 21 -.

4.2 In areas where nitrous oxide enrichment can occur, do not smoke and do not use naked flames.

4.3 Do not use nitrous oxide for applications for which it is not intended. Especially do not use nitrous oxide as a substitute for pressurised air (e.g. for operating pneumatic tools).

4.4 Nitrous oxide is non-corrosive. It can be used with any oxygen compatible material.

5 When nitrous oxide is heated to above 650°C, it decomposes into nitrogen and oxygen. This decomposition in closed vessel could cause a sudden pressure increase and a violent rupture of the vessel (tank, cylinder, etc…)..

6 Nitrous oxide is a “green house gas” but has no other harmful effect to the environment. The contribution of N_2O produced by the gas industry, to the global warming potential is negligible. Thus N_2O can be released under certain conditions to the atmosphere.

7 N_2O Manufacturing (production) specific hazards and prevention measures

7.1 Nitrous oxide is manufactured by thermal decomposition of ammonium nitrate.

7.2 Ammonium nitrate is an explosive compound that must be handled with care and stored with adequate fire protection. The contamination of ammonium nitrate with combustible substances can lead to ignition and/or the formation of toxic carbon monoxide during the manufacture of nitrous oxide.

7.3 Ammonium nitrate during the process is heated up to 250°C. Protection against contact with hot reactor surfaces is necessary.

7.4 Nitrous oxide during the process is purified with corrosive substances (caustic soda and sulphuric acid). When handling these substances the common safety measures must be observed.

8 N_2O cylinder filling specific hazards and prevention measures.

8.1 Pollution of N_2O cylinders with moisture is hazardous as it causes corrosion, which in turn can cause cylinders to burst.

8.2 N_2O is filled in liquid form under pressure in the cylinders. It is hazardous to overfill cylinders with liquefied gases, as they can consequently burst. Each cylinder must bear a readable tare weight indication, which has to be considered at the filling process. (Filling weight = tare weight + weight of the filled gas).

8.3. Cylinders must be emptied safely prior to tare weight check. In case of a difference between tare weight and actual weight the cylinder must be de-valved and inspected internally.

8.4. The quantity of N2O in a cylinder can only be measured by weight and not by pressure.
.

8.5 Weighing scale used to fill .N_2O cylinders should be certified by a third party and must be frequently checked using test weights.

8.6 You must know how to stop the cylinder-filling process in case of an emergency.

8.7 N_2O cylinders should be fitted with valves with built-in bursting discs. Make sure you know how to identify those valves and what to do in case a bursting disc blows out. (Go away and wait until the cylinder is empty).

8.8 When not connected to the filling rack, cylinders must be capped and secured against falling.

8.9. Don't mix nitrous oxide with flammable gases, because a violent explosion might occur.

8.10 Before de-valving, vent slowly, and weigh the cylinder to make sure that no liquid is left.

9 N_2O storage specific hazards and prevention measures

9.1 Liquid N_2O storage tanks are registered pressure vessels, you must know what the indications engraved in the identification plate mean. Tank pressure monitoring and control is critical, operating instructions must be known and respected, uncontrolled deviations must be reported immediately.

9.2 Pressure relief devices protect storage tanks against overpressure hazards, you must know their set points.

9.3 It is hazardous to overfill liquid N_2O storage tanks. Level of liquid N_2O in a storage tank is monitored.

9.4 Flexible hoses should be coupled to safety lines secured at both ends (trailer or truck at one end and storage tank at the other end).

9.5 A liquid N_2O release in the atmosphere generates a deep cloud made of moisture condensation. Do not expose yourself to the cloud and try to get out of the cloud to breathe.

9.6 Keep the entire N_2O equipment free from oil and grease.

9.7 Electrical heating inside the storage tanks is allowed only to heat the liquid phase. If the gas phase is heated, a violent decomposition of N_2O may occur.

INERT GASES (NITROGEN & ARGON)

1 Nitrogen is referred to as N_2, Argon as Ar. They are non-flammable, colourless, odourless and tasteless gases. Nitrogen is slightly lighter than air, while Argon is heavier than air. They are essential parts of the atmosphere which normally contains 79 % inert gases (78 % nitrogen + 1 % argon) ; the balance, 21 %, is oxygen.

2 The inert gases are not toxic but do not support life and cause asphyxiation. When liquid nitrogen and argon evaporate the gas produced is very cold and so is much heavier than air. Thus it can collect in areas below ground level and confined spaces, such as pits and trenches where the gas may be slow to disperse. A person can become unconscious immediately when entering an atmosphere which contains excessive proportions of inert gases (and, therefore, a shortage of oxygen). If the oxygen concentration is low, death can follow rapidly.

2.1. Before entering vessels and enclosed spaces in which an accumulation of inert gases may have occurred, ensure that the atmosphere has been tested and that the oxygen content is within safe limits (19-23 %). A work permit is required - see Leaflet 20 .

2.2. Ensure that rooms or spaces where inert gases are stored or handled have either good ventilation or that their atmosphere is monitored for O2 content.

2.3. Do not stop ventilators in rooms where inert gases are stored or handled. Make sure that atmosphere monitoring systems are in operation.

3 Inert gases cylinder filling specific hazards and prevention measures.

3.1. Pollution of cylinders with moisture is hazardous as it causes corrosion which in turn may cause pressurized cylinders to burst.

3.2. You must know how to stop the cylinders filling process in case of an emergency.

3.3. When not connected to the filling rack, cylinders must be capped and secured.

4 Liquid inert gases storage hazards and prevention measures

4.1. Liquid inert gases are stored in registered pressure vessels. There is an identification plate on the vessel; you must know what the engraved information means. Tank pressure monitoring and control is critical, overpressure protections must be kept in good condition, operating instructions must be known, uncontrolled deviations must be reported.

4.2. It is hazardous to overfill liquid storage tanks, level in the tank must be monitored.

4.3. A liquid inert gas release in the atmosphere generates a deep cloud made of moisture condensation. Do not expose yourself to the cloud and try to get out of the cloud to breathe.

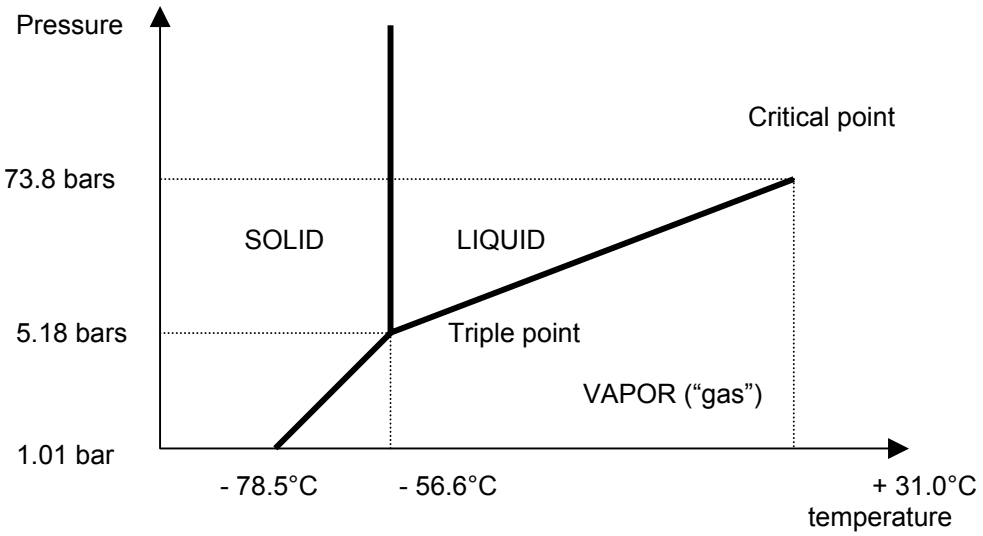
CARBON DIOXIDE

1. CO_2 specific properties

1.1. CO_2 can be produced, stored or used in any of the three different physical states (gas, liquid, solid) in which a substance can exist, solid CO_2 is usually designated as "dry ice".

1.2. The following diagram summarizes the physical state of CO_2 when pressure and temperature vary

Diagram 1: section of CO_2 p versus t diagram



Note that:

- liquid CO_2 may exist only when temperature is below 31°C
- when liquid CO_2 pressure drops below 5.18 bars (4.18 bar[g]) and/or its temperature drops below – 57°C, solid CO_2 is formed.

1.3. Hazardous conditions may be created when CO_2 temperature and/or pressure are not properly controlled

1.4. CO_2 is hazardous as it can generate low temperature (cryogenic burns), ice plugs (overpressure and striking objects) and hazardous atmospheres: with increasing exposure time and concentration over 3% in air, vital functions such as breathing are affected. Over 10% in air, loss of consciousness happens in one minute and would result in death if no prompt action is taken.

1.5. CO_2 concentration in the air that we breathe must be kept below 5000ppm TLV-TWA, usual concentration in ambient air is around 350ppm. Higher concentrations might be tolerated for short exposure time (see below).

1.6. In potentially exposed working places where room ventilation is less than 6 volumes per hour, CO_2 concentration must be monitored in addition to oxygen concentration monitoring as CO_2 is not an inert gas in regard with severe physiological effects over 30000 ppm (TLV-STEL Ceiling). Specific Threshold Limit Values depend upon local regulations and may vary from one country to another.

2. Production of liquid CO_2

2.1. Low (negative gauge pressure) at plant inlet booster suction may cause air pollution of the plant feed stream. This leads to monitor the possible oxygen pollution of the plant feed stream when it contains flammable substances. Also, raw gas supply process or equipment might be damaged by negative gauge pressure.

2.2. You must know the maximum (and sometimes minimum) allowed concentrations of plant feed stream components and what to do if limits are not respected…

2.3. Low temperature and high pressure are potential hazards which require adequate operating and maintenance practices, do not perform tasks that you have not been trained to.

2.4. Relatively large quantities (several tons) of ammonia are used in the liquid CO_2 production process. Ammonia (NH3) is a hazardous material (toxic and corrosive) which requires stringent operating, maintenance and emergency procedures that personnel must perfectly know and respect.

2.5. The smell of ammonia is characteristic and we can smell a few ppm in the air that we breathe. Ammonia leaks are not acceptable and must be detected and reported immediately. NH3 leaks must be fixed as soon as possible by properly trained and qualified personnel.

2.6. Ammonia is highly soluble in water but it releases a lot of heat and the pH of ammonia solutions is high. Ammonia solutions must be treated as hazardous waste.

2.7. Special protective clothing and breathing apparatus (appropriate canisters and Self-Contained Breathing Apparatus) are available and maintained in a ready to use condition at dedicated locations in the plant. You must know those locations.

2.8. Personnel are trained to use breathing apparatus and to wear special protective clothing.

2.9. Only approved relief valves can be used for liquid CO_2 service.

2.10. Ammonia is a toxic, corrosive and flammable gas. Eye wash, emergency showers and suitable fire fighting devices are available and you must know where they are located and how to use them.

3. Liquid CO2 storage and transfer

3.1. Liquid CO_2 storage tanks are registered pressure vessels, you must know what the indications engraved in the identification plate mean. Tank pressure monitoring and control is critical, operating instructions must be known and respected, uncontrolled deviations must be reported immediately.

3.2. Pressure relief devices protect storage tanks against overpressure hazards, you must know their set points. Only relief devices designed for liquid CO_2 service can be used.

3.3. Storage tanks are often equipped with a low pressure alarm set not below than 8 bar[g]

3.4. It is hazardous to overfill liquid CO_2 storage tanks. Level of liquid CO_2 in a storage tank must be monitored.

3.5. On liquid CO_2 lines, there must always be a pressure relief valve between two valves.

3.6. During transfer of liquid CO_2, ice plugs may be generated inside the piping or flexible hose when transfer procedures are not respected. This can lead to serious incidents caused by overpressure, low temperature, high velocity pieces of dry ice and whipping hoses.

3.7. Liquid CO_2 pressure must be kept above 8 bar[g] until flexible hoses are drained.

3.8. Flexible hoses must be coupled to safety lines secured at both ends (trailer or truck at one end and storage tank at the other end).

3.9. A liquid CO_2 release in the atmosphere generates a deep cloud made of moisture condensation and dry ice crystals. Do not expose yourself to the cloud and try to get out of the cloud to breathe.

4. CO_2 cylinders filling

4.1. Pollution of CO_2 cylinders with moisture is hazardous as it causes corrosion which in turn can cause cylinders to fail, sometimes violently.

4.2. CO_2 is filled in liquid state under pressure in the cylinders. It is hazardous to overfill cylinders as they can consequently burst. Each cylinder must bear a readable tare weight indication (total weight = tare weight + weight of filled CO_2).

4.3. Cylinders must be emptied prior to tare weight check. In case of a difference between tare weight and actual weight the cylinder must be inspected.

4.4. The quantity of CO_2 in a cylinder can only be measured by weight and not by pressure.

4.5. Weighing scales used to fill CO_2 cylinders must be certified by a third party and frequently checked using test weights.

4.6. You must know how to stop the cylinder filling process in case of an emergency

4.7. Most of CO_2 cylinders are fitted with valves with built-in bursting discs. Make sure you know how to identify those valves and what to do in case a bursting disc blows out…(Go away and wait until cylinder is empty .. no more gas blowing).

4.8. When not connected to the filling rack, cylinders must be capped and secured.

4.9. Before de-valving cylinders, vent slowly and weigh the cylinder to make sure that no liquid is left.

5. Dry ice manufacturing, storage and handling

5.1. A dry ice production press is hazardous : high pressure and low temperature liquid CO_2 feed, high speed moving mechanical parts, hydraulic flexible hoses at very high pressure…

5.2. Wear your personal protective equipment as required (Safety hard hat, glasses, gloves and shoes).

5.3. The ground around a hydraulic press might be oily and slippery. Oil leaks are contained in order to avoid pollution of soil and water (surface and underground). You must know the local waste management procedure.

5.4. Report oil leaks so that adequate maintenance is performed.

5.5. Moving and cutting tools (press, saw, packaging machine) are fitted with protective devices to avoid hand injuries, make sure that these protections work properly and do not by-pass them!

5.6. Dry ice is cold (about – 78°C) you must wear adequate safety gloves to handle it.

5.7. Dry ice sublimates into CO_2 vapour, this can lead to asphyxiation in confined spaces such as small closed workshops, sawing and packaging section, storage containers and closed transport vehicles or storage area. Both O_2 and CO_2 concentrations may need to be monitored in case of marginal ventilation (less than 6 room volumes per hour). Make sure that you know how to check that atmosphere monitoring devices operate properly.

5.8. When storing dry ice products in transport containers, do not put your head or breathe

inside the container.

6. Refer to and learn the Standard Operating and Maintenance Procedures which are made available by your management. When you do not know, ask questions and do not take chances.

HYDROGEN

1 Hydrogen is referred to as H_2. It is a colourless, odourless and tasteless gas. It is non-toxic but does not support life and acts as an asphyxiant. It is the lightest element/gas known.

2 Hydrogen is highly flammable and most mixtures of hydrogen and air will burn or even explode. It ignites more easily than any other common gas and a high pressure leak can even ignite spontaneously. It burns with a hot and almost invisible flame. Hydrogen fires are difficult to extinguish. If you do extinguish a hydrogen flame and do not stop the flow of hydrogen, the escaping gas can be re-ignited, sometimes explosively...

2.1. When approaching a hydrogen leak, hold some readily combustible material such as a rolled up newspaper or a straw broom in front of you.

2.2. To extinguish a hydrogen fire, shut off the source of supply, provided that this can be done safely. If the hydrogen supply cannot be shut off keep nearby equipment cool by drenching with water until the flame has extinguished itself.

2.3. Never release or vent hydrogen into buildings or confined spaces.

2.4. Ensure that buildings in which hydrogen is stored or handled have adequate ventilation at high and low levels to prevent the build-up of an explosive atmosphere, especially in the ceiling. Keep all ventilation openings clear and do not block them for any reason.

2.5. Do not smoke or bring matches and lighters into an area where hydrogen is manufactured, stored or used.

2.6. Do not bring to any hydrogen installation any unauthorised electrical equipment such as torches, radios or power tools. Use only approved lighting apparatus.

2.7. Do not carry out any hot work such as cutting, grinding, welding or soldering on a hydrogen installation. When hot work is necessary obtain a Work Permit - see Leaflet 22 -.

2.8. Do not tamper with or damage grounding systems ; they are provided to prevent the accumulation of static electric charges which could act as a source of ignition.

2.9. Before opening plant and equipment on a hydrogen installation for maintenance or any other purpose obtain a Work Permit. This Permit will require all pipes and vessels to be purged with nitrogen before work commences.

2.10. Before admitting hydrogen into a system, purge it with nitrogen to ensure that a flammable mixture cannot be developed. For liquid hydrogen system, Helium purge is required after or before nitrogen purge.

2.11 Never vent hydrogen from a high pressure source such as a cylinder in order to remove contaminants. Always use an external source of nitrogen or air for this purpose.

2.12. It is recommended to either permanently or periodically monitor hydrogen systems (pressure vessels and piping) using explosive atmosphere detectors in order to identify leaks as early as possible and take necessary corrective actions.

3 Hydrogen cylinders filling hazards and prevention measures.

3.1. Pollution of hydrogen cylinders with moisture is hazardous as it causes corrosion, which in turn can cause pressurized cylinders to burst.

3.2. You must know how to stop the cylinder-filling process in case of an emergency.

3.3. When not connected to the filling rack, cylinders must be capped and secured against falling.

3.4. Don't mix hydrogen with oxidising gases, because a violent explosion might occur.

4 Liquid hydrogen storage specific hazards and prevention measures.

4.1. Liquid hydrogen storage tanks are registered pressure vessels, you must know what the indications engraved in the identification plate mean. Tank pressure monitoring and control is critical, operating instructions must be known and respected, uncontrolled deviations must be reported immediately.

4.2. Pressure relief devices protect storage tanks against overpressure hazards, you must know their set points.

4.3. Operation of liquid hydrogen storage tanks requires specific instructions and training. Storage tank and surroundings must be in perfect condition and cleanliness.

4.4. Immediately report any abnormal condition.

ACETYLENE, CALCIUM CARBIDE, LIME SLUDGE AND PURIFYING MATERIALS

1 ACETYLENE

1.1. Acetylene is a gas, often referred to as C_2H_2 ; when in cylinders it is known as Dissolved Acetylene (DA). Acetylene is colourless, invisible, slightly lighter than air, non-toxic and does not support life ; it can cause asphyxiation. Industrial acetylene, because it is slightly impure, smells like garlic.

1.2. Acetylene burns with a smoky flame ; when burning it develops a lot of heat and high temperature. Mixtures of acetylene and air ignite or explode easily, this reaction can be started by a spark, small flame or hot spot.

1.2.1. To extinguish an acetylene fire, shut off the source of supply, provided that this can be done safely. If the acetylene supply cannot be shut off, keep nearby equipment cool by drenching with water until the flame has extinguished itself.

1.2.2. Never release or vent acetylene into buildings or confined spaces.

1.2.3. Ensure that buildings in which acetylene is manufactured, stored or used have adequate ventilation at high and low levels. Keep all ventilation openings clear and do not block them for any reason.

1.2.4. Do not smoke or bring matches or lighters into an area where acetylene is manufactured, stored or used.

1.2.5. Do not bring to any acetylene installation any unauthorised electrical equipment such as electric torch, radios or power tools. Use only approved tools and lighting devices.

1.2.6. Do not carry out any work which could produce hot spots or sparks such as grinding, cutting, welding or soldering in an acetylene plant. When it is necessary, obtain a Work Permit - see Leaflet 20 -.

1.2.7. Do not tamper with or damage grounding systems ; they are provided to prevent the accumulation of static electric charges which could act as a source of ignition.

1.2.8. Before opening plant equipment in an acetylene plant for either maintenance or cleaning, obtain a Work Permit. This Permit will require all pipes and vessels to be isolated and purged with nitrogen before work commences when safe atmosphere is restored.

1.2.9. Before admitting acetylene into a system, purge with nitrogen to ensure that a flammable mixture cannot be developed.

1.3. When heated or compressed above normal operating limits acetylene may decompose and explode.

1.3.1. Never heat a pipe or vessel containing acetylene.

1.3.2. Open and close valves in acetylene systems slowly.

1.3.3. Avoid rapid increases in pressure in acetylene systems, for instance on cylinder charging racks.

1.4. Only certain materials are suitable for use with acetylene ; in particular, acetylene forms explosive compounds with copper, silver and mercury.

1.4.1. Never use copper, silver or mercury in acetylene plants.

1.4.2. Report to your supervisor if you see any copper, silver or mercury in an acetylene plant and check with him/her that any materials which you use are approved.

2 CALCIUM CARBIDE

2.1. Calcium carbide is a solid, manufactured from coke and lime. It is delivered either in steel drums or containers. The size of carbide particles can vary from supplier to supplier.

2.1.1. Become familiar with the size ranges normally used and report any change to your supervisor.

2.2. Calcium carbide reacts spontaneously with water and forms acetylene, lime sludge, some impurities and produces heat. In the normal process for production of acetylene, water must be in excess to carry off the heat which is formed and temperature is closely monitored.

2.2.1. Always maintain adequate water flow to generators.

2.3. Calcium carbide also absorbs moisture from the air ; this reaction also produces acetylene and heat. As there is no excess water, hot spots can form on the surface of the carbide and start decomposition of acetylene (explosion).

2.3.1. Avoid accidental contact between carbide and water or moist air.

2.3.2. Regularly remove carbide dust and dispose of it according to instructions.

2.4. If carbide drums or containers are not perfectly airtight, air and moisture can enter and react with the carbide to produce acetylene. If this happens, there is a possibility of explosion, particularly when the drums are opened :

2.4.1. Do not handle drums roughly ; in particular, do not drop them.

2.4.2. Do not open hot or swollen drums.

2.4.3. Keep drums closed when not in use.

2.4.4. Open drums according to company procedures.

2.4.5. Empty drums completely.

2.4.6. Report damaged containers to your supervisor.

3 LIME SLUDGE

3.1. Lime sludge contains acetylene which has been dissolved in the water of the generator. It may also contain particles of calcium carbide which have not finished reacting with the water completely ; these particles can produce acetylene.

3.1.1. Ensure that areas where lime sludge is handled are well ventilated and that the rules for smoking, unauthorised electrical equipment and hot work are the same as those for acetylene - see 1.2.1., 1.2.2., 1.2.3. and 1.2.4.

3.2. Lime sludge contains chemical impurities like ammonia, hydrogen sulphide and phosphine, which can be irritating or toxic.

3.2.1. When handling lime sludge, in pits or drains for instance, use protective equipment and clothing as instructed e.g. boots, goggles, gloves and masks...

4 PURIFYING MATERIALS

4.1. Most acetylene production processes use chemicals for drying and purifying the gas.

4.1.1. Follow the general rules given in Leaflet 19 and always wear the appropriate protective clothing and equipment when handling those materials.

CYLINDERS FOR COMPRESSED GASES

1 Cylinders for compressed gases are manufactured, filled, inspected and tested in accordance with specific regulations. Relevant regulations must be identified and made available for review. Relationships between regulations and work instructions must be explained to employees.

2 High pressure gas cylinders are made of steel, aluminium alloys or composite materials. Cylinder valves need be permanently protected with a removable or permanent (open) cap.

3 Valve outlets are also made in conformity with standards and national specifications. In order to avoid confusion between flammable and non-flammable gases, the valves on flammable gas cylinders have a left hand outlet thread and those on non-flammable gas cylinders have a right hand outlet thread. (Hydrogen left hand ; oxygen, nitrogen and argon right hand).

4 The gaseous contents of cylinders are identified by adhesive labels, stencilling and permanent stamping (not in all countries) and a system of colour coding allows consistent identification in all of the European Union countries.

4.1. Obtain from your supervisor the details of colour coding and labelling applicable to the cylinders which you will be handling.

5 Each cylinder has the following information permanently stamped into the metal :

- material characteristics,
- filling pressure,
- test pressure,
- cylinder weight,
- manufacturer and country of origin,
- date of pressure tests and/or inspections with the stamps of the testing authorities.

5.1. Never remove or erase these marks.

5.2. Never stamp mark a cylinder unless you are authorised to do so.

5.3. Only fill cylinders which carry the correct identification.

6 Cylinders have to be subjected to inspection and hydraulic testing by the manufacturer before they can be put into service.

7 Cylinders have to be inspected and/or hydraulically tested at set intervals throughout their working life.

7.1. Obtain from your supervisor the rules which apply to the cylinders which you will be handling and learn how to read testing dates on cylinders.

7.2. Never fill a cylinder which has not been tested or examined within the appropriate period.

8 A cylinder which is in a satisfactory condition to be filled must conform to the following :

- it must not be soiled,
- pressure test date must be valid,
- it must not show any physical damage such as dents, burn marks,...
- it must not be rusty,

- it must be free from corrosion by chemicals,

- maximum allowed working pressure must be consistent with filling pressure and over pressure protections of filling rack,

- the valve must be of the correct type, clean and in good condition,

- the residual contents must be the same gas as indicated by label and colour,

- the valve protecting cap must be available.

8.1. Examine all cylinders before filling to see that they are in a satisfactory condition.

8.2. Report to your supervisor any cylinders which you consider to be unsatisfactory.

9 Cylinders standing on uneven surfaces and cylinders with defective foot rings are unstable and may fall down.

Cylinders which are standing unattended and unsupported may be knocked over ; in falling, they may hit other cylinders and cause them to fall.

9.1. Always let cylinders stand on flat and level surfaces and secure them (chains, pallets,...).

9.2. Report any cylinders with defective foot rings to your supervisor.

9.3. Never leave cylinders freestanding in places where they can be accidentally knocked over.

10 Never transfill cylinders without the appropriate qualification, procedures and equipment.

11 Adapters to convert cylinder valves from one type of gas to another can lead to contamination and serious accidents. Their use is forbidden.

11.1. Report the presence of any adapters to your supervisor.

12 When handling cylinders into or out of a pallet, make sure that the pallet is in good condition, report deficiencies to your supervisor. Do not move the gate or bar before having untightened the strap around cylinders and made sure that cylinders inside pallet are steady. Never try to grasp a falling cylinder, just keep clear. Always close the bar or gate when not handling cylinders in a pallet and lock the bar open when handling cylinders.

13 Keep clear of forklifts handling pallets.

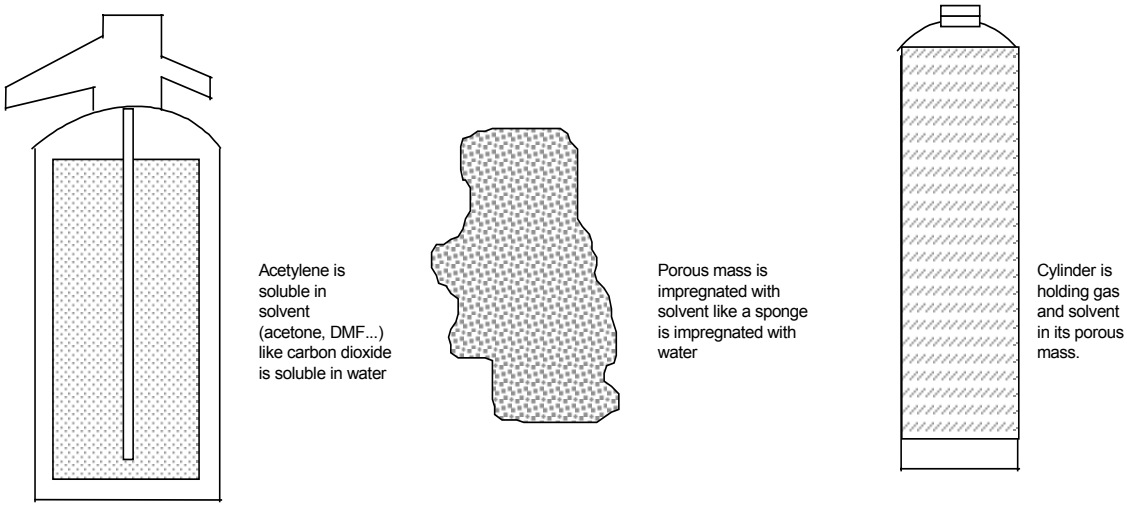
ACETYLENE CYLINDERS

1 CYLINDERS

1.1. Acetylene is unstable and cannot be stored at high pressure in the same way as other gases in normal compressed gas cylinders.

To overcome this difficulty, acetylene is dissolved in a solvent which is held in a porous mass inside the cylinder shell.

These techniques are based on the following principles :



The cylinder shell itself is made of steel and is either of extruded or welded construction. All cylinders are fitted with valve outlets and have a left hand thread (because acetylene is a flammable gas) or a special connection.

Cylinders are made in accordance with different standards and regulations and can only be filled in countries the regulation of which they comply with.

Some specifications require that the cylinders are fitted with safety devices. These may be in the form of bursting discs or fusible (capable of being molten) plugs. These devices are fitted either in the valve, on the shoulder of the cylinder or in the base of the cylinder.

1.1.1. Ask your supervisor how to identify the cylinders which may be filled at your facility and what to do if you find cylinders which do not conform to these specifications.

1.1.2. Never fill acetylene into a cylinder designed for another gas ; there will be an immediate risk of explosion inside the cylinder.

1.2. All cylinders are stamped on the shoulder or a reinforced part of the neck ring with identification marks. These vary between countries but normally include :

- manufacturing specification,
- test pressure,
- serial number,
- tare weight.

1.2.1. Never remove or deface these marks or stamp any additional marks.

1.2.2. Never fill a cylinder unless it carries the correct identification marks.

1.3. Acetylene cylinders have to be internally inspected at regular intervals, depending on the manufacturing specification and national regulations.

1.3.1. Obtain from your supervisor the rules which apply to acetylene cylinders in your works and how to read inspection date.

1.3.2. Never fill a cylinder which has not been internally examined within the appropriate period.

1.4. Cylinders can only be filled if they are in a satisfactory condition.

1.4.1. Never trans-fill acetylene.

1.4.2. Examine all cylinders before they are sent for filling. If a cylinder is satisfactory:

- it is not soiled externally,
- it is not damaged by dents or burn marks,
- it is not rusty, paintings in good condition,
- it is not been corroded by chemicals,
- the valve is in good condition and is not tarnished with soot.

1.5. Cylinders can be misused by customers, either by withdrawing the gas too fast or by using the cylinder on its side. In both cases solvent is lost. When excess solvent is lost it must be replaced before the cylinder is sent for filling.

1.5.1. Check solvent content by comparing actual weight of cylinder with the tare weight stamped on it, making allowances for ambient temperature and gas content as measured by pressure gauge (charts are available in the workshop).

1.5.2. Check that the cylinder is not overdue for internal examination. The operation is carried out by specially trained personnel (your supervisor will explain how to identify a cylinder which is due for internal examination).

2 SOLVENTS

2.1. The solvents used in acetylene cylinders are acetone and di-methylformamide (DMF). Acetone is the most commonly used solvent. DMF is used in some countries for cylinder bundles.

2.1.1. Find out from your supervisor which solvent is used in cylinders in your company.

2.2. Acetone is a colourless liquid, with fragrant mint-like odour ; it is flammable and narcotic in high concentrations ; breathing acetone vapour can cause headaches and sickness.

2.2.1. See 2.3.1. - 2.3.4.

2.3. DMF is a colourless flammable liquid with a characteristic odour ; it is toxic and highly irritating. DMF can be absorbed through the skin. In consequence of that,

2.3.1. Do not block ventilation in places where solvents are stored or handled.

2.3.2. Do not bring any source of ignition (matches, lighter, heating and cutting equipment) into a solvent storage or handling area.

2.3.3. Keep drums closed when not in use.

2.3.4. Wear goggles, gloves and other personal protective equipment as requested - see Leaflet 19 (Solvents) -.

2.3.5. Always transfer DMF as instructed.

2.3.6. If DMF contacts the skin flush it off with water.

2.3.7. If any skin irritation or injury develops, get medical assistance.

3 SPECIAL HAZARDS WITH ACETYLENE CYLINDERS

3.1. Acetylene within a cylinder can decompose explosively, with or without apparent cause. This may be preceded by localised heating in the cylinder (hot spots).

3.1.1. If you detect a hot cylinder, close the valve and spray the cylinder with water from a safe place (shelter, distance,…). Advise your supervisor immediately.

See Leaflet 16 for handling of acetylene cylinders in fire situations.

3.2. In case of damaged cylinder or activities such as de-valving, inspecting or de-massing, there is a risk of exposure to asbestos which needs to be prevented by adequate operating procedures including requirement to wear respiratory protective equipment.

LOADING AND TRANSPORTING CYLINDERS

1 Some of the gases stored in cylinders could be dangerous if they leak out.

1.1 Make sure that you know the properties of the products you handle e.g. whether they are toxic, flammable, oxidants, asphyxiants, etc... Ask for the relevant Material Safety Data Sheets.

1.2. Know the colour coding and any other system of identifying the gas.

1.3. Learn how to identify the different types of valves and how to detect faults in valves and cylinders.

1.4. When rolling cylinders do not use the valve hand wheel as this could open the valve. Only handle capped cylinders.

1.5. Never smoke when handling gas cylinders of any sort.

1.6. Do not subject cylinders to shocks, for example by throwing them on or off vehicles or platforms.

1.7. Do not allow oil, grease or other chemicals to come into contact with cylinders or valves.

2 Improper handling of cylinders can injure your hands, back or feet.

2.1. Wear the correct protective clothing: GLOVES AND SAFETY SHOES ARE ALWAYS REQUIRED, other means of protection like safety glasses and hard hats may be required too.

2.2. Know the handling characteristics of different types of cylinders ; in particular the weights and sizes of standard cylinders.

2.3. Always handle cylinders as you have been instructed.

2.4. If a cylinder must be lifted, use the proper technique. Do not attempt to lift large or heavy cylinders alone - get help.

2.5. When positioning cylinders, avoid trapping your fingers between them.

2.6. IF A CYLINDER STARTS TO FALL, DO NOT TRY TO STOP IT - LET IT GO.

2.7. Check that cap or guard is firmly fixed before handling the cylinder.

2.8. Never lift a cylinder by the cap, valve or guard, unless it has been specifically designed for the purpose.

2.9. Where appliances have been provided for moving cylinders, such as barrows, pallets, trolleys or hoists, use them in preference to manual handling.

2.10. Check that the floors of vehicles are free from oil, grease and loose objects and report to your supervisor any which are in an unacceptable condition.

2.11. Use extra care in wet or icy weather when the ground can be slippery.

3 If a cylinder is not fastened it can be readily knocked over by an impact or sudden movement.

3.1. Know the approved loading and unloading methods and use them at all times.

3.2. Check that all the fastening devices, such as straps, chains and railings are in good condition and are being used correctly.

3.3. Ensure that all cylinders are properly secured in pallets or on vehicles before the vehicle or pallet is moved so that they cannot fall or roll over.

4 Pallets safe operating and maintenance rules

4.1. Pallets must be inspected prior to loading or unloading cylinders.

4.2. A pallet inspection check list is used to perform the inspection.

4.3. Pallets which are showing defects must be taken out of operations and repaired or scrapped.

4.4. Prior to opening the front gate/bar of a pallet to unload cylinders, the strap must be loosened and a cylinder moved in order to release possible instability of cylinders inside the pallet.

4.5. Grounds on which pallets are stored must be horizontal, even, clean and solid.

CRYOGENIC LIQUIDS, SPILLS AND VAPOUR CLOUDS

1 In our industry the main cryogenic liquids are oxygen, nitrogen and argon kept at such low temperatures that they are in liquid form.

2 Liquids can be held in a variety of containers - such as dewars for small quantities or specially insulated tanks and road tankers for large quantities. Each type of container has its own filling procedures.

2.1. Use only containers designed and identified for the specific cryogenic liquid you are handling.

2.2. Always follow the correct transfer procedure (including transfer equipment, correct coupling, hoses, etc...).

3 Boiling and splashing always occur when charging a warm container. Wear proper protective equipment (goggles or face shield, gloves,...).

3.1. Stand clear of boiling and splashing liquid and its issuing gas.

4 High concentrations of oxygen are a fire hazard. Excessive amounts of nitrogen and argon in the air reduce the concentration of oxygen and can cause asphyxiation.

4.1. Never release cryogenic liquids in confined areas.

4.2. Always handle cryogenic liquids in well-ventilated areas to prevent hazardous concentrations of gases.

5 Cryogenic liquids are so cold that they can freeze skin and other human tissues immediately, thus inflicting serious injuries. Breathing the very cold gases which arise from vaporising cryogenic liquids can cause serious damage to the lungs.

5.1. Never allow any unprotected part of your body to touch un-insulated pipes or vessels containing cryogenic liquids. Wear protective clothing (goggles, gloves and safety shoes).

6 When a cryogenic liquid is released into the atmosphere, its extremely low temperature condenses the atmospheric water vapour and this forms a dense fog. A cryogenic liquid spill is often identified by the presence of a low-lying cloud of fog creeping over the ground.

These clouds can be dangerous as you do not know their temperature or composition. Visibility inside the cloud is very low and you could fall, perhaps into a stream of cryogenic liquid.

If the cloud is of nitrogen or argon then it is likely that the cloud does not contain sufficient oxygen to support life. In this case you could collapse immediately and death could follow.

6.1. DO NOT ENTER A VAPOUR CLOUD ; but see (8.2.) below.

6.2. When you see a cryogenic spill or a large vapour cloud notify your supervisor immediately.

6.3. If possible shut off the source of liquid, by use of a remotely controlled valve if one is fitted. Do not expose yourself to a hazard, such as high oxygen, combustible or asphyxiating atmospheres or cryogenic liquid.

7 If the spillage was near to a vehicle the cold liquid could freeze the tyres to the ground and make them so hard and brittle that the tyres could explode.

7.1. If liquid has reached the tyres do not attempt to move the vehicle. Also do not start engine in case of oxygen spill.

8 Low or high oxygen contents will generally exist inside and in the immediately vicinity of the vapour clouds. However, wind and weather conditions could spread hazardous conditions beyond the vapour cloud. Watch the windsock frequently.

8.1. Keep clear of the vapours and be prepared to move if the wind changes. Portable oxygen analyzers can be used to evaluate oxygen enrichment or deficiency hazards.

8.2. If it is essential to enter a cloud caused by nitrogen or argon, then wear a self-contained breathing apparatus provided you are trained and qualified to do so. A standby man, also wearing a breathing apparatus must monitor personnel in action.

9 If the release gas is oxygen, then your clothes could get saturated with and could catch fire very easily. Also a fire may occur at any time in an oxygen cloud, in case it contacts highly combustible material.

9.1. If you suspect that you have been contaminated with oxygen do not go near any source of ignition for not less than 15 minutes. Ventilate your clothing ; change if possible. DO NOT SMOKE OR GET NEAR SMOKERS!

10 If the cloud has been caused by oxygen, a running or starting internal combustion engine could explode. If the cloud has been caused by nitrogen or argon the vehicle could stall, thus trapping the occupants in the cloud.

10.1. If roads, railway lines, rivers or canals bordering the site are threatened by the liquid or the vapour cloud, then your supervisor may instruct you to notify the authorities to stop or divert traffic. No traffic must be allowed to enter the cloud. (An emergency call list should be available).

10.2. Shut off petrol or diesel engines on any equipment that may be remaining in the area.

11 Carbon steel becomes brittle when in contact with cryogenic liquids, so steel plates can crack and structural steel beams can fail and piping can burst.

11.1. If necessary and on the advice of your supervisor, divert the liquid away from vulnerable plant equipment towards a safe area by using stainless steel or aluminium sheet or clean sand dikes. Do not allow liquid oxygen to enter drains or sewers.

11.2. Water sprayed from a fire hose will help to vaporise the liquid and protect vulnerable steelwork by coating it with ice. However, judgement must be made on the weather and wind conditions. It may not be desirable to speed up vaporisation as the resulting larger vapour clouds could endanger staff and third parties.

11.3. If so advised by your supervisor, shut down any air conditioning or ventilating systems that may draw vapours or gases from the spill into buildings.

11.4. Call the Fire Department in the case of a large LOX spill. Have them stand by until the spillage is dispersed. Do not allow vehicles to enter the vapour cloud.

11.5. Keep all visitors to the site advised as to the hazards of the spill and arrange for their evacuation from the area unless they are company staff who are qualified to assist with the emergency.

11.6. If liquid oxygen reaches a black top area do not allow any movement of machines or people until it is fully unfrozen.

11.7. When the cloud has cleared and the emergency is over, do not enter any area below ground level e.g. a pit or gulley, without checking the atmosphere to ensure that it does not contain either a deficiency or an excess of oxygen.

FORK LIFT TRUCKS

1 It is dangerous to use a forklift truck for any job for which it is not designed.

1.1. Passengers must never be carried, either in the cab or on the forks.

1.2. A truck should not be used as a crane unless the correct accessory is fitted and the weight of the object plus accessory is less than the capacity of the truck.

2 If the truck is overloaded or is used on a slope or uneven ground then the steering can be adversely affected or the load may slip off.

2.1. You must thoroughly understand the characteristics and capacity of the truck and never overload it.

2.2. Never hoist on uneven ground with the mast tilted away from vertical position.

2.3. Travel only at a safe (low) speed, particularly over uneven ground. Respect speed limitations.

2.4. When travelling, the forks should be raised just enough to clear any obstructions due to unevenness of the ground. The load should be carried as low as possible ; to maintain maximum stability the forks should be raised no more than approximately 150 mm.

2.5. Do not take the truck on to soft ground which may not be able to support it and cause it to tilt.

2.6. When travelling up on ramps, the forks should be raised and the mast tilted back to clear the slope of the ground.

2.7. When travelling down a ramp the above procedure should apply, but with the load trailing (back up driving).

2.8. Never raise or lower the load while moving.

3 If the forks are not fully engaged, the load may fall.

3.1. Always check that the forks are fully engaged and load is stable before moving.

4 An electrically driven truck is noiseless and in a noisy environment a pedestrian may not be aware of its approach. Also keep in mind that under certain conditions the driver's sight may be obstructed.

4.1. Keep concentrated on your driving.

4.2. Ensure that everyone has cleared the area before lowering or moving the load.

4.3. Do not back up while concentrating on the load in front.

4.4. Only use the allowed roadways when travelling in order to reduce the risk of colliding with people.

4.5. Be especially cautious when approaching buildings corners, intersections, doorways.

5 If regular maintenance is not carried out, deficiencies may develop in the steering, brakes or hoisting mechanism. Regulations request periodical inspections which must be documented.

5.1. Carry out routine checks (e.g. battery acid level ; tyres for wear, damage and pressure; water and oil levels, brakes, steering, etc...) regularly as requested by management.

5.2. If the truck is electricity driven never inspect the battery near a naked flame or while smoking.

5.3. If you think the truck is unsafe in any particular way do not use it but report it immediately to the supervisor.

6 A truck with an internal combustion engine can be a source of ignition.

6.1. Before taking a truck into an area which contains flammable materials check with your supervisor that its use there is allowed.

7 Unusually sized loads could contact obstacles.

7.1. Before travelling with a wide load check that both sides of the access way are free of obstacles.

7.2. If it is necessary to travel with the load in an elevated position, then the load should be secured to the forks and only lifted for the minimum time necessary to clear the obstacle. Before lifting, check that there is sufficient headroom over the distance to be travelled. On these occasions the driver should be assisted by another operator.

7.3. Persons guiding the driver should keep at a safe distance from the machine and its load and never stand underneath the elevated forks.

8 When used for handling cylinders bundles there is a risk of moving them when still connected to the gas manifold.

8.1. When moving cylinder bundles from manifolds, make sure that they have been disconnected.

9 If a fork lift truck is not used in a safe manner, it might be very hazardous.

9.1. Loads should only be left in proper storage areas and not allowed to obstruct ways, emergency exits or fire fighting equipment.

9.2. Always park safely with the forks lowered. Remove the ignition key. Chock the wheels when necessary (slope).

9.3. A FORKLIFT TRUCK CAN ONLY BE DRIVEN BY A PROPERLY TRAINED AND CERTIFIED DRIVER.

CRITICAL SAFETY SYSTEMS - ALARM & TRIPPING DEVICES

1 These systems are required to avoid hazardous situations arising in plant operation.

2 The main characteristics which may change are pressure, temperature, flows and levels.

3 The changes may be the effect of several causes including instrument or equipment failure, human error, uncontrolled process deviation, loss of utility,...

4 The main objectives of critical safety systems are :

- to give warning by audible or visual means (alarm),
- to shut down a plant (tripping),
- to release pressure in a safe manner.

5 Examples of conditions requiring alarm-tripping devices are :

- high temperature	- acetylene generators, machinery bearings.
- low temperature	- outlets from vaporisers.
- high pressure	- pump discharges, filling lines.
- low pressure	- compressor or pump suction lines.
- high (excess) flow	- emergency shut-off valves on cryogenic storage tanks.
- Low flow	- cooling water systems.
- High level	- storage tanks.
- Low level	- oil sump.
- High vibrations	- compressors, motors.
- High voltage	- equipment malfunction.
- Low voltage	- supply fault, excess consumption.
- High current	- use of unauthorised appliances, short-circuit.
- Low current	- cryogenic pump starvation.
- Ground fault	- on electrical circuits / equipment.
- High/low oxygen content	- in a room or confined space.

6 The main types of device are :

- Safety valves relieve pressure by discharging to a safe area ; they are designed to close automatically when pressure returns to normal.

- Bursting discs relieve pressure by rupturing ; once ruptured they have to be replaced.

- Fuses or differential protection act when current in a circuit exceeds the value for which it is designed (short circuit, ground fault).

- Alarms are normally flashing lights, horns, but can be connected to telephone line for monitoring,...

- Emergency stop push buttons - these are to be used by operating staff to shut down plant or equipment in case of emergency.

7 Make sure that you know what all the alarms and protective devices are in your work area, what they mean and what action to take when they are activated.

Report all instances when alarms or protective devices are activated to your Supervisor, so that proper investigations can be made and deficiencies are corrected.

Never bypass, isolate or change the setting on an alarm or protective device. This could endanger plant and personnel.

Never try to repair an alarm or protective device ; if you know or suspect that one is faulty, report to your supervisor.

Alarms and protective devices must be checked and/or operationally tested at regular intervals. Make sure that you know the periodicity and report any case of non-compliance to your supervisor.

8 Make sure that you know the Critical Operating Parameters of the process or equipment that you operate and what to do in case they reach the control limits.

PRESSURE

1 When handling gases it is most important to understand what is meant by pressure ; how it is generated and what safeguards are necessary to contain it in order to prevent injury to personnel or damage to equipment.

Pressure can be generated in many ways, the most common being :

- by mechanical means, such as a pump or compressor,

- by heating vessels or piping, either deliberately or accidentally e.g. cylinders in fires,

- by the vaporization of cryogenic liquids in confined spaces e.g. in a pipeline between two closed valves,

- by chemical reaction e.g. explosion of a mixture of hydrogen and oxygen/air.

The unit of measurement most commonly used is the “bar” ; the name is derived from the fact that it is approximately equal to barometric pressure.

Pressure is indicated on gauges or other measuring devices which may be marked in different units such as bars, “atmospheres”, “pounds per square inch” (psi), “kilopascal” (kPa).

- 1 bar approximately equals 1 atmosphere (atm),
- or 100 kPa,
- or 14.7 psi.

For very low pressures units might be millimeters or inches of water column.

Pipelines and vessels are often referred to as “high pressure”, “medium pressure” or “low pressure”. These terms do not have any exact definition and should not be interpreted as having any real significance. If a pipeline or vessel contains any gas or liquid under pressure it constitutes a potential hazard and must be protected against overpressure.

Pressure gauges are used to know whether a system is pressurized or not.

Pressure vessels have the maximum allowable working pressure, service and test pressures marked on the nameplate.

1.1. Assume that all pipes and vessels contain gas or liquid under pressure unless you can positively prove otherwise.

1.2. If the pointer of a pressure gauge is stationary or reads zero.

- tap the gauge with your finger to make sure that the pointer is free and is not stuck. Do not do that when pressure gauge is fitted with electrical switches !

- if there is a valve between the system and the gauge, make sure that it is open.

1.3. Report leaks from systems under pressure immediately.

1.4. Always relieve the pressure in a vessel or system before commencing repairs. Never repair a leak while the system is under pressure. If in doubt, check with your supervisor.

1.5. Never disconnect a pipe or flexible hose when it contains pressure ; it will straighten or “whip” and could cause severe injury.

1.6. Before breaking into a pipe or vessel relieve the pressure in it (do this slowly through a vent valve taking care that flow is directed to a safe place and cannot affect other people or equipment) and make sure it is isolated. (Work Permit requested - see Leaflet 22 -).

1.7. Cryogenic liquids must never be trapped between two valves or closed ends. Check that there is a relief valve to protect any part of the system where this could occur and always operate valves in the correct sequence.

1.8. Pressure systems have to be tested periodically. This must always be done by trained personnel. Personal Protection Equipment must be worn during this operation and, when appropriate, operators must be protected (shielded) from the pipe or vessel being tested.

1.9. You might hear about “absolute” or gauge pressure.

Absolute pressure = gauge pressure + atmospheric pressure.

Most of instruments exhibit gauge pressure.

ELECTRICITY

1 Electricity is hazardous. You cannot see it. Only full respect of stringent rules by qualified personnel will prevent accidents.

1.1. Only qualified personnel is allowed to open electrical cabinets and work on electrical circuits.

1.2. Always de-energize, isolate and lockout the electrical circuits before making repairs or adjustments - See Leaflet 22 -.

1.3. Never switch electricity “on” and “off” with wet hands or when standing on a wet floor.

1.4. Always allow easy access to electrical equipment, switches and plugs, do not store combustible materials in their vicinity.

1.5. Keep electrical equipment dry and clean.

1.6. Do not use adaptors. They may overload the circuit and cause a short-circuit and fire.

1.7. Troubleshooting or repair of energized electrical equipment requires specific procedures and permits.

2 Electricity can be hazardous if it is not handled properly. Poor maintenance or poorly executed repairs may result in fires or electric shock.

2.1. Do not attempt to carry out electrical repairs unless you have been properly trained and are authorised to do so. If in doubt - do not attempt to use or repair the equipment but call an electrician.

2.2. If at any time an electrical plug, connector or cable is found to be hot or exhibits evidence of burns, report it immediately to your supervisor.

2.3. In the event of a fire on electrical equipment, switch off the power and then use a CO2 or dry powder extinguisher. Do not use water or foam (see Leaflet 16).

2.4. If a fuse blows, have it replaced by a similar one (ask the electrician). Do not use a fuse of higher rating as this may not protect the equipment. If the replacement fuse blows within a short time then have the equipment checked by an electrician.

2.5. Never replace a fuse by some makeshift such as a piece of wire, a nail, silver paper, etc... This is highly dangerous.

2.6. Same comments when a differential protection trips or is out of service.

3 An electric shock, no matter how slight, is a warning that something is wrong.

3.1. If you receive a shock - switch off the power, label the equipment so that no-one else will try to use it and report the matter to your supervisor.

3.2. If someone is suffering from electric shock and is still in contact with the electrical supply do not touch the person with your bare hands. If possible switch off the electricity and apply artificial respiration if the person has stopped breathing. Call for assistance.

3.3. If you cannot de-energize the circuit/equipment, try to push the person away using a long wooden pole or equivalent mean of non-conductive material before attempting first aid. Call for assistance.

4 Many items of electrical equipment - e.g. switches, some motors, produce sparks when in use or when switched off and on and so can be a source of ignition for flammable atmospheres.

4.1. Do not introduce unauthorised electrical equipment e.g. torches, radios, portable power tools, into potentially flammable atmospheres such as acetylene plants or flammable gas cylinder filling areas (hydrogen and hydrogen mixtures...).

FIRE

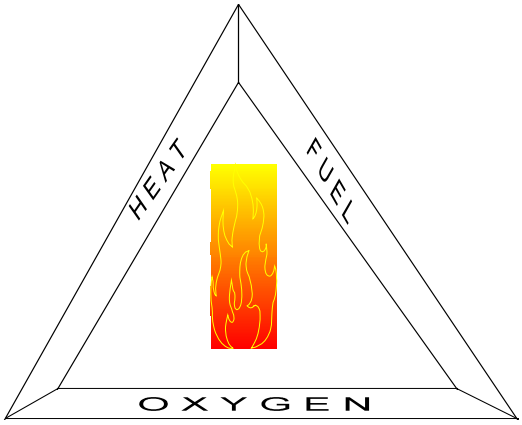
1 Every employee must be trained in the emergency response procedures and actions necessary to prevent the spreading of fires.

In order to know how to prevent fires from starting, it is necessary to understand the basic process ; fire is a reaction resulting in the release of heat, light and smoke, which is started and maintained by the simultaneous presence of three factors :

a Fuel, i.e. a combustible material,

b Oxygen (or oxidizing agent), usually air which contains 21 % oxygen,

c An external source of ignition (heat, shock, flame,...). Once a fire has started it generates its own energy / heat supply.



Fuels which exist in our factories are :

- gases, such as hydrogen, acetylene, natural gas, propane, butane, propylene,…
- flammable liquids such as diesel oil, oils, solvents, liquefied natural gas, propane, (LPG), etc...

The main sources of ignition are :

- smoking,
- welding, flame-cutting, grinding,
- friction,
- short circuits,
- heat and sparks,
- mechanical shocks,
- high velocity metal chip in oxygen piping.

Once fires have started, they spread by different means :

- conduction : metallic frames / piping have a high heat conductivity,

- convection : hot gases and vapours rise up and transport heat and pieces of burning materials...

- radiation : high temperature generates heat which travels across open spaces without any lame or burning material (this is what you feel when you stand in front of a fire place).

2 Specific hazards in our industry are represented by :

Cylinders : if exposed to excessive heat, cylinders may explode ; alternatively the material may be weakened so :

Keep all cylinders away from heat sources

Calcium Carbide : when wet, calcium carbide generates heat and acetylene gas which is highly flammable and potentially explosive...

Keep drums of calcium carbide in dry conditions and not exposed to heat.

Oxygen-fed fires : oxygen vigorously supports combustion. In oxygen, everything burns more or less violently.

Report leaks from oxygen systems immediately and make sure that they are promptly fixed.

Hydrogen fires : hydrogen burns with an invisible flame : precautions and procedures are detailed in Leaflet 4.

Report a hydrogen fire, or a suspected hydrogen fire to your supervisor immediately.

Acetylene fires : special training is required to deal with acetylene fires on plant. Cylinders need be either taken away from fire if not yet hot or cooled down with large quantities of water when their removal is too hazardous.

Electrical equipment : electrical equipment gets hot when it is overloaded or in case of short circuit.

Report any electrical equipment, such as motors, generators, cables, switchgear which is found to be hotter than normal.

Machinery : motion generates heat and all machinery is designed to operate between certain temperature limits (critical are valves on reciprocating Oxygen compressors).

Report any cases of machinery overheating to your supervisor.

Welding, cutting and grinding operations : sparks and molten metal can ignite combustible materials in the vicinity. Also torches generate high temperature flames.

Before starting work check that there are no combustible materials in the vicinity. Work in specified areas only or get a Work Permit. See Leaflet 22.

Chemicals : some chemicals ignite when exposed to heat.

Clothing : clothing, particularly soiled clothing, can ignite when exposed to heat or flame.

Keep all clothing which is not being worn in authorised lockers.

Electric or gas cookers, fires and heaters : use only those cookers, fires and heaters which have been authorised by management in the authorised area (kitchen).

3 All employees will be trained in basic fire prevention, fire fighting and emergency procedures before commencing work.

3.1. Know which extinguishers can be used to fight particular types of fire and be able to recognise fire-fighting appliances by type, colour and use - see attached chart -

3.2. Easy access to fire-fighting equipment must be maintained.

3.3. Report any use of fire extinguisher so that it is replaced immediately.

3.4. Fire fighting equipment need be inspected periodically.

4 Emergencies :

4.1. If you hear the alarm, proceed to your meeting point via the normal escape route or, if not available, its nearest alternative. All employees must know the escape route and meeting point. Learn what to do in case of an emergency.

4.2. If you discover a fire :

- sound fire alarm,
- fight fires with appropriate extinguisher,
- do not allow fire to spread so as to cut off escape route,
- if fire cannot be extinguished, personal safety comes first : escape !

4.3. Fire and emergency instructions must be posted and maintained at various places in your plant or office. You must know these places and instructions.

FIRE EXTINGUISHERS

TYPE	**GROUP 1** WATER	**GROUP 2** CARBON DIOXIDE	**GROUP 3** VAPORISING LIQUID	**GROUP 4** DRY POWDER	**GROUP 5** FOAM
COLOUR		According to national regulations / standards			
CLASS A FIRES HYDROCARBONS (FLAMMABLE SOLIDS)	EXCELLENT - COOLS DOWN - Not for calcium carbide !	SMALL SURFACE FIRES ONLY	SMALL SURFACE FIRES ONLY	SMALL SURFACE FIRES ONLY	YES - COOLS -
CLASS B FIRES FLAMMABLE LIQUIDS	NO	YES	YES - EXCELLENT	YES - EXCELLENT	YES - SMOTHERS FIRE -
CLASS C FIRES FLAMMABLE GASES	YES - COOLS	NO	NO	NO	NO
CLASS D FIRES MOLTEN METAL & REACTIVE POWDERS	NO	NO	NO	SPECIAL EUTECTIC POWDERS	NO
FIRES INVOLVING ELECTRICITY	NO - HAZARDOUS	YES - EXCELLENT	YES - EXCELLENT	YES	NO

HAND TOOLS

1 Misuse of tools or using defective tools can result in severe injuries. Also, using inappropriate tools might lead to damaged tools or equipment.

1.1. Use the Right Tool for the Job

1.1.1. Do not use make-shifts - such as using a spanner to hammer, pliers instead of the correct spanner, etc...

1.1.2. Use the correctly sized spanner (preferably a ring, box or socket spanner) for nuts and bolts.

1.1.3. Never use pliers on a nut, while an adjustable spanner should only be used as last resort.

2 If you let tools deteriorate then they can break or lose grip when being used

2.1. Keep Tools in Good Condition

2.1.1. Unsafe tools include spanners with worn, splayed or cracked jaws, screwdrivers with broken blades ; hammers with loose heads or split handles ; mushroomed heads on punches and chisels ; files without handles ; blunt cutting tools, etc...

2.1.2. Tools which have deteriorated in this way must not be used until they have been repaired. If they cannot be repaired economically they must be scrapped.

2.1.3. Cutting tools should be dressed frequently to keep them sharp.

3 If you do not use a tool correctly you run a greater risk of being injured

3.1. Selection and use of tools must be such that the worker will not losehis/her balance or be struck by the tool in case something goes wrong.

3.2. Knives are very frequently the cause of injuries. The cutting stroke should always be away from the body and the hand which is holding or steadying the work should not be in the path of the blade to prevent injury.

3.3. A screwdriver should not be applied to an object held in the hand - place the work on the bench.

3.4. A spanner should be pulled towards you - not pushed. If it is pushed and the nut suddenly breaks loose, then you can fall forward.

3.5. Do not attempt to get extra leverage on a spanner or pipe wrench by slipping a length of pipe over the handle of the tool. This can strain the tool to breaking point. Use torque adjustable wrenches.

3.6. If a spanner is slightly too large, do not make a fit by using packing, such as a washer. Get the correct size of spanner, or if one is not available use an adjustable spanner.

4 Unless you carry or store tools properly they can injure yourself or others.

4.1. Carry Tools Safely

4.1.1. Never carry tools in such a way that might interfere with using both hands freely on a ladder or else.

4.1.2. A strong bag, bucket or similar closed container should be used to hoist tools from the ground to the job, while they should be returned in the same manner, not brought down by hand, carried in the pockets, or dropped to the ground.

4.1.3. Chisels, screwdrivers and sharp tools should never be carried in the pockets. They should be carried in a toolbox, in a carrying belt (sharp or pointed end down) , in a pocket tool pouch.

4.1.4. Tools should be handed from one workman to another, never thrown. Edged or pointed tools should be handed with the handle towards the receiver or ideally in an adequate casing.

4.2. Keep Tools in a Safe Place

4.2.1. Tools should not be left in elevated positions such as scaffolds or shelves as they can fall on persons below (especially when one opens a cabinet).

4.2.2. When tools are not in use they should be put in a toolbox. If left on the floor even for a few minutes, someone may trip on them.

4.2.3. Sharp tools should not be left lying on a bench or in a drawer. When not in use they should be kept in a rack or special section of the toolbox, in such a way as to protect the user and prevent damage to the cutting edge.

4.2.4. Make sure that sharp tools are never left hidden under paper, rags or other materials or mixed with other tools in the toolbox.

4.2.5. It is advisable to slip plastic, metal or fibre guards over the sharp edges of tools before putting them away. This protects both you and the tool.

5 Loose clothing can be snagged by tools, nails or working materials.

5.1. Dress for the Job

5.1.1. Wear protective clothing as appropriate - i.e. safety shoes ; a glove on the hand which is steadying the work when using a cutting tool ; safety glasses when working with striking tools, hard hats when necessary.

6 Machine tools in workshop need be maintained and operated by qualified persons only and be equipped with appropriate guards.

PORTABLE ELECTRIC TOOLS

1 A portable electric tool, if misused, can cause serious injuries : severe lacerations, electric flash burns, particles in the eyes, minor electric shocks that may cause falls and severe electric shocks having fatality potential.

1.1. INSPECT THE TOOL THOROUGHLY BEFORE USING

1.1.1. Make sure that the casing is not damaged, if it is damaged, do not use the tool and report to your supervisor.

1.1.2. If the tool is not double insulated or low voltage (24 V), then check that it is properly grounded and protected by 30 mA differential protection.

1.1.3. Make sure that all cables and plugs are in good condition and the insulation is complete and undamaged.

1.1.4. Check that the power supply is the correct voltage as instructed on the manufacturer's label.

1.1.5. Make sure that the power cable is long enough to enable the tool to be used easily without straining the cable. If it does not have sufficient slack, then use a proper extension cable. Do not use a makeshift, temporary connection.

1.1.6. Check the guard on an electric saw to be sure that it operates freely. It must enclose the teeth completely when it is not cutting and the unused portion of the blade when it is cutting.

1.1.7. Check that portable grinders are fitted with guards in good working order.

1.2. EXERCISE CARE IN USE

1.2.1. Power cables on the floor create a tripping hazard and may be damaged. When possible suspend them over aisles or work areas so that they will not be struck or damaged. Keep them away from heat, oil and chemicals.

1.2.2. Under wet conditions, the risk of electric shock is increased. Make sure that all connections are sound and do not stand in water. Differential protections at 30 mA or low voltage (24 V) tools are recommended.

1.2.3. Never connect a portable electric tool to a lighting socket (such types of sockets are prohibited).

1.2.4. When using a drill the work should be anchored or clamped to prevent whipping.

1.2.5. A circular saw should be started and stopped outside the work and should not be forced into the work.

1.2.6. Make sure that the power cord cannot get in contact with rotating parts and tools.

1.2.7. Portable grinders should be handled with care to avoid damaging the grinding wheel.

1.2.8. Grinding wheels should be kept away from water and oil.

1.2.9. Disconnect the power line before changing accessories and when not in use.

1.2.10. Do not attempt a makeshift repair on a faulty tool. Report it to the supervisor and have it properly maintained / repaired.

1.2.11. Electric tools are a source of ignition. Do not use them in explosive or flammable atmospheres, such as in acetylene plants or hydrogen storage areas unless the atmosphere has been tested and a work permit obtained.

1.2.12. When work is finished (even temporary) switch off the tool and wait until it has stopped rotating before putting it on the bench or floor.

1.2.13. When disconnecting a tool from the power supply always pull the plug, do not pull the cable as this can loosen the connections inside the plug.

1.3. STORE CAREFULLY

1.3.1. Do not leave tools in an overhead place where they can fall from...

1.3.2. Do not leave tools on the floor where they will be a tripping hazard or get damaged.

1.3.3. Store tools carefully so that saw blades and abrasive wheels are protected from damage and the cables and plugs are clear of any sharp objects.

1.4. WEAR CORRECT PROTECTIVE EQUIPMENT

1.4.1. EYES PROTECTIONS SHOULD ALWAYS BE WORN WHEN USING ANY TYPE OF POWER TOOL.

PORTABLE PNEUMATIC TOOLS

1 Hazards

Misuse of a portable pneumatic tool can result in hazardous conditions, causing severe and often disabling injuries. Only trained personnel may use portable pneumatic tools.

1.1. Use the right tool and inspect it thoroughly before use.

1.1.1. Check that the pressure of the compressed air supply is adequate for the tool by referring to the manufacturer nameplate and the pressure gauge on the supply line. Make sure that risk of overpressure is properly addressed.

1.1.2. If air is supplied from a cylinder or a bundle, make sure that there is a regulator fitted with a pressure relief device to control the line pressure. Never take air direct from a cylinder or rely on the cylinder valve to control the line pressure (see also item 1.3.)

1.1.3. Check that all parts of the tool and the supply hoses are in good condition. Supply hoses must be long enough and if couplings are required they must be properly selected and used. Report any defect to your supervisor.

1.1.4. Check that the control switches operate correctly and the air supply can be isolated in case of emergency.

1.1.5. Check that you have all the necessary accessories and small tools such as chuck operating key before starting.

1.1.6. Supply hoses should be as short as possible. When possible hoses are hung at 2 meters above ground. If hoses have to lie on the floor, make sure they are protected from vehicles such as barrows and forklift trucks and that people cannot trip over them.

1.2. Wear protective clothing and equipment as specified ; eye protection must always be worn ; gloves may be necessary for some operations but ensure that you can still operate all the controls. With some tools, hearing protections are necessary ; if in doubt ask your supervisor. Make sure your clothing cannot be caught by rotating parts.

1.3. Only use compressed air for driving a pneumatic tool. Nitrogen can only be used occasionally under Work Permit restrictive conditions. Never use oxygen or other gases.

1.4. Exercise proper care in use :

1.4.1. Do not stretch supply hoses ; if you have to move from your original position and the hose is not long enough, stop work. Either move the job within range of the hose or extend the hose with an authorised coupling and re-test it before use (see 1.1.6. above).

1.4.2. Shut off, release pressure and disconnect air supply before changing accessories.

1.4.3. Make sure the workpiece is properly secured before starting work, if necessary in a vice or clamp.

1.4.4. Make sure that you are properly positioned and balanced before operating the tool. Remember that the action of the tool produces high torque which might cause the tool to twist or “kick”.

1.4.5. Ensure that the supply hose is kept away from the rotating parts (tool, chuck,...).

1.4.6. Abrasive wheels must be kept away from water and oil.

1.5. When work is complete,

1.5.1. Shut off air supply, release pressure and disconnect air supply before disconnecting tool.

1.5.2. Store tool and accessories in a safe dedicated place.

CHEMICALS

1 In air separation, liquid carbon dioxide, dissolved acetylene and cylinder filling plants, various chemicals are used for such operations as purifying, cooling, drying, water treatment, cleaning, etc... These can be handled safely provided that their properties are understood and adequate precautions taken. Material Safety Data Sheets and/or specific work instructions must be posted where chemicals are used and stored.

1.1. Before use, carefully examine all labels on the container. Read the Material Safety Data Sheet and comply with its requirements, especially wear adequate protective equipment.

1.2. Do not put a chemical into an unmarked or unsuitable container. Always use the approved tightly closed container and make sure that it is clearly labelled with the name and type (i.e. “flammable”, “highly corrosive”, “poisonous”) of the chemical.

1.3. Withdraw only the amount of chemical needed for the job in progress. Guard it from contamination and return any unused chemical to stores.

1.4. Do not dump waste or surplus chemicals into the sewer, the drain or into normal waste container. Segregate hazardous waste and dispose of it in an authorised manner (report to your supervisor).

1.5. Any spillage of chemical should be reported to your supervisor immediately. He/she will advise the best method of clearing it up safely. Do not allow chemicals to creep into the sewer grid.

2 Some chemicals are flammable - i.e. they burn in the presence of air. Some flammable liquids (solvents) are very volatile, they freely produce a vapour which when mixed with air can explode violently.

3 Chemicals such as acids and alkalis rapidly attack the skin and sensitive membranes, causing serious damage.

Many chemicals are poisonous. It is not always necessary to swallow a chemical to be poisoned by it. Breathing its vapour may be dangerous ; while some can be absorbed into the bloodstream through the skin.

3.1. Always wear the correct protective equipment when working with or near a chemical.

3.2. Learn the correct first aid treatment to be adopted in the event of being splashed with, breathing or swallowing the chemical.

3.3. If a chemical comes in contact with skin or eyes, immediately flush the contaminated part with water for several minutes to dilute and wash away the chemical. Remove clothing from affected areas. Then apply the appropriate first aid treatment and if necessary get medical help. Report incident to your management.

Know where the nearest eyewash and safety showers are located.

3.4. Always get medical help if chemical has entered the eyes or been swallowed.

3.5. If your clothing becomes contaminated with a chemical then change it and have the contaminated articles washed.

3.6. After handling the chemical, carefully wash your hands before eating and feed away

from the potentially contaminated area.

4 Solvents are a special case. All the precautions in this leaflet should be applied, and there is further information in Leaflet Number 21.

5 Chemicals are stored in dedicated areas which are designed to prevent negative impact on environment in case of spillage. Such areas are usually fitted with retention basins. Draining of retention basins is governed by stringent procedures.

6 Disposal of hazardous waste must comply with regulations and must involve officially qualified subcontractors.

SOLVENTS

1 Solvents are used in many areas of our work. They can be hazardous if mishandled so you must understand their properties and related hazards. Always wear the recommended personal protective equipment. Work in well ventilated areas.

1.1. Use only solvents which have been authorised by Company Management as suitable for a particular job.

1.2. Before use make sure that you know the job method and are familiar with the precautions to be adopted. Ask your supervisor for the manufacturer's recommendations (Material Safety Data Sheet).

1.3. Keep the solvent in a closed container. Do not transport or keep it in an open vessel such as a bucket and do not bring excess quantities of solvent to the working area.

1.4. Do not pour used solvent down a drain. Have it collected for disposal in a suitable manner.

2 Solvents have a powerful degreasing action on the skin. This removal of the body's natural fat can cause dermatitis, while if they enter the eyes they can cause at least temporary inflammation and could create permanent disability.

2.1. Avoid contact with the skin and eyes. Do not use for cleaning hands. Wear suitable gloves (and apron if necessary) and eye protection and, when requested breathing apparatus or respirator.

2.2. Any spills should be reported to your supervisor immediately, as they should be cleaned up to prevent contamination of the atmosphere and accidental skin contact.

2.3. If any skin irritation or injury develops get medical advice.

3 Some solvents are narcotic - i.e. induce drowsiness and ultimately unconsciousness ; while some are toxic and can injure vital organs of the body.

3.1. Ensure good ventilation in the area of the job. Do not breathe the vapours.

3.2. If the use of a respirator is advised, make sure that the canister is suitable for the solvent you will be handling.

3.3. Do not lean over any vessel containing the solvent.

3.4. If any vessel or other confined space has contained a solvent do not enter it without a self-contained breathing apparatus or equivalent until it has been purged with air, tested and confirmed free from traces of vapour. This anyway requires a Work Permit and special procedures.

3.5. If a solvent has been used for internal cleaning of a vessel, all traces of solvent must be removed using the approved procedure before bringing it back into operation. Again a Work Permit is required.

4 Some solvents are flammable, can readily be ignited and the vapour can form an explosive mixture with air.

Some of the non-flammable solvents (e.g. methylene chloride, trichloroethylene) produce poisonous vapours if heated.

4.1. Keep all solvents and their vapours away from flames, hot surfaces or welding arcs and do not smoke while handling them.

WORK PERMIT

1 Some tasks can be hazardous unless special precautions are taken. A Work Permit procedure must exist so that for specific job activities a formal and documented approach is used to

- identify roles and responsibilities,
- identify hazards and define specific work instructions which prevent identified hazards.

1.1. A Work Permit makes the person who is ultimately responsible for the work consider all possible hazards and remove them or mitigate them before allowing work to proceed.

1.2. A Work Permit informs the person carrying out the work of the specific procedures and precautions they must use in order to carry out the work safely.

1.3. Work Permit procedure is used when construction, maintenance or repair work is done on or in the vicinity of process equipment, particularly under following circumstances :

- when safety equipment or protective device have been temporarily rendered inoperative,
- entering confined spaces e.g. tanks, vessels, ducts or trenches.
- grinding, burning, welding, soldering or similar types of work performed elsewhere than in dedicated workshops (Work Permit is sometimes named “Fire Permit” or “Hot Work Permit” in this case).
- electrical work or work near high voltage lines.
- opening a process line or vessel, cutting or tapping lines or equipment.
- when oxygen enrichment or deficiency can happen.
- when electrical, mechanical or process equipment has to be isolated and locked-out.
- elevated work.
- excavation work.

If in doubt whether a Work Permit is required, check with your supervisor.

1.4. The issue and control of a Work Permit is the responsibility of the Plant Manager or his/her nominated delegate.

This responsibility continues through the entire operation and includes monitoring of the actions called for on the Permit and the subsequent signing off when the work has been completed.

When work is to be carried over into a second day or working period, it is the responsibility of the manager taking over to issue a new Permit before continuing the work. This requires implementation of the whole process as described below...

1.5. Make sure that the rules given below are followed during the whole period covered by the Work Permit.

1.5.1. Before allowing work to proceed, the person responsible shall check that the requirements of the Permit have been carried out. Personnel need be instructed at the place where work will take place before they start to work.

1.5.2. During the work the person responsible shall check that the required safety measures are being carried out.

1.5.3. When work is being carried out in a confined space, the person responsible must ensure that all necessary back-up and support (equipment and personnel) as well as safety and emergency equipment are available, instructed and in working order. You must know your Company Confined Space Entry procedure and always comply with.

1.5.4. Nobody is allowed to remove or disturb any equipment or signs associated with a Work Permit situation, excepted when instructed to by the Work Permit signer.

1.5.5 When equipment lockout is necessary, Work Permit signer needs make sure that lockout plan is properly implemented and documented.