Storage and use of oxygen and fuel gases on board ships

HSE information sheet

Engineering Information Sheet EIS43

Introduction

Industry, including shipbuilding and ship-repairing, makes widespread use of oxygen and fuel gases for welding, cutting, gouging, brazing and heating processes. While care is needed when this work is performed inside workshops etc the risks are greatly magnified when it is carried out in enclosed or confined spaces. Leakage of oxygen or fuel gas into such a space on a ship can quickly cause a fire or explosion if a source of ignition is present. Consequently, stringent precautions must be taken if accidents are to be avoided.

While this guidance relates primarily to ships it is also relevant to larger boats and the fabrication or repair of large structures containing numerous internal spaces. For example, the topside modules of offshore production platforms are now much more enclosed as a result of the inclusion of blast walls and protected control rooms. Although there is not the same history of incidents involving oxygen and fuel gases in such premises, some serious accidents have occurred.

Many accidents have resulted in loss of life following fires and explosions on ships. The fire on HMS Glasgow on 23 September 1976, for example, killed eight workers. Improvements have been made in the methods of supplying and using fuel gases and oxygen on board ship. These include:

- improved design and location of manifolds;
- systematic maintenance of hoses and other apparatus;
- identification of hoses and other apparatus;
- the use of control valves to shut off non-essential manifolds.

Manifold, in this context, means a gas distribution outlet point located downstream of a pressure regulator and fitted with more than one hose connection. (This differs from another description which industry often applies to fixed distribution systems, ie pipework connecting cylinder supplies at full cylinder pressure upstream of a pressure regulator.)

General precautions that should be taken include:

- cylinders containing flammable gases or oxygen should not be taken below decks unless they are placed in a part of the vessel which is adequately ventilated;
- hoses and torches must be of good construction, sound material and be adequately maintained;
- ensuring that when work ceases for the day, or for a substantial period, hoses and associated equipment are withdrawn through the topmost completed deck or, on a vessel undergoing repair, to a weather deck.

Oxygen

Oxygen is not a flammable gas but its presence is normally necessary for combustion to occur. Air contains approximately 21% oxygen but if a small amount of excess oxygen is introduced, materials which are not normally easily combustible will burn with ferocity. Oxygen has no smell (unless it has been artificially stenched – see below) and instruments have therefore been designed to detect excess oxygen. These instruments are useful in finding suspected leaks. However, it may not be reasonably practicable to use them to continuously monitor the atmosphere if there are many compartments in a ship in which leaking oxygen may accumulate.

Oxygen must never be used:

- for ventilating or sweetening the stale atmosphere of a confined space;
- for blowing dust off clothing; or
- in place of compressed air to drive pneumatic tools.

Fuel gases

The fuel gases normally used in shipyards are propane and acetylene.

Propane is stenched with a fish smell and is explosive when mixed with air at concentrations from 2% to 9%. It is heavier than air and will collect at the lowest level. Even a large, relatively unconfined space can be potentially dangerous should propane accumulate. Any leaking propane will continue to accumulate after work has ceased for the day and may reach a concentration sufficient to form an explosive vapour at the bottom of the space.

Acetylene has a garlic smell and has a lower explosive limit of 2.5%. However, it differs from other fuel gases used in gas welding (or flame cutting) in that it is potentially unstable, and in the liquid state or as a gas under pressure may decompose violently. Hence there is no clearly defined upper explosive limit for acetylene. It is lighter than air and it will accumulate in enclosed or confined spaces with poor upper-level ventilation.

Supply of gases from bulk installations

Oxygen and fuel gases are often supplied from bulk installations. Further advice on bulk storage of liquefied petroleum gas (LPG) can be found on HSE's LPG web pages www.hse.gov.uk/gas/lpg/index.htm.

Where oxygen is stored in bulk systems in shipyards or similar large-scale operations, it should be odorised (stenched), where reasonably practicable. Proper installation is required and you should contact your gas supplier to ensure the installation is carried out safely.

From bulk installations, gases are piped – either above or below ground – to terminals at the dockside or on the building berth. These terminals should have easily-identifiable stop valves so that they can be quickly located and closed in an emergency. From the terminals, large-diameter flexible hoses pipe the gases to supply manifolds on the ship. If the vessel is in the water it is important to ensure that hoses are adequately looped to allow for any movement caused by tide or wind.

Manifolds should be of robust construction and should be sufficiently large to avoid them becoming hidden or being accidentally damaged. The manifold gas outlet valves should be operated by wheel-type or knurled knobs. Figure 1 shows an example of a well-designed manifold.

Manifolds should be sited only on decks open to the weather and where they are not susceptible to accidental damage.

Supply of gases from cylinders

The cylinders for different gases should be clearly distinguished from each other. Normally, oxygen cylinders are coloured black, acetylene cylinders maroon and propane cylinders orange (sometimes called red).

All gas cylinders should be fitted with appropriate regulators and pressure gauges. Regulators for fuel gases and oxygen are designed to be non-interchangeable. Regulators for acetylene and propane are marked with details of the duties for which they are suitable. Acetylene and propane and regulators should not be interchanged.

On larger ships, cylinders may be taken on board. They should be carefully sited, preferably on a deck which is open to the weather, and where there is no risk of heavy articles or welding slag falling onto them from above. Cylinders must not be allowed to come into contact with electrical conductors or welding cables, as arcing may occur which could heat or damage them. All gas cylinders should be properly secured and fuel gas cylinders should be kept in an upright position to avoid the liquid contents entering the supply hoses.

Occasionally, cylinders may have to be taken below deck. Only small cylinders – up to 11 kg – should be taken below and they should be placed in well-ventilated areas and removed to the open air when work ceases. An appropriate fire risk assessment should be completed that identifies the controls required to justify taking compressed gas cylinders below decks.

Hoses

Oxygen hoses are normally coloured blue, acetylene hoses red, and propane hoses orange. Hoses should not be interchanged between the gases.

Hoses should be of good quality to resist kinking and abrasion. They should comply with the current standard (BS EN ISO 3821:2010 *Gas welding equipment. Rubber hoses for welding, cutting and allied processes*).

Hoses are usually supplied in 20 m lengths complete with end fittings. They can be joined together by joining the hose end connectors to a separate coupler. The use of 'T' pieces or other types of multi-connector should be discouraged. However, if this type of connector is used, it must not be sited below a weather deck.

To prevent cross-connection, all oxygen fittings should have plain nuts and right-hand threads whereas fuel gas fittings should have grooved nuts and left-hand threads. The thread sizes for oxygen and fuel gases should be different to those for compressed air tools and other equipment.

To prevent oxygen and fuel gases back-feeding into the wrong hose, a non-return valve should be fitted at the torch end. Flashback arresters should be fitted to prevent flashbacks travelling along gas hoses either to other operators or the gas supply. It is usually convenient to fit arresters at the gas manifolds.

Gas hoses should be properly maintained. The user should inspect them regularly, looking particularly for any chafing, splitting or cracking which is most likely to occur near fittings. Hoses should be regularly examined and leak-tested (once a month is recommended) to the hose design working pressure using compressed air or nitrogen. To ensure that all hoses are recalled for inspection they should be clearly marked with an identifying name or number and the identity recorded of the person to whom the hose has been issued. The details can be marked on a tag or a coupler or onto the hose. Hose markings can be protected with heat-shrunk polythene sleeves. A colour-coding system may help to ensure that only hoses which are within their inspection period are used.

If subcontractors bring their own hoses into the yard, the yard management should seek verification that they have been appropriately examined and tested. If this is not the case, the yard should examine and test them themselves. All subcontractors' hoses should be marked to distinguish them from those provided by the yard.

Torches

Torches (sometimes referred to as blow pipes or cutters) should be of robust construction and the gas outlet valves should be operated by knurled knobs to minimise the risk of accidental opening. Like hoses they should be marked to identify the person the torch was issued to. Torches should be leak-tested before being issued and checked regularly thereafter. All employees who use torches should be supplied with flint igniters to light them.

Use of hoses and torches

The dangerous practice of kinking hoses to cut off the gas supply before changing torches should be forbidden because it is usually impossible to achieve a complete gas seal. Therefore, the gas must be turned off at the cylinder or manifold no matter how inconvenient this may be.

Hoses should never be coiled around gas cylinders. When not in use hoses should be coiled up tightly and stored in a place where they will not be damaged. When taken below deck they must be carefully routed to avoid damage and to aid subsequent retrieval. When they have to pass over sharp edges suitable packing should be used to prevent kinking and chafing.

End-of-shift precautions

When work ceases for the day, or for a substantial period, the supply valves of all cylinders and manifolds should be fully closed and the hoses disconnected from the supply. Any cylinders which have been taken below deck must be brought up to a weather deck. Additionally hoses must be brought up to a deck which is open to the weather or which is very well ventilated by natural means. There are very few situations where it is really impracticable to withdraw hoses.

To make sure that the appropriate disconnections are made, adaptors should be provided which ensure that the supply end of the gas hoses cannot be coupled directly to manifold outlets. Such adaptors should be marked or numbered and issued to authorised users along with torches and other equipment. Figure 2 shows a suitable arrangement of an adaptor in use. At the end of the shift the adapters and torches should be returned to the stores. A search should be made if all the adaptors and torches that have been issued on that day are not returned at the appropriate time.

Management should ensure that regular checks are made by a responsible person so as to ensure that the above precautions have been taken, particularly at the end of a shift. Safe working practices should be closely supervised.

Information, instruction and training

All the users of oxy-fuel gas equipment must be fully informed of the risks associated with the gases they use and they must be thoroughly trained in the safe systems of work in force.

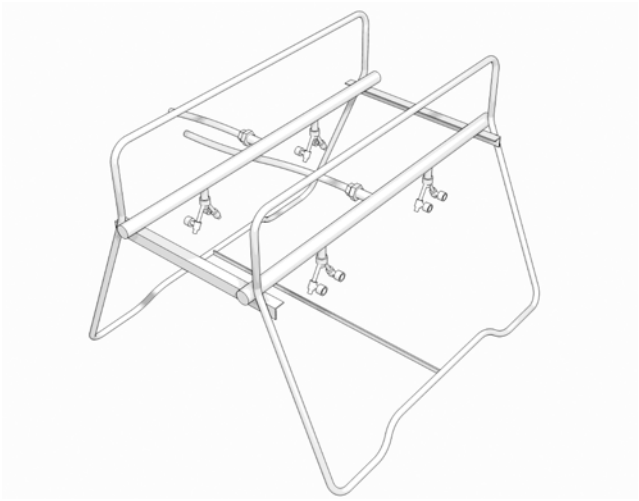

Figure 1 Example of well-designed manifold

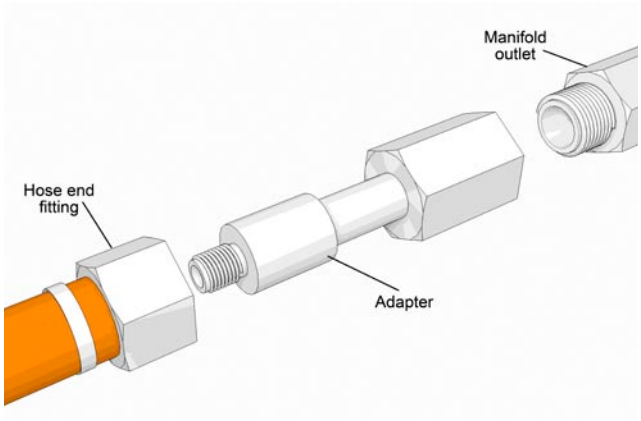

Figure 2 Suitable arrangement for use of an adaptor

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

This document is available at:
www.hse.gov.uk/pubns/eis43.htm