INDEX

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Target Audience:
FOD AFQ Inspectors (Bands 0-4)
FOD Specialist Group Inspectors (Med, Occ Health and Occ Hyg) (Bands 0-3)
FOD Railway Inspectors (Bands 2-4)
HID Inspectors (LD 5 and OD) (Bands 0-3)

OXY-FUEL GAS CUTTING: CONTROL OF FUME, GASES AND NOISE

This 2-part OC, advises field staff about fume, gas and noise hazards associated with oxy-fuel gas cutting. The attached **information document (ID)** which may be copied to interested persons outside HSE, gives guidance on reduction and control methods.

INTRODUCTION

1 Oxy-fuel gas cutting is used to cut metal in a wide variety of industries including shipbuilding and repairing, construction, metal fabrication, car repair and scrap metal processing. Its widespread use is due to the low cost of the equipment and its ability to cut a wide range of thicknesses. When used manually to cut uncoated steel in an open environment, low levels of exposure to fumes and gases are encountered. However, occupational exposure limits can be exceeded when cutting:

1) in an enclosed or confined space;

2) coated or contaminated steel; and

3) using mechanised cutting.

2 It is therefore essential that a suitable and sufficient assessment under the Control of Substances Hazardous to Health Regulations 1999 (COSHH) is conducted for each particular application in which the process is used and that appropriate control measures are established. This OC and ID provide further advice on these issues. Where there is concern about possible exposure to lead, inspectors should also refer to **OC 298/15** *The Control of Lead at Work Regulations 1998.*

3 This OC covers oxy-fuel gas cutting in the scrap metal industry however, for more in-depth guidance see File 9 of *The British Scrap Federation (now the British Metals Federation) Health and Safety Manual* (FOD subject file 840). The fire and explosion risks associated with the process are not included in this OC. Inspectors should instead refer to HS(G)139 *The safe use of compressed gases in welding, flame cutting and allied processes,* INDG327 *Take care with acetylene,* INDG314 *Hot work on small tanks and drums* and INDG297 *Safety in gas welding, cutting and similar processes*.

BACKGROUND

4 The reaction of iron with oxygen forms iron oxides. If iron is progressively heated in an oxygen atmosphere the speed of this reaction increases. At a temperature of 650ºC the reaction becomes spontaneous, provided sufficient fresh oxygen is available. The oxy-fuel gas cutting process takes advantage of this reaction by using a pre-heating flame, formed by the combustion of a mixture of oxygen and fuel gas, to heat steel to between 700ºC and 900ºC. A jet of oxygen, the cutting oxygen, is then directed onto the pre-heated steel resulting in an exothermic reaction. As the resulting iron oxides have a lower melting point than iron itself, the heat generated by the reaction is sufficient in conjunction with the heating flame, to progressively melt the iron oxides. The iron oxides remain molten long enough for the kinetic energy of the oxygen jet to sweep them away from the cutting area.

5 The range of metals that can be cut by oxy-fuel gas cutting is limited by the fact that the melting point of the oxide has to be below the melting point of the parent metal. As a result the process is normally limited to carbon-manganese and low alloy steels. In the case of stainless steel, cast iron and non-ferrous metals the melting point of the oxide is higher than that of the metal. Oxy-fuel gas cutting can however still be used to cut these materials by using one or more of the following methods:

1) injecting iron powder into the flame to form a low melting point, fluid slag;

2) oscillating the torch; or

3) using a wire feed.

6 However, in each case the quality of the cut will be impaired. Most stainless steel is any case cut by the plasma arc process (see **OC 668/22** *Plasma cutting: Control of fume, gases and noise*) which is not subject to the same temperature limitations.

7 The 5 most commonly used fuel gases are acetylene, propane, methylacetylene-propadiene (MAPP), propylene and natural gas. The process is often referred to in conjunction with the fuel gas used, ie oxy-acetylene cutting. It is also commonly known as flame cutting. The choice of fuel gas affects the flame temperature and hence the cutting speed. Acetylene and propane have similar cutting speeds although oxy-acetylene cutting uses less fuel gas. Natural gas has the lowest flame temperature and MAPP gas is generally used for deep water cutting.

8 Oxy-fuel gas cutting can be conducted using handheld cutting equipment, as is commonly used for processing scrap metal and for demolition work. Portable cutting units are also available which can be guided either by hand, by guide rails or by some other similar means. These units are typically used to undertake such work as ship-repair. Mechanised, profile cutting tables are more common in metal fabrication where there are a number of specialist companies who undertake profile cutting on a subcontract basis. Typically such companies have a small number of employees and as a result of the associated lack of resources often experience greater difficulty in complying with the requirements of COSHH. This frequently results in one or more of the following; failure to conduct a suitable and sufficient COSHH assessment, failure to establish adequate fume control measures and failure to supply suitable respiratory protective equipment (RPE).

CUTTING PROCESSES

9 The alternative cutting processes to oxy-fuel gas cutting are detailed in the **ID paras 32-34**. The scope for process substitution as required by COSHH is however limited, particularly in the case of manual oxy-fuel gas cutting. Mechanised, profile cutting has greater scope for substitution, eg by abrasive water jetting or laser cutting. Inspectors should be aware of the limitations of these processes, for example in terms of their speed, the thickness of metal they can cut and their greater initial cost. They also introduce other hazards which will need to be controlled. However, the possibility of process substitution should still be discussed, particularly when mechanised oxy-fuel gas cutting is encountered and the user is looking to upgrade or replace the existing system.

10 The cutting table used for mechanised oxy-fuel gas cutting can often be used with either a plasma or a laser cutting head. The same table extraction system can also be used. Most of the equipment available is imported.

ACTION BY INSPECTORS

11 Where inspectors encounter oxy-fuel gas cutting they should ensure the precautions set out in the ID are adopted. Particular attention should be paid to the following key issues:

1) a suitable and sufficient COSHH assessment has been conducted which gives due consideration to process substitution particularly where the process is used in either the scrap metal or demolition industries (**ID paras 19-20** and **34-35**);

2) the presence of any coatings or contamination has been identified and appropriate control measures have been established (**ID paras 8-10** and **38-40**);

3) where the process is conducted in a confined space adequate control

measures are in place (**ID paras 24-25**, **49-50** and **53**);

4) where RPE is used it has not been provided in preference to control by other means. The RPE should also be adequate and suitable (**ID para 51**); and

5) where mechanised cutting is encountered involving the use of multiple cutting heads due consideration has been given to assessing and controlling noise levels (**ID paras 18**, **26-28** and **37**).

ENFORCEMENT

12 The following is a guide to when enforcement action may be appropriate. It is based on the Enforcement Management Model (EMM) Operational version 2.0 and the document ***EMM: Guidance on the application to health risks*** (available on the intranet). Any action taken should reflect any subsequent changes to EMM. **The final decision on enforcement action should also take account of local factors.**

Risk

13 **Acute/chronic exposure to particulate fume and gases**. Oxy-fuel gas cutting can result in exposure to a wide range of different hazardous fumes and gases (**see ID paras 7-10** and **12-16**). High, short-term exposure to certain components can prove fatal if very high exposures are experienced (see **para 14**). Acute exposure to fume can cause metal fume fever while chronic exposure to iron oxide fume can also result in conditions such as siderosis.

Immediacy of risk

14 There have been some reported cases of oxy-fuel gas cutting in a confined space resulting in serious ill health and even death. A failure to adopt suitable control measures including local exhaust ventilation (LEV) and RPE, can result in exposure to high levels of nitrogen dioxide. Oxy-fuel gas cutting of the following materials may also result in the possible risk of a serious health effect unless adequate control measures are taken including RPE and where reasonably practicable, LEV:

1) cadmium based alloys;

2) polyurethane foam; and

3) metal coated with chromium or lead based paints.

NB. The possible risk of a serious health effect can arise even when the above materials are cut manually in an open environment.

15 Where the risk of a serious health effect is identified inspectors should consider issuing a prohibition notice as discussed in EMM Section 2.

Benchmark standards

16 Where oxy-fuel gas cutting is used in a confined space or to cut the materials listed at **para 14**, the benchmark should be considered as a nil/neglible risk of a serious health effect. When cutting other materials the benchmark should be considered as a nil/neglible risk of a significant health effect. In both cases the benchmark should be achieved where possible by a package of measures including using the correct nozzle size, keeping the flame as short as possible, delaying the application of any coating until after cutting has been completed, removing any coatings or contaminants prior to commencing cutting, LEV and RPE.

Risk gap

17 The risk gap as derived from EMM table 2.1 for 2 key scenarios is summarised below. Inspectors may use the scenarios as a guide to making their assessment of actual risk, and the subsequent risk gap. However, inspectors must ensure that they base their assessment of risk on the factors they find at site.

Scenario	Actual risk	Risk gap
Mechanised cutting of mild steel in open workshop using dry bed system without adequate ventilation (assuming a number of cutting heads are in use at any one time).	Remote risk of a significant health effect.	Moderate
Oxy-fuel gas cutting of galvanised steel without adequate ventilation.	Possible risk of a significant health effect.	Moderate

Initial enforcement expectation (IEE)

18 The following publications are relevant to deriving the authority of standards for use in EMM table 5.1 and hence for deciding the IEE.

Title	Authority
HSE Booklet L5 (*third edition 3/99 General COSHH ACoP and Carcinogens ACoP and Biological ACoP*	Defined
Booklet COP2 *Control of lead at work Approved Code of Practice, Regulations and Guidance*	Defined and established
Guidance Note EH 40 *Occupational exposure limits 2001*	Established

Guidance Note EH 54 *Assessment of exposure to fume from welding and allied processes*	Established
Guidance Note *EH55 The control of exposure to fume from welding, brazing and similar processes*	Established

19 The EMM considers COSHH assessment as an administrative measure. The standard for COSHH assessment is a defined standard as it is found in the Control of Substances Hazardous to Health Regulations 1999. Any absence, or inadequacies with an assessment should be considered using EMM table 5.2.

Compliance issues

20 Where an inspector is considering issuing an improvement notice (IN) to enforce better control, confirmation should be obtained that the relevant occupational exposure levels (OESs) (such as that for iron oxide or zinc oxide) are exceeded. Confirmation will also be required that the reason for exceeding the OES has not been identified and that appropriate action to remedy the situation as soon as reasonably practicable, has not yet been initiated. Identifying the reason for exceeding the OES, and implementing remedial action to form part of the IN. Similarly, where there is exposure to a substance that has a maximum exposure level (MEL) confirmation should be obtained that the MEL has been exceeded or in the opinion of specialist group inspector (occupational hygiene), exposure has not been reduced so far as is reasonably practicable.

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TOP