# TTE TRAINING LIMITED

## Phase 1 Fabrication

## Carousel 1

# SAFETY IN THE USE AND STORAGE OF OXY-FUEL GAS CUTTING EQUIPMENT

# SAFETY IN THE USE AND STORAGE OF OXY-FUEL GAS CUTTING EQUIPMENT

## INDEX



## OBJECTIVE

On completion of this module the trainee should have an understanding of the safety requirements, procedures and correct methods of operation when setting up and using thermal cutting equipment to cut ferrous metals.

## THE FLAME CUTTING PROCESS

'Flame cutting' is a process used for cutting steel by means of the chemical action which takes place when oxygen comes into contact with metal that has been heated to a high temperature.

The process involves heating the metal to its combustible temperature, approximately 900˚ C and a stream of high pressure oxygen is directed onto the heated spot. The oxygen causes a rapid oxidation of the metal to take place and the high pressure of the oxygen is used to remove the oxides which are formed leaving a cut in the metal. The width of the cut will depend upon the size of the oxygen cutting stream.

The flame cutting process can only be used on materials whose melting point of its oxides are below the melting point of the parent metal, therefore, non-ferrous metals cannot be cut by this method. There are a number of alternative methods available for the cutting of these materials.

The heat required for this process is obtained by mixing a combustible gas, usually propane or acetylene with oxygen. This is known as 'Pre-heating' flame, and the job of the pre-heating, as the name suggests, is to heat the metal prior to the cut taking place and serves no other purpose. The cut being formed purely by the action of the oxygen stream on the heated metal.

The flame cutting process can be used either by means of a hand cutting torch or by a machine. Owing to the difficulty of maintaining a constant even rate of travel over the work, the quality of the cut produced with a hand cutting torch is inferior to that of a correctly adjusted machine cut. A considerable amount of practice is necessary to develop skill when using the hand torch, the use of a guide should be used to keep the torch on the correct line of cut and means of maintaining the correct distance between the nozzle and the workpiece would be found to be of great assistance.

Care should be taken when flame cutting near to certain metals, namely Titanium as the heat produced from the cutting flame could damage the metal beyond repair.

Non-Ferrous metals and some steels cannot be cut by the flame cutting process. Plasma-arc cutting is now recognised as the most practical method of cutting these materials.

The quality of the cut with both hand torch and machine cutters depends mainly on the following conditions:-

1. The correct nozzle size for the thickness of material being cut.

2. The condition of the nozzle.

3. The correct distance of the nozzle from the surface of the metal.

4. The correct pre-heating flame.

5. The correct cutting speed.

6. The correct pressure of the gases.

7. The condition of the plate surface being cut.

## SAFETY IN THE USE OF GAS CUTTING/WELDING EQUIPMENT

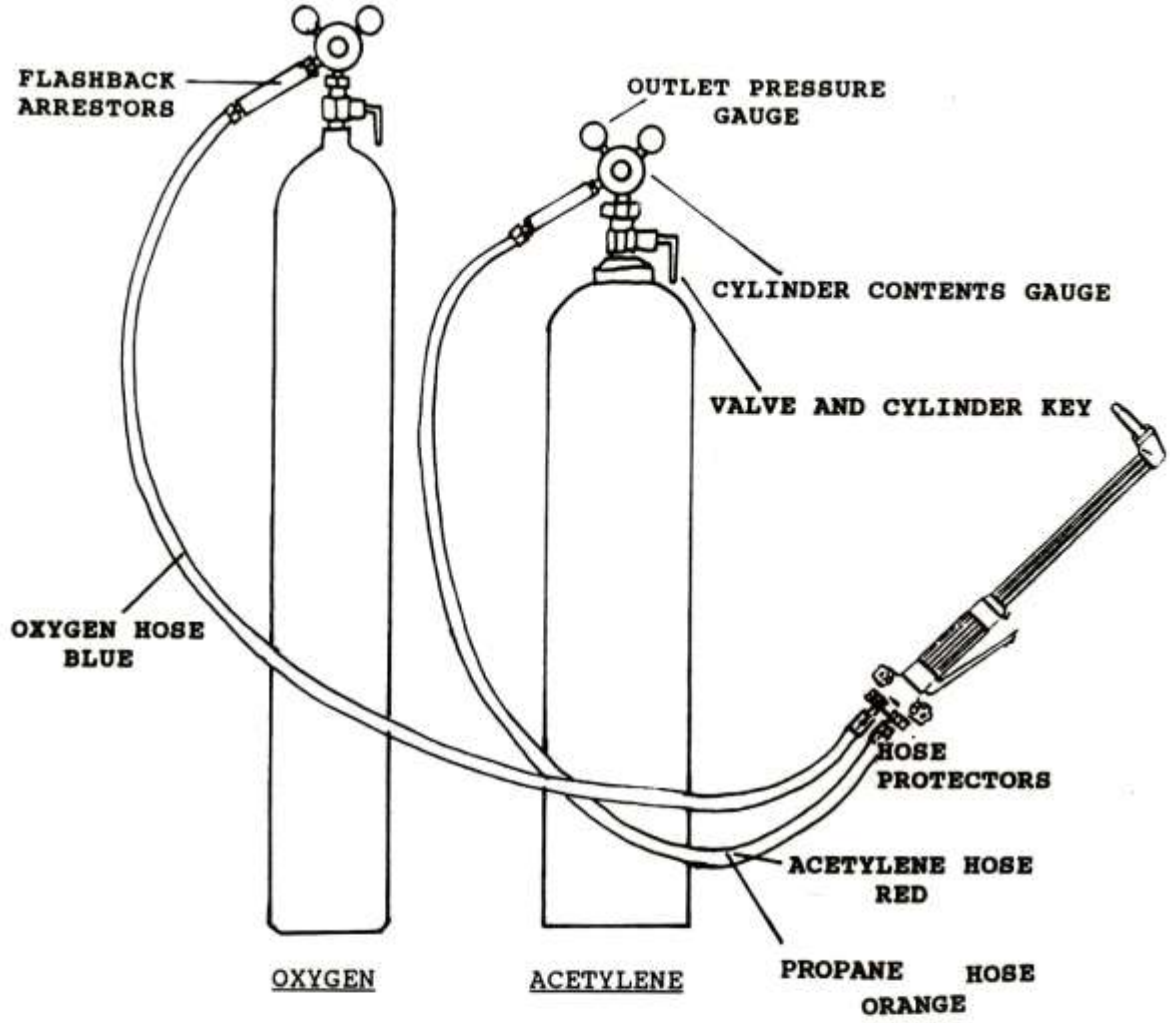
As a result of a number of mishaps with fuel gas cutting and welding equipment over the last few years, the Materials Group have made a number of recommendations in the safe use and inspection of this equipment.

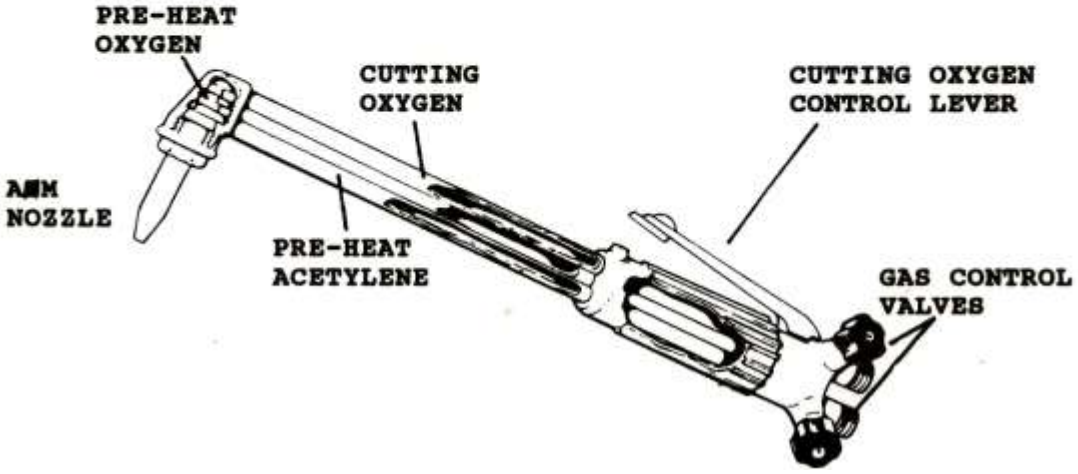
1. That all oxygen and fuel gas cylinders/manifold systems should be fitted with the appropriate flash back arrestors to comply with legislation guidelines.

2. All monthly inspection procedures for cutting/welding equipment should be updated.

3. All cutting/welding stations using oxy-fuel gas should be provided with a permanent notice giving important safety checks.

## OXY-PROPANE/OXY-ACETYLENE WELDING AND CUTTING EQUIPMENT




## CUTTING TORCH

## FLASH BACK ARRESTORS

This devise is designed to prevent any flame from reaching the cylinder and regulator and only through regular maintenance and testing can we rely upon it to perform its job correctly. As with regulators, they must be returned at regular intervals for checking and repair.

The arrestor is attached to the outlet side of the regulator by means of a captive nut which is either a RIGHT HAND screw thread or LEFT HAND in the case of combustible gas fittings.

In the event of a flash back or back pressure feeding, the arrestor is designed to close down the flow of gas to the blowpipe automatically.

To reset the arrestor, the valves on the torch should be closed and left for thirty seconds. On re-opening the valves, the arrestor will automatically reset itself. It should be well noted that before any attempt is made to reset a flash back arrestor, the initial cause of the shutdown should be found and corrected.

**Resetable Flashback Arrestor**

**In-line and non-resetable**

## MONTHLY INSPECTION OF ALL EQUIPMENT

A competent person should be appointed to be responsible for the monthly checking of all equipment. The results of this inspection should be recorded and copies retained. Any faulty equipment must be withdrawn from use for repair or replacement.

The monthly inspection should cover all of the following:

## PRESSURE REGULATORS

1. Visually check for broken glasses, damaged indicator needles, sticking of needles or failure to zero.

2. Check for smoothness of operation or pressure control screw. Check that the line pressure gauge needle rises smoothly as the regulator control screw is slowly opened.

3. Check over a 10 minute period that the high pressure or low pressure gauge does not creep upwards.

4. Gauges shall be returned to an approved dealer/supplier every 24 months for replacement, or at any time a fault or inaccuracy is suspected.

## HOSES

1. All hoses must comply with the company's recommended standards.

2. Visually examine for cracks or perishing.
(Test any suspected portion by twisting the tube between the hands).

3. Replace any cracked or perished hoses.

4. Check that the correct type of hose check valve is fitted.

5. Hose attachments shall be fixed to the hose using only "factory fitted" connections.

## BLOW PIPE

1. Visually examine for any mechanical damage affecting safe operation, e.g. bent, worn or stiff valves, damaged threads or facings at all connections. REPLACE OR SEND FAULTY EQUIPMENT TO AN APPROVED REPAIRER.

2. Check that the nozzle orifice is in good condition and free from obstruction. If defective destroy nozzle and fit new one.

## HOSE CHECK VALV E

1. Ensure that the hose check valve fitted is of the latest recommended type.

2. Blow a small amount of gas through the hose, to ensure that the hose check valve seat is not stuck.

3. Disconnect each hose complete with its hose check valve. Using specially made adaptors as necessary, connect the check valve end of each hose to a pressure reducing valve on a cylinder of compressed air or nitrogen. DO NOT USE OXYGEN OR FUEL GAS. Apply a pressure of not more than 0.2 bar (3 psi) and immerse the free end of the hose in water; if bubbles continue to issue from the hose end the hose check valve must be replaced, and the new replacement checked. Note this pressure test is in the opposite direction to normal flow, and a hose check valve is designed to close fully at pressures below 0.2 bar.

## FLASH BACK ARRESTORS

Visually check for signs of mechanical damage.

Check that the flashback arrestors are fitted to the cylinder regulators correctly.

Dependant on type there is a specified period that they are valid for use and must be taken out of use/replaced.

**NOTE:** All installations must be fitted with flashback arrestors. Required on fuel gas and oxygen cylinders or manifold systems.

## LEAKAGE CHECKS

After completing the above checks and correcting all faults found, the equipment should be re-assembled and checked for leaks at the maximum working pressure (for acetylene this must not exceed 0.6 bar: 9 psi). Leakage shall be detected by immersing in water where practical, or by coating with an appropriate leak detection soap over the area to be examined using the following procedure:

1. Remove the cutting/welding nozzle and replace with a blanking nozzle.

2. GENTLY OPEN ALL VALVES TO MAXIMUM OPERATING PRESSURE. Test all joints, connections and valve spindles for leaks. Tighten connections or send equipment for repair as necessary.

3. Close cylinder valve.

4. Remove blanking nozzle and replace cutting/welding nozzle.
5. Open cylinder valve, stop off nozzle with thumb. (Reduce gas pressure to 0.4 bars, 5 psi if necessary). Test for leaks at nozzle to torch connection.

6. Check that each torch valve, cylinder regulator, control valve and cylinder valve will fully close at the maximum working pressure. This shall be done by immersing the nozzle under water and check for gas bubbles after closing each valve in turn with the other valves open.

## OPERATIONAL CHECK

1. Set pressure regulators to normal operating conditions and purge each line in turn.

2. Light the torch using the recommended procedure. Adjust the flame and allow to burn for one minute.

3. Extinguish the torch, close the cylinder valves, open torch valves, one at a time, and allow gas to flow out until gauge reads zero then slacken off pressure regulator and close the torch valves.

4. If all is satisfactory, sign the appropriate form and return the equipment to service.

## NOTES:

**Repair or Servicing of Equipment**

All equipment shall be repaired or serviced only by an approved Contractor.
After fitting of new hoses the hoses shall be pressure tested and leak tested to the satisfaction of the person appointed for Monthly Inspection.

## GAS CUTTING/WELDING EQUIPMENT

## OPERATOR SAFETY CHECKS

1. Do not use equipment which can be seen to be damaged or faulty. (Faulty equipment must be sent to an approved repairer).

2. Ensure that the main cylinder valve is on the opposite side to the gas outlet, is easily accessible and a key is available for us in an emergency.

3. Check that nozzles are not blocked and used recommended lighting and extinguishing procedures.

4. Hoses when replaced shall be fixed only with “factory fitted” fixings.
DO NOT USE JUBILEE CLIPS.

## WORKING IN CONFINED SPACES

1. Any oxygen or fuel gas equipment must be checked for leaks before it is taken into a confined space.

2. Gas cylinders should not be taken into confined spaces.

3. If gas cylinders need to be taken into a confined space, this should only be done when giving the correct authority and special precautions must be taken.

4. If equipment must be left unused in a confined space, turn off all gases at the cylinder when not in use.

## OXYGEN ENRICHMENT

Serious, and in some cases fatal, accidents are caused each year by the release of oxygen into the air into confined spaces, such as boiler drums, tanks and similar fabrications, during welding or cutting work. Figures made available by the Factory Department of the Ministry of Labour and National Service indicate that a fairly high proportion of the accidents reported as being due to the use of gas welding and cutting apparatus occurred as a result of oxygen enrichment.

The danger exists because many materials, such as clothing, burn very much more fiercely in an atmosphere containing more than the usual 21% of oxygen; only a relatively small increase in this percentage is sufficient to produce a dangerous condition. Should such an increase in the oxygen content occur, any sparks or spatter falling on the worker's clothing will cause the cloth to catch fire and to burn very rapidly; the worker will almost certainly be badly burned and, if he cannot escape quickly from the vessel in which he is working, he may be burned to death.

Oxygen has no smell, neither can it be seen; it is not easy, therefore, to detect that excess oxygen is present until it is too late.

Accidental oxygen enrichment could almost always be avoided if more care was taken. Also, it should be noted that, in gas putting inside a vessel of other confined spaces, local fume extraction is ESSENTIAL in order to remove any cutting oxygen not consumed by the oxidation reaction.

The first cause of accidental oxygen enrichment is the use of oxygen to 'sweeten' the air in a confined space when the atmosphere becomes stale.

This practice leads to the first recommendation:

1. Do not use oxygen to 'sweeten' the air in a confined space, or release it for any other purpose. To do so endangers your life and the lives of others working near you. Preferably light the blowpipe before entering, so as not to release gas into the atmosphere of the vessel, especially if it is of small dimensions. *

- **WARNING**

Do not work in a confined space with welding or cutting equipment unless you are using the means provided to ensure that the air remains safe to breathe during the whole period that you are working. (See "Health and Safety in Welding" published by the Institute).

The second cause is faulty equipment; a small leak in a valve, connector, hose etc. can result in a gradual building-up of oxygen that may become dangerous. This cause suggests the second recommendations:

2. Do not use defective or damaged equipment, and make sure, by frequent inspection that your equipment is in first-class order and that it is free from leakages of gas. If your equipment is damaged, or if you detect a gas leak, have it repaired at once. Tomorrow may be too late.

The third cause is equipment left inside the vessel during lunch breaks or overnight. Even a very small leak, allowing gas to escape into a vessel over a long period, can produce a dangerous condition. The third recommendation is therefore:

3. Never leave gas welding or cutting equipment inside a confined space unless you are actually using it. Whenever you leave your work for more than a few minutes, take your blowpipe outside, so that the air inside cannot become dangerous.

Although this information sheet has dealt only with oxygen enrichment, it is also dangerous to allow acetylene or other fuel gas to be released into the air in a confined space. This is covered in the booklet "Health and Safety in Welding", published by the Institute, and will also be the subject of a future information sheet.

## WORKING IN CONFINED SPACES

The following extract was taken from the Daily Mirror, December 1976 and should act as a warning to all persons who carry out work in confined spaces including those who have had many years of experience.

### VANISHING SMOKES SIGNALLED WARSHIP DISASTER

Workman refitting a top-secret warship were given a dramatic warning of disaster.

They lit cigarettes on the ship's bottom deck and the tobacco burned down to their fingers before they had time for a puff.

But, instead of recognising the danger, the men were baffled, an inquest heard yesterday.

They did not realise oxygen had leaked into a cramped machine room. Minutes later a welder lit his torch – and the bottom deck of the guided missile destroyer HMS Glasgow became an inferno in which eight men died.

The tragedy happened at Swan Hunter's Neptune Yard at Newcastle-upon-Tyne.

The inquest at Newcastle was told by a fire chief that new safety regulations were needed in the ship building industry. Divisional Commander, Norman Todd of the Tyne and Wear Brigade said: "There was no effective fire alarm system installed to our knowledge and no effective way of getting a message to anyone".

Nine hundred men were evacuated from the ship.

The story of the danger signal that went unrecognised was told by electrician George Bainbridge, 50. He said when he and a workman lit up, their cigarettes 'shrivelled up'. He added: "I lit another and the same thing happened. I had no idea why".

Factory Inspector, Gordon Harding said the rapid blaze was caused by an enrichment of the air by oxygen. This made normally fire-resistant materials burn readily – and accounted for the vanishing cigarettes.

Swan Hunter director, Colin Douglas said all gas containers should be turned off after use and the pipes disconnected.

Mr John Richardson, whose job was to check safety, said he could not be sure that all the oxygen pipes had been disconnected after the previous night shift.

Inquest verdicts : Misadventure.

## EQUIPMENT ASSEMBLY

1. Stand both cylinders VERTICALLY either in a cylinder trolley or in cylinder stands or SECURE the cylinders UPRIGHT against a wall with a length of chain. Cylinders should NEVER be used lying on the floor.

2. Ensure that jointing surfaces of cylinder valves are FREE FROM OIL OR GREASE.

3. Safeguarding the eyes and face, momentarily open the valves of each cylinder, one at a time, to dislodge any dirt or obstruction.

4. Screw the appropriate regulator into each cylinder and tighten. Excessive tightening is not necessary but make certain the joints are gas-tight. The oxygen has RIGHT HAND screw threads. The left hand thread equipment is distinguishable by the notch on the corners of the nuts.

5. Screw FLASH BACK ARRESTORS onto their appropriate regulator outlets.

6. Blow through the hoses with OIL-FREE air to remove any dirt or dust before connecting hose connections. OXYGEN SHOULD NOT BE USED FOR THIS PURPOSE.

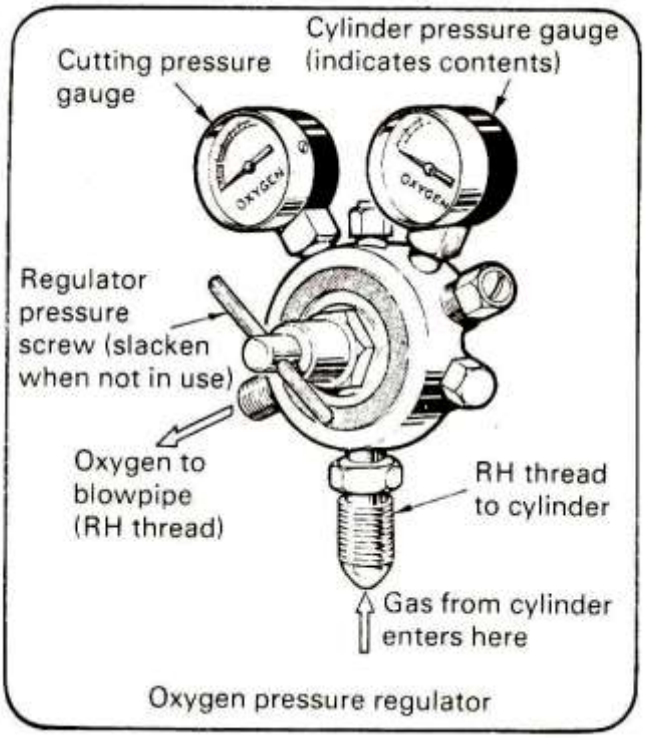
7. Connect the hoses to their respective flashback arrestors using HOSE CONNECTORS. These also have left and right handed screw threads.

8. Connect the hoses to the blowpipe using HOSE PROTECTORS ONLY. These are a one way valve system designed to prevent any blowback in the blowpipe reaching the hose by only allowing the gas to flow from the hose to the blowpipe. The connections on the blowpipe are marked ‘0’ (for oxygen) and ‘A’ (for acetylene) respectively.

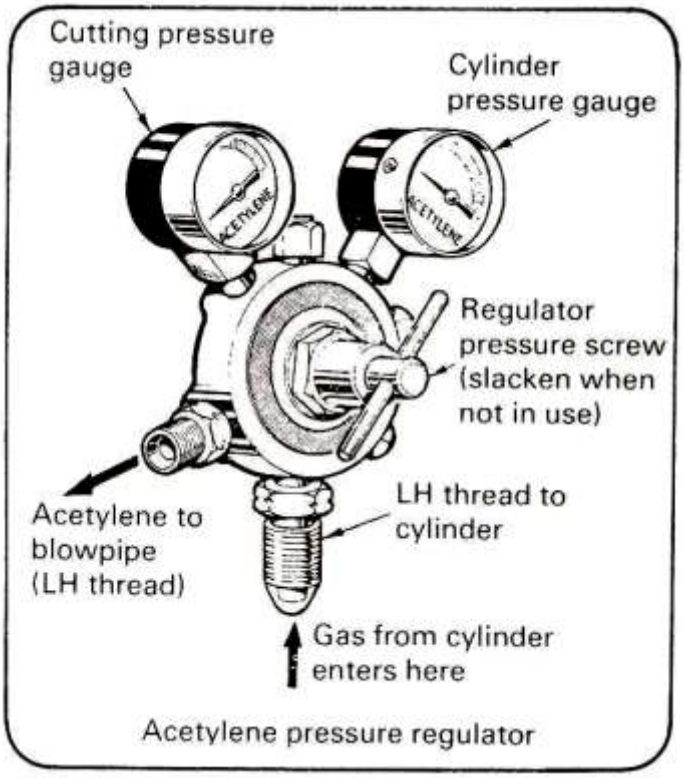
9. Ensure that the blowpipe control valves are closed and fit the appropriate size nozzle to the blowpipe.

10. Test for leaks.

## *NON-COMBUSTIBLE GAS REGULATOR*




## *COMBUSTIBLE GAS REGULATOR*



## *HOSES*

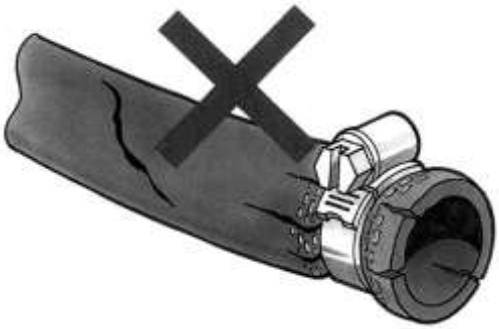
**Red –** acetylene and other fuel gases (except LPG)

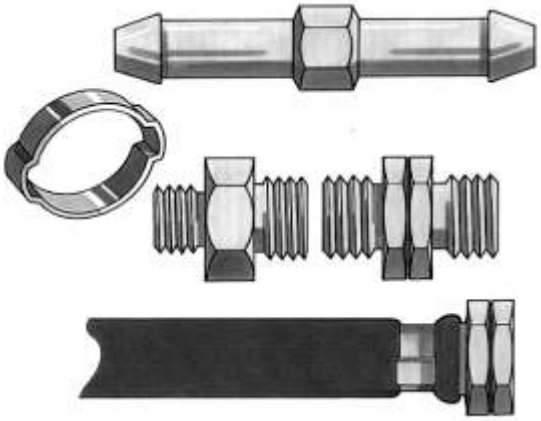
**Orange –** Liquefied Petroleum Gases

**Blue –** Oxygen

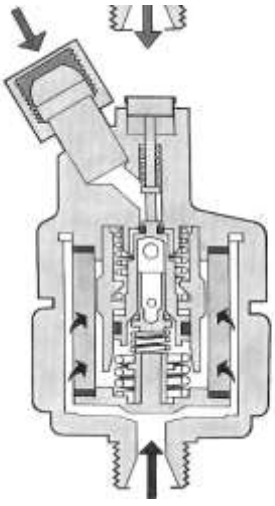
**Black –** inert and non-flammable gases

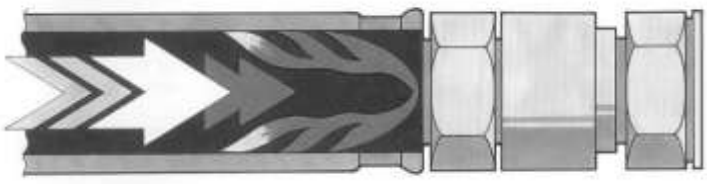
## *HOSE CONNECTORS*





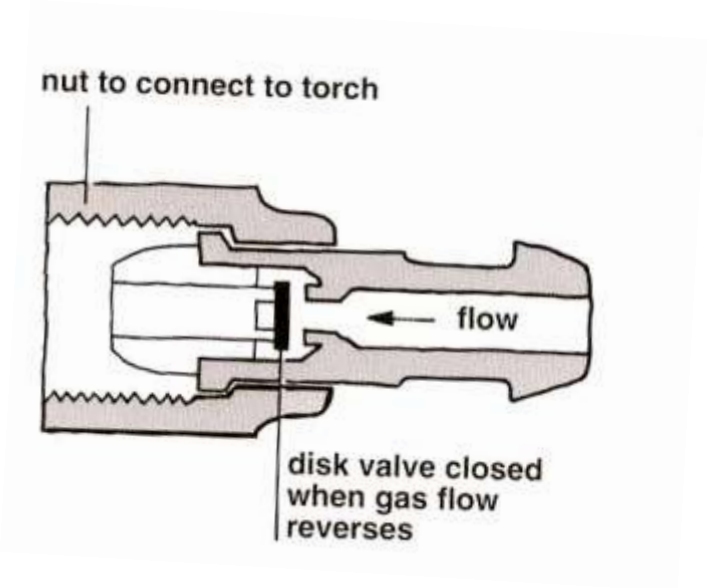
## *FLASHBACK ARRESTORS*





**Flashback arrestors must be fitted to the outlets of both oxygen and fuel gas regulators.**

## *HOSE PROTECTOR*




## LIGHTING UP PROCEDURE FOR OXY ACETYLENE EQUIPMENT

1. Using a spindle key slowly open each cylinder valve. DO NOT OPEN SUDDENLY as this can damage the regulator with the possibility of an accident. Open the valve one full turn only. The contents of the cylinders will be indicated on the contents gauge.

2. Open the acetylene control valve on the blowpipe and then set the outlet pressure by turning the regulating screw clockwise until the required pressure setting is indicated on the outlet pressure gauge. When set close the control valve on the blowpipe.

3. Open the control valve on the blowpipe for the oxygen and set the pressure in the same manner as for acetylene. Then close the control valve again. The equipment should now be ready for use.

4. Open the acetylene control valve slightly just to let enough gas flow to ignite safely. Leave the gas to blow for a few seconds to purge any air that may be in the tube. Pointing the nozzle safely into an open space ignite the acetylene using a spark lighter to give a yellowish flame.

5. If the flame gives off a black sooty smoke then increase the acetylene until there is just a faint trace of smoke, i.e. the smoke just ceases.

6. Open the oxygen control valve and increase the flow of oxygen until the required flame setting is reached. The equipment can now be used for the welding task in hand.

## LIGHTING UP PROCEDURE FOR OXY-PROPANE EQUIPMENT

1. Open the valves on each cylinder one full turn using the correct spindle key. This should be done slowly to avoid damage to the regulator.

2. Set the recommended pressures for cutting (see cutting data sheet) by screwing in the regulator pressure control valve to the required marks shown on the regulator thimble.

3. Open each valve in turn on the cutting torch for a few seconds to purge the lines of any air which may be present then close the valves. The equipment is now ready for use.

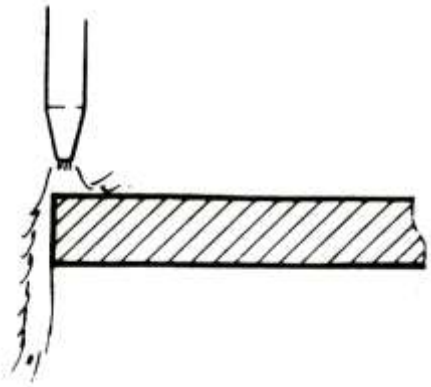
4. TO LIGHT THE TORCH. First open each valve on the cutting torch by half a turn. Light the torch using a recommended spark lighter (care must be taken to avoid burning the hand). Adjust the flame to give the required setting for the job in hand.

Combined cutting and welding torch

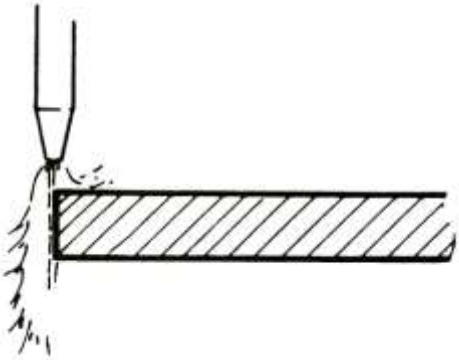

Single action cutting torch

## OXY-PROPANE/OXY-ACETYLENE CUTTING PROCESS

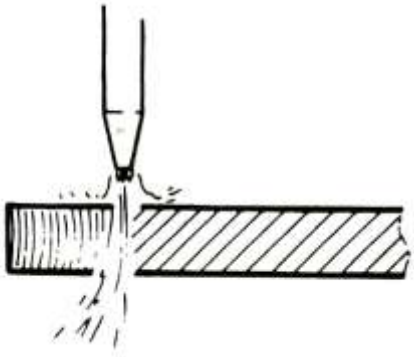
1. Nozzle is held stationary over metal edge until the corner reaches a bright red heat.



2. Oxygen is directed at the heated edge



3. As soon as the jet has melted a groove, through the thickness of the plate, the nozzle is traversed to start the cut and continued at a steady rate to complete that cut.



## CLOSING DOWN PROCEDURE

When extinguishing an oxy-fuel gas flame and closing down equipment on completion of work. The following procedures must be taken:-

1. Always turn off the fuel gas control valve on the blowpipe first to extinguish the flame. Then turn off the oxygen valve. This will prevent any flame creeping into the blow pipe nozzle.

2. Close the cylinder valve on each cylinder using the correct cylinder key by turning to the right until firmly closed, never use excessive forces.

3. The hoses must next be purged of gas. This is done by opening the valve on the blowpipe and allowing all the pressure to be released. Acetylene first then the oxygen.

4. Release the pressure regulator screw on each regulator by turning in an anti-clockwise direction.

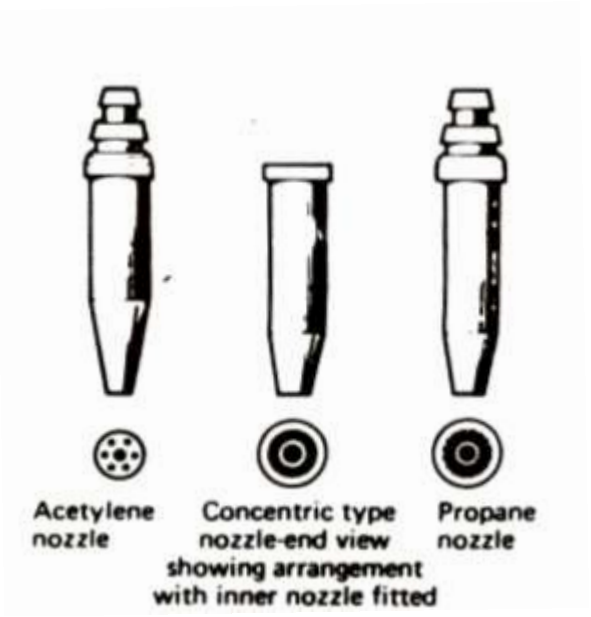
5. Finally, close each valve on the blowpipe.

**NOTE:**

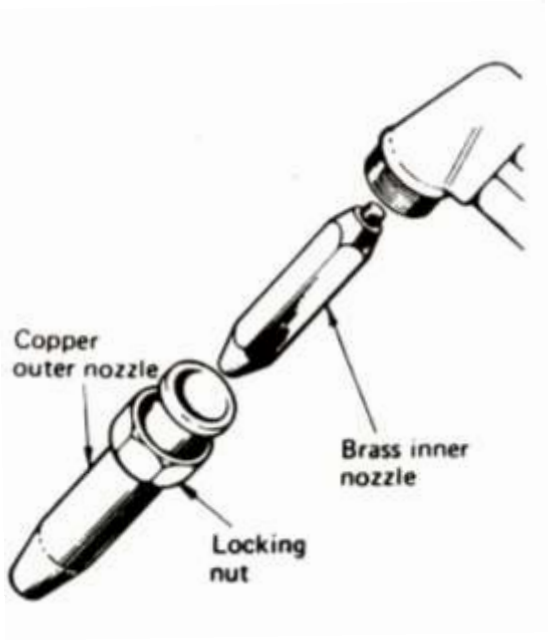
If these precautions are not adhered to, back pressure feeding could occur, which would result in the flashback arrestors being triggered off requiring re-setting before any more work could commence. Alternatively, if the hoses are not purged correctly and back pressure feeding occurred, a gas mixture could form in the hoses which could explode if an attempt was made to light the flame.

## CUTTING DATA 'SAFFIRE' UNIVERSAL CUTTER (FOR USE WITH TYPE P-NM NOZZLE AND PROPANE FUEL GAS)

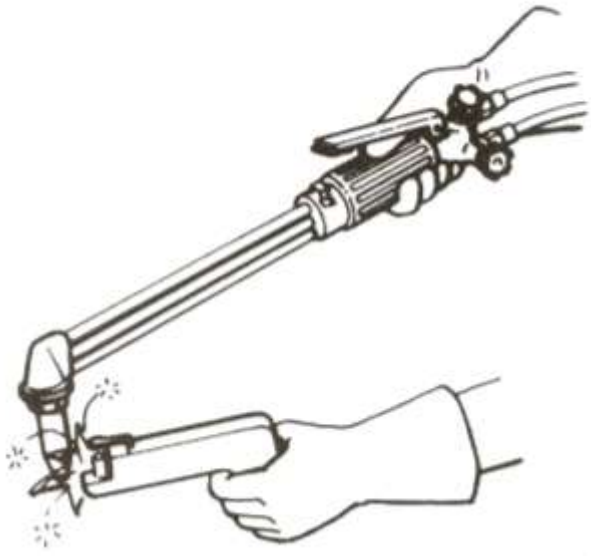
| MATERIAL ins | ¼ | ½ | 1 | 2 | 3 | 4 | 6 |
|---|---|---|---|---|---|---|---|
| THICKNESS mm | 6 | 13 | 25 | 50 | 75 | 100 | 150 |
| NOZZLE SIZE ins | 1/32 | 3/64 | 1/16 | 1/16 | 1/16 | 5/64 | 3/32 |
| OXYGEN 1bf/in2 PRESSURE | 35 | 40 | 45 | 55 | 65 | 50 | 55 |
| kgf/cm2 | 2.5 | 2.8 | 3.2 | 3.9 | 4.6 | 3.5 | 3.9 |
| PROPANE 1b/in2 PRESSURE | 3 | 3 | 4 | 4 | 4 | 4 | 6 |
| kg/cm2 | .21 | .21 | .28 | .28 | .28 | .28 | .42 |
| CUTTING in/min SPEED | 22 | 20 | 17 | 13 | 8.5 | 6.5 | 5.5 |
| cm/min | 56 | 51 | 43 | 33 | 22 | 16 | 14 |




***NOZZLE TYPES***

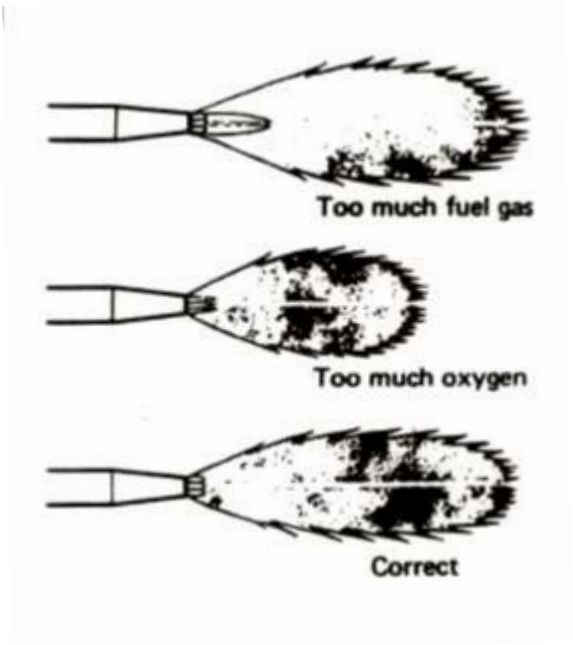



***FITTING THE NOZZLE***



Warn others when lighting up

***LIGHTING THE BURNER***




***FLAME SETTING***

# SAFETY IN THE USE & STORAGE OF COMPRESSED GAS CYLINDERS

## INDEX



## NOTES ABOUT CYLINDERS

Cylinders intended for the storage of compressed gages are subject to statutory regulations British and International standards.

These define the materials of which the cylinder is made, the method of construction, its tested pressure and the maximum permissible working pressure.

To prevent the interchange of fitting between cylinders containing combustible and non-combustible gases, the valve outlets are threaded in opposite hands:-

a) Non-combustibles like Oxygen, Argon and Nitrogen have right hand threads

b) Combustibles like Acetylene, Propane and Hydrogen have left hand threads.

Gas cylinders are always labelled with their contents and are painted different colours depending on the gas contained. (NB: Colour schemes are changing to meet new legislation requirements)

For example:-

| | | Old Scheme | New Scheme |
|---|---|---|---|
| OXYGEN | - | BLACK | GREY:WHITE CAP |
| ACETYLENE | - | MAROON | TBA |
| PROPANE | - | RED (Labelled Propane and highly flammable). | TBA |

## SUMMARY OF GASES USED IN OXY – FUEL CUTTING

| GAS | CHARACTERISTIC | CYLINDER | THREAD |
|---|---|---|---|
| Oxygen | No smell, non toxic will not burn, but supports and accelerates combustion. | Black<br>Grey/White cap<br>Storage pressure | Right hand<br>3500 P.S.I |
| Acetylene | Distinctive Garlic like smell<br>Fire and explosive hazard<br>lighter than air. | Maroon<br>Storage pressure | Left hand<br>250 P.S.I |
| Propane | Distinctive Fish like smell<br>Fire and explosive hazard<br>Heavier than air (can collect in ducts and drains). | Red<br>Storage pressure | Left hand<br>250 P.S.I |

## CARE IN THE STORAGE OF CYLINDERS

It is best to store full or empty gas cylinders in the open in a security fenced compound, but with some weather protection cylinders should not be allowed to stand directly on wet ground, as this will cause corrosion.

Within the storage area oxygen should be stored away from empties, and different gases segregated from each other.

Do **NOT** store other products in a gas store, particularly oils and corrosive substances.

Store all cylinders upright taking steps to see that they are secured to prevent them falling.

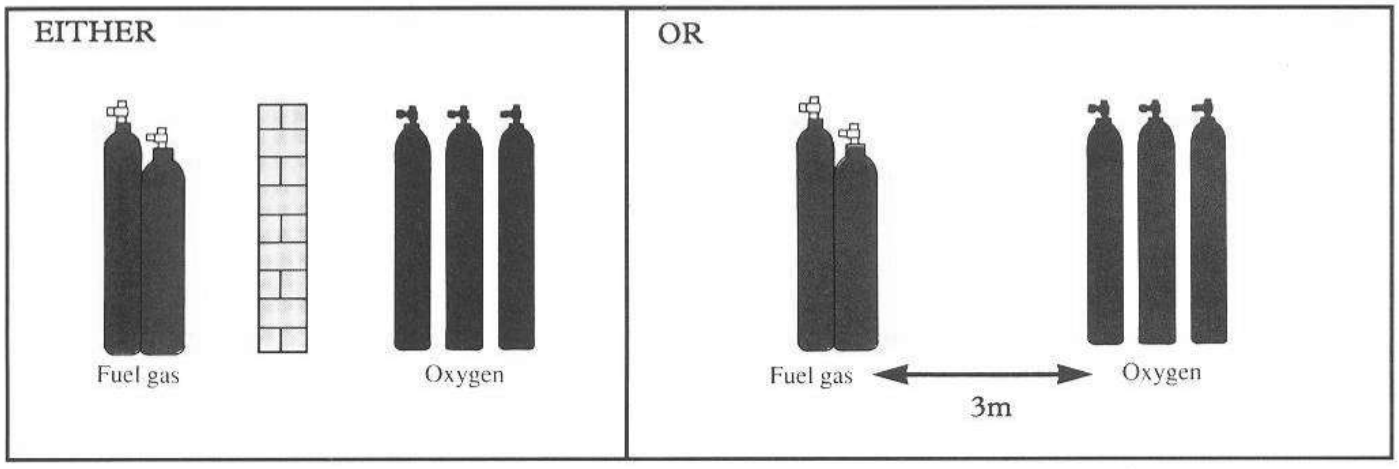
Acetylene and Propane must **NEVER** be stacked horizontally in storage or in use.

Acetylene must **NEVER** be drawn from a horizontal cylinder.

If an Acetylene cylinder has been laid horizontally, before use it must be stood upright and left for an hour prior to any operation to ensure the cylinder contents have settled.

Do not expose cylinders to heat as it may weaken the cylinder wall and increase the internal pressure of the contents.

Do not smoke, wear oily and greasy clothes or have exposed lights or fires or fire where compressed gases are stored.



## CARE IN THE HANDLING AND USE OF CYLINDERS

When transporting cylinders to the point of use, properly equipped vehicles should be employed which are capable of carrying them without risk of them dropping or colliding with each other.

Never roll a cylinder along the ground as it damages the cylinder and may cause the valve to open, become damaged or even be broken off.

'Milk Churning' cylinders on their bases is permissible over relatively short distances.

When using a cylinder trolley make sure the cylinders are properly located and secured, and the cylinder valves are shut.

Never transport cylinders with the regulations and hoses fixed unless on a purpose built trolley or carrier.

Never lift a cylinder with magnets or chains if a rope or bandage sling is used, lift only one cylinder at a time and ensure the sling is correct and aligned.

Never lift a cylinder by its valve. If possible always use a purpose designed cradle:

Don't use cylinders as rollers, work support or jacks.

Keep cylinders away from heat sources, such as furnace stoves, boilers etc.

Do not attempt to repair or modify cylinders.

If a cylinder is damaged report immediately.