Other Gases			
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REVIEW OF OXYGEN INCIDENTS 1990-1995

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Summary

This note presents the results of a review of oxygen incidents reported to HSE over the period 1990-1995. It also provides details of the main sources of guidance on the storage, handling and use of oxygen.

Q1 What was the source of the data for the review?

A: The information for the review was extracted from FIREX, the DST E5 fire and explosion incident database. All the incidents on FIREX have been reported to HSE under RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations).

Q2 How many incidents were attributed to the use or handling of oxygen?

A: 122 incidents were identified as being directly attributable to the use or handling of oxygen. These included 15 major injuries and 88 minor injuries. There were no fatalities over the six year period of the review.

The incidents fall into five main categories:

- hot work;
- cylinder filling;
- breathing/respiratory equipment;
- substitution;
- fire.

The details are summarised in the table below:

ACTIVITY	YEAR							
	1990	1991	1992	1993	1994	1995	Total	Injuries
Hot work	13	11	19	11	11	19	84	10 major 68 minor
Cylinder filling	1	1	1	3	2	1	9	4 major 2 minor
Breathing	0	1	3	1	0	2	7	0 major 4 minor
Substitution	3	0	1	2	1	2	9	1 major 6 minor

Fire	1	0	2	0	1	0	4	0 major 6 minor
Miscellaneous	4	2	1	2	0	0	9	0 major 2 minor
TOTAL	22	15	27	19	15	24	122	15 major 88 minor

Q3 What were the main causes of the hot work incidents?

A: Hot work incidents are those where oxygen was used in an oxy/fuel process such as welding, cutting, burning etc. Only incidents where there were problems with the oxygen supply or the associated equipment have been included. Incidents involving flammable gases or where the process acted only as a source of ignition have been excluded.

The causes of incidents are often difficult to identify as much of the evidence is destroyed. Most are attributed to:

a) contamination of equipment;

It is often difficult to identify the particular contaminant responsible for an incident. Valves and regulators can easily be contaminated by oil, grease and dust in a working environment.

b) opening valves too quickly;

The resulting high velocity gas can project any particles through the system causing impacts and frictional heating. In addition, rapidly opening valves into a 'dead end' such as a closed valve or regulator can also generate heat through compression of the oxygen. The heat generated can be sufficient to cause ignition. This type of heating may be the cause of flash fires which occasionally occur in older type multi-cylinder packs where each cylinder is fitted with its own valve. It is possible for the operator to use individual cylinders rather than the pack as a whole leading to large pressure differences across the pack.

c) leaks from damaged hoses or poor connections causing oxygen enrichment of clothing particularly gloves. Subsequent ignition caused burns, severe in some cases.

d) damage to hoses from hot slag/metal, hot surfaces or the oxy/fuel flame itself, causing leakage and ignition;

Q4 What were the main causes of the other incidents?

Cylinder filling

The cylinder filling incidents were generally attributed to contamination. Oxygen cylinders used in welding may be contaminated with hydrocarbon gas by the user, prior to return to the gas company for refilling.

Respiratory equipment

These incidents usually involved flash fires/explosions originating at the pressure regulator. The cause was generally attributed to contamination by the user, or ignition by adiabatic compression caused by opening the valve too quickly.

Substitution

Substitution incidents are incidents where compressed air or nitrogen has been substituted with oxygen, either accidentally or deliberately. This usually occurs where equipment is being pressurised for some reason. The oxygen reacts explosively with any oil or grease present and the equipment may be blown apart. These are potentially very serious accidents, fatalities having been reported in the past.

Fire
The fire incidents are where oxygen cylinders have been caught up in a fire and have exploded, injuring firemen. The Fire Authorities have procedures for dealing with gas cylinders in fires but inevitably they may not always be aware of the presence of cylinders.
Miscellaneous
The miscellaneous incidents do not fit into any particular category. Most of them involve some form of oxygen leak, often followed by a fire. They include:

- a leak when a mobile crane overturned and damaged the feed line to a LOX tank;
- leaks when oxygen supply lines were damaged by contractors (two separate incidents). The lines were concealed and the contractors had not been informed of their presence;
- a fire when a cylinder was damaged by being dropped.

Q5 Have there been any incidents involving liquid oxygen (LOX)?
A: Only one of the incidents covered by the review involved a LOX installation. A mobile crane overturned, damaging the feed line to a LOX tank. There was a minor release but no fire.
A small number of LOX incidents which happened abroad have been reported in the literature. Some of them resulted in fires. The causes are not always reported by they include:

- damage to pipework by vehicles;
- failure of connections during loading/unloading;
- road traffic accidents involving LOX tankers.

Q6 What published guidance is available?
HSE Guidance
HSE 8(rev 2) Take care with oxygen, fire and explosions hazards in the use of oxygen.
British Compressed Gases Association
Code of Practice CP 19 Bulk Liquid Oxygen Storage at users' premises. Rev 2 1996
Code of Practice CP 20 Bulk Liquid Oxygen Storage at production sites. Rev 1 1996
Code of Practice CP 7 The safe use of oxy-fuel gas equipment (individual portable or mobile cylinder supply). Rev 2 1996.
Other guidance
Industrial Gases Committee:
04/93/E Fire hazards of oxygen and oxygen enriched atmospheres
33/86/E Cleaning Equipment for oxygen service
NFPA 53 Guide on fire hazards in oxygen enriched atmospheres
ASTM:
G63 Standard guide for evaluating non-metallic materials for oxygen service
G88 Standard guide for designing systems for oxygen service
G94 Standard guide for evaluating metals for oxygen service
British Standard BS 4N 100: 1999 Aircraft oxygen systems and equipment
Part 1: Design and installation
Part 2: Tests for the compatibility of materials in the presence of oxygen
Part 3: Testing of equipment and systems
Part 4: Guide to the physiological factors
Part 5: Guide to fine and explosion hazards associated with oxygen
Part 6: Guidance and recommendations on the selection of materials for use with oxygen
Part 7 Guide to cleaning, labelling and packaging