

**Approval Conditions
for Operating
Mandatory Safety Training Courses**

Part II – Module 6

Course Design and Specifications

For

(A) Gas Welding Safety Training Course

**(B) Gas Welding Safety Training
Revalidation Course**

Version Control Record

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Inquiry

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1. Overview

- 1.1 The terms and abbreviations adopted in this module follow those defined in Part I. This module is Part II – 1(a) of the AC which covers 2 gas welding safety training courses, i.e. full course and revalidation course. This module should be read together with Part I of this AC.
- 1.2 Gas welding and flame cutting (“gas welding”) is a hazardous trade process. Gas welding operators in the trade should receive proper gas welding skills training and gas welding safety training to safeguard themselves and others during welding processes. Therefore, the LD has introduced a safety training and certification scheme under the Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation (“the Regulation”), Cap 59AI, to ensure that every worker conducting gas welding (“GW”) in industrial undertaking has undergone appropriate safety training and held valid certificate. In this regard, the CL is empowered by the Regulation to recognise the following safety training courses:
- (A) Gas Welding Safety Training Course (“full course”); and
- (B) Gas Welding Safety Training Revalidation Course (“revalidation course”).
- 1.3 Procedures for application for course recognition are stipulated in the GN. Applicant who wishes to run full course or revalidation course should submit an application to the CL for course recognition.
- 1.4 Unless stated otherwise, requirements stated in this module are applicable to both full course and revalidation course.
- 1.5 TCP should ensure that the course materials used should comply with the requirements of this module.
- 1.6 The objective of the full course is to provide basic knowledge on occupational safety and health for workers engaged in gas welding

processes. The trainees will be issued with a certificate upon successful completion of the course.

- 1.7 Revalidation course aims to provide refresher training to holders of GW certificates, which are expiring or expired, to enhance or reinforce their occupational safety and health knowledge in connection with gas welding. Upon successful completion of the course, the trainee will be issued with a new certificate.
- 1.8 At the end of full course, the trainees should be able to:
 - 1.8.1 Describe general features of the Factories and Industrial Undertakings Ordinance (“FIUO”) and the Occupational Safety and Health Ordinance (“OSHO”) and their subsidiary legislation in connection with gas welding processes;
 - 1.8.2 Define responsibilities of various duty holders in relation to gas welding processes;
 - 1.8.3 Describe common types of hazards, unsafe conditions and unsafe acts relating to gas welding processes;
 - 1.8.4 Comprehend safety measures and precautions that can be adopted in gas welding processes, including emergency preparedness;
 - 1.8.5 Describe general safe practices on the use and maintenance of gas welding equipment and personal protective equipment; and
 - 1.8.6 Describe the typical/alarming accidents (including causes and related preventive measures) associated with gas welding, in particular those occurred during the five years preceding the conduct of the full course.
- 1.9 At the end of revalidation course, the trainees should be able to:
 - 1.9.1 Describe general features of the FIUO and the OSHO and their subsidiary legislation in connection with gas welding processes;
 - 1.9.2 Define responsibilities of various duty holders in relation to gas welding processes;
 - 1.9.3 Describe common types of hazards, unsafe conditions and

- unsafe acts relating to gas welding processes;
- 1.9.4 Comprehend safety measures and precautions that can be adopted in gas welding processes, including emergency preparedness;
- 1.9.5 Describe general safe practices on the use and maintenance of gas welding equipment and personal protective equipment; and
- 1.9.6 Describe the typical/alarming accidents (including causes and related preventive measures) associated with gas welding, in particular those occurred during the five years preceding the conduct of the revalidation course.

2. Admission criteria

- 2.1 Full course is run for trainee who does not possess a GW certificate or possess a GW certificate which has expired for more than 3 months.
- 2.2 A TCP should ensure that applicant to be admitted to a revalidation course should, at the time of application, be holding a GW certificate which either will expire within 6 months or has expired for not more than 3 months.
- 2.3 A TCP should ensure that trainee admitted to its full course and revalidation course has attained the age of 18 years.

3. Qualifications of trainer

- 3.1 A TCP should ensure that its trainer on the ***theory session*** of either GW safety training course should at least possess the following:
- 3.1.1 One of the qualifications from items 1 to 3 stipulated in **Annex 1**;
- 3.1.2 A certificate of gas welding skills training issued by the Vocational Training Council (“VTC”), Construction Industry

Council (“CIC”) or equivalent;

- 3.1.3 A certificate of an acceptable instructional skills training course, such as the certificate course of Basic Instructional Techniques by The Education University of Hong Kong or the certificate course of Occupational Safety and Health Trainer by the Occupational Safety and Health Council (“OSHC”) or the certificate course of Effective Site Safety Training and Instructing Techniques Course by CIC or equivalent; and
 - 3.1.4 2 years working experience relevant to gas welding operation.
- 3.2 A TCP should ensure that its trainer on the *practical session* of the full course should at least possess the following:
- 3.2.1 A certificate of gas welding skills training issued by VTC or CIC or hold a recognized trade testing certificate in gas welding or complete an apprenticeship scheme in welding trade or equivalent;
 - 3.2.2 A certificate of Safety Supervisor Course issued either by OSHC or CIC or equivalent;
 - 3.2.3 4 years relevant working experience on gas welding operation; and
 - 3.2.4 Sound lecturing, instruction and assessment skills and competent to conduct the course by reason of his/her experience and training.

4. Trainees to trainer ratio

- 4.1 A TCP should ensure that the maximum ratio of trainees to trainer is 40 to 1 for theory session of either GW safety training course and is 20 to 1 for the practical session of full course.

5. Class size

- 5.1 A TCP should ensure that the maximum size of a class is 40 trainees and it is the same for the full course and the revalidation course.

6. Course duration

- 6.1 A TCP should ensure that the minimum course duration of full course should be 7 hours (break between half-day sessions or lunch time not included) and it should include a practical session of about 3 hours on general safe practices and complete check of equipment, fittings and fixtures; an examination session of 30 minutes; and a total of not more than 30 minutes recess time.
- 6.2 A TCP should ensure that the minimum course duration of revalidation course should be 4 hours and it should include an examination session of 30 minutes and a total of not more than 15 minutes recess time.
- 6.3 A TCP is allowed to use the time saved from the practical training, particularly in a small class size situation, to supplement additional relevant materials in the practical session if all the trainees have completed the practical training as specified in relevant course materials. In such case, the TCP should properly record the supplemented training and produce the records, upon request, to an occupational safety office of the LD for inspection.
- 6.4 A TCP should make an application in writing to the CL for seeking approval for a special arrangement on the partition of course duration, if needed, where the duration of each half-day session should not be less than 3 hours. The CL will consider the application when the special arrangement does not affect the quality of training and course monitoring.

7. Attendance

- 7.1 A TCP should ensure that any trainee who is absent from the theory class for more than 15 minutes for any half-day sessions will be disqualified to attend the examination.

8. Lesson plan

- 8.1 A TCP should ensure that its full course and revalidation course should be taught in accordance with the lesson plans stipulated at **Annex 2** and **Annex 3**, respectively

9. Course contents

- 9.1 A TCP should ensure the course materials used for full course and revalidation course should include all the topics and details stipulated at **Annex 4** and **Annex 5**, respectively. The course contents include the reference teaching time and the additional requirements for the delivery. The TCP should also supplement additional materials in accordance with the needs of the trainees and the latest safety information.

10. Display, demonstration and practising

- 10.1 A TCP should provide suitable and sufficient equipment (including at least a full set of gas welding equipment including gas cylinders with safety devices, connections, blowpipes and nozzles, storage set and a full set of personal protective equipment) for the purpose of display, demonstration or practising. The details are stated in relevant sections of the course contents at **Annex 4** and **Annex 5**.

- 10.2 In the practical session of full course, demonstration on the correct methods and procedures of the use of the above-mentioned equipments are required. A TCP should ensure that every trainee should safely complete the hands-on practice.
- 10.3 Regarding the revalidation course, a TCP should ensure that explanation to the trainees on the correct operating procedures of the gas welding equipments and correct methods of wearing of the personal protective equipment through demonstration is properly conducted.
- 10.4 A TCP should ensure that storage and use of dangerous goods, gas welding equipment and apparatus; discharge of exhaust gases and ventilation of classroom, etc. shall comply with all relevant legislation as administered by various government departments such as Buildings Department, Electrical and Mechanical Services Department, Fire Services Department, Environmental Protection Department, etc.
- 10.5 A TCP should provide a purpose-designed premises such as a factory unit for practical session of full course having regard to the means of escape, fire prevention, effective natural and artificial ventilation.

11. Examination

- 11.1 A TCP should ensure that every trainee attending the examination should meet the required attendance and the requirement of completing the hands-on practice.
- 11.2 A TCP should ensure that the examination papers used are issued and specified by LD.
- 11.3 A TCP should provide the answer sheet at **Annex 6** to the trainee for the examination.
- 11.4 A TCP should ensure that the invigilator and the trainee should sign on the answer sheet.

- 11.5 Time allowed for the examination is 30 minutes and the passing mark is 75%.

12. Validity period of certificate

- 12.1 A TCP should ensure that the validity period of GW certificate issued is 5 years.

- 12.2 For full course, validity period of the certificate should be counted from the date when the trainee successfully completes the course.

- 12.3 For revalidation course, validity of the certificate should be counted from the day—

12.3.1 immediately after the expiry date of the current certificate if the revalidation course is successfully completed within 6 months prior to expiry of the current certificate; or

12.3.2 of completing the revalidation course if the revalidation course is successfully completed within 3 months after expiry of the current certificate.

13. Standard certificate format

- 13.1 A TCP should ensure that the front side of the GW certificate should be designed with the required words, in the format as shown in **Figure 1** and according to the specifications below. The reverse side is left to the TCP to include other information as appropriate, which should be commensurate with the purpose of the certificate.

Figure 1: Required Words and Design Format of the Front Side of GW Certificate

氣體焊接安全訓練課程證明書
Certificate for Gas Welding Safety Training Course
工廠及工業經營(氣體焊接及火焰切割)規例
Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation

持證人姓名 Holder's Name
(中文) :
(English) :

編號 Reference No. :

完成課程日期 Date of Course Completion :
(日/月/年/年/年/年) (dd/mm/yyyy)

有效期限 Validity Period : 由 From 至 To 止
(日/月/年/年/年/年) (dd/mm/yyyy)

本證明書由 [某發證機構] 簽發
Issued by [provider of recognised training course]

此證明書須由持證人擁有及保存。
This certificate is owned and should be kept by the certificate holder.

(not to scale)

- 13.1.1 The certificate should be made of durable materials, either laminated or plastic, and in standard size of 85 mm x 55 mm;
- 13.1.2 A photograph (minimum size of not less than 20 mm x 25 mm) of the trainee should be incorporated into the certificate for easy identification;
- 13.1.3 For laminated card, the corner of the trainee's photo should be stamped with the TCP's company's chop;
- 13.1.4 For plastic card, the trainee's photo should be printed on the card;
- 13.1.5 Unless otherwise specified, information on the certificate should be printed in both Chinese and English;
- 13.1.6 The certificate should contain the following information:
 - The name of certificate, i.e. “氣體焊接安全訓練課程證明書” and “Certificate for Gas Welding Safety Training Course”;
 - The empowering legislation, i.e. “工廠及工業經營(氣體焊接及火焰切割)規例” and “Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation”;
 - The Chinese and English name as printed on the Hong Kong Identity Card (or equivalent identity documents) of

the certificate holder;

- Reference number of the certificate (an “R” should be appended to the last digit of the reference number to denote that the certificate is issued for a revalidation course);
- Date of Course Completion (in the format of DD/MM/YYYY);
- Validity period with starting date and expiry date (in the format of DD/MM/YYYY);
- Name of the certificate issuing course provider; and
- The wordings of “此證明書須由持證人擁有及保存。” and “This certificate is owned and should be kept by the certificate holder.”

14. Training records

14.1 A TCP should submit the record of every certificate issued according to the required details stipulated in **Table 1** as well as the name of the course.

Table 1 : Example of Training Records

HKID/ Passport No. (TRT1)	Name of trainee (TRT2)	Class Ref. (TRC1)	Name of Trainer (TRC2)	Date of Course completion (TRC3)	Certificate Effective Date (TRT3)	Certificate Expiry Date (TRT4)	Certificate Serial No. (TRT5)
A123456(1)	Chan Siu On	ABC1	HAU To-si	13/06/2011	13/06/2011	12/06/2016	W396000201R
A123457(2)	Chan Siu Chuen	ABC1	HAU To-si	13/06/2011	23/09/2011	22/09/2016	W396000202R
A123458(3)	Chan Siu Feng	ABC2	HAU To-si	18/06/2011	18/06/2011	17/06/2016	W396000203
A123459(4)	Chan Siu Lin	ABC2	HAU To-si	18/06/2011	18/06/2011	17/06/2016	W396000204

Annex 1

Qualifications of a Gas Welding Safety Training Trainer

Item	Qualifications		
1.	A Registered Safety Officer under the Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations; or		
2.	A person possessing at least any one of the following qualifications and experience from items (i) to (iv); or		
	Academic Qualifications	Experience	
(i)	A recognised degree or post-graduate diploma in occupational safety and health, or equivalent.	A cumulative total of <u>not less than one year</u> of experience directly involving occupational safety and health related work.	or
(ii)	A degree in Science or Engineering, or equivalent, and a recognised certificate, diploma or higher diploma in occupational safety and health.	A cumulative total of <u>not less than one year</u> of experience directly involving occupational safety and health related work.	or
(iii)	A recognised certificate, diploma or higher diploma in occupational safety and health.	A cumulative total of <u>not less than two years</u> of experience directly involving occupational safety and health related work, <u>one year</u> of such experience must be obtained after the academic qualification on the left column.	or
(iv)	A recognised certificate in construction safety.	A cumulative total of <u>not less than two years</u> of experience directly involving occupational safety and health related work, <u>one year</u> of such experience must be obtained after the academic qualification on the left column.	
3.	A person recognised by the CL as being competent to teach training course of MBST (Construction Work).		

Annex 2

Lesson Plan for Gas Welding Safety Training Course

Section	Topic & Content	Time (Minutes)
1	Introduction to Arrangements of the Course	10
2	Relevant Occupational Safety and Health Legislation Applicable to Gas Welding	20
3	Responsibilities of Various Duty Holders Connected with Gas Welding Process	15
4	Common Types of Hazards, Unsafe Conditions and Unsafe Acts, and Risk Assessment of Gas Welding	30
Recess		15
5	Case Study and Analysis of Common Serious Accidents	20
6	Safety Measures for Gas Welding	40
7	General Safe Practices of Gas Welding	60
Break between Half-day Sessions or Lunch Break		
8	Explanation, Display, Demonstration and Practice (The maximum ratio of trainees to trainer for the practical session is 20 to 1)	150
Recess		15
9	Conclusion of the Course	5
10	Written Examination	30
11	Review of the Examination Paper After the Examination	10
Total Time 【Class+Exam+Review】		420 (7 Hrs)

Annex 3

Lesson Plan for Gas Welding Safety Training Revalidation Course

Section	Topic & Content	Time (Minutes)
1	Introduction to Arrangements of the Course	5
2	Relevant Occupational Safety and Health Legislation Applicable to Gas Welding	20
3	Responsibilities of Various Duty Holders Connected with Gas Welding Process	15
4	Common Types of Hazards, Unsafe Conditions and Unsafe Acts, and Risk Assessment of Gas Welding	25
5	Case Study and Analysis of Common Serious Accidents	20
Recess		15
6	Safety Measures for Gas Welding	35
7	General Safe Practices of Gas Welding	60
8	Conclusion of the Course	5
9	Written Examination	30
10	Review of the Examination Paper After the Examination	10
Total Time 【Class+Exam+Review】		240 (4 Hrs)

Course Contents for Gas Welding Safety Training Course

Course Contents for Gas Welding Safety Training Course

Factories and Industrial Undertakings
(Gas Welding and Flame Cutting) Regulation



**Occupational Safety and Health Branch
Labour Department**

**The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department**

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7. General Safe Practices of Gas Welding.....	35
8. Explanation, Display, Demonstration and Practice.....	45

1. Introduction to Arrangements of the Course

[Reference teaching time for Section 1: 10 mins]

1.1 Training Venue, Training Equipment and Examination Requirements

- To introduce briefly about the training venue, training equipment and the examination requirements

1.2 Introduction to the Course Contents

- To introduce briefly about the course structure and contents

1.3 Objectives of the Course

Gas welding and flame cutting (“gas welding”) is a hazardous trade process. Gas welding operators in the trade should receive proper gas welding skills training and gas welding safety training to safeguard themselves and others during welding processes. Therefore, the Labour Department has introduced a safety training and certification scheme under the Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation, Cap 59AI, to ensure that every worker conducting gas welding in industrial undertaking has undergone appropriate safety training and held valid certificate.

The objective of the “Gas Welding Safety Training Course” is to provide basic knowledge on occupational safety and health for workers engaged in gas welding processes. The trainees will be issued with a “Certificate for Gas Welding Safety Training Course” upon successful completion of the course.

At the end of the course, the trainees should be able to:

- Describe general features of the Factories and Industrial Undertakings Ordinance and the Occupational Safety and Health Ordinance and their subsidiary legislation in connection with gas welding processes;
- Define responsibilities of various duty holders in relation to gas welding processes;
- Describe common types of hazards, unsafe conditions and unsafe acts relating to gas welding processes;

- Describe the typical/alarming accidents (including causes and related preventive measures) associated with gas welding, in particular those occurred during the five years preceding the conduct of the course;
- Comprehend safety measures and precautions that can be adopted in gas welding processes, including emergency preparedness; and
- Describe general safe practices on the use and maintenance of gas welding equipment and personal protective equipment.

2. Relevant Occupational Safety and Health Legislation Applicable to Gas Welding

[Reference teaching time for Section 2: 20 mins]

2.1 Occupational Safety and Health Ordinance (Chapter 509)

Purposes

- To ensure the safety and health of employees when they are at work
- To prescribe the occupational safety and health measures
- To improve the safety and health standards applicable to workplaces
- To improve the safety and health aspects of working environments of employees

Coverage

- This ordinance covers almost all workplaces - places where employees work, including offices, shopping arcades, supermarkets, hospitals, construction sites, etc.
- However, there are a few exceptions, including places where only self-employed persons work and domestic premises where the only employees are domestic servants.
- Every employer must, so far as reasonably practicable, ensure the safety and health at work of all his employees.

The Roles of the Duty Holders

Under this ordinance, everyone has a role to play in creating a safe and healthy workplace.

- **Employers** should contribute to safety and health in their workplaces by:
 - providing and maintaining plant and work systems that do not endanger safety or health;
 - making arrangement for ensuring safety and health in connection with the use, handling, storage or transport of plant or substances;
 - providing all necessary information, instruction, training and supervision for ensuring safety and health;
 - providing and maintaining safe access to and egress from the workplaces;

and

- providing and maintaining a safe and healthy work environment.
- **Employees** should also contribute to safety and health in the workplaces by:
 - taking care for the safety of himself and other persons;
 - taking care for the safety and health of persons at the workplace; and
 - using any equipment or following any system or work practices provided by their employers.

2.2 Factories and Industrial Undertakings Ordinance (Chapter 59)

- Provide for the safety and health protection to workers in the industrial sector
- Coverage
 - factories
 - construction sites
 - catering establishments
 - cargo and container handling undertakings
 - repair workshops and other industrial workplaces
- **General Duties of Proprietors**

Every proprietor of an industrial undertaking must, so far as is reasonably practicable, ensure the safety and health at work of all persons employed by him. The matters to which that duty extends include:

 - providing and maintaining plant and work systems that do not endanger safety or health;
 - making arrangements for ensuring safety and health in connection with the use, handling, storage or transport of plant or substances;
 - providing all necessary information, instruction, training and supervision for ensuring safety and health;
 - providing and maintaining all parts of the workplace and means of access to and egress from the workplace that is safe and without risk to health; and
 - providing and maintaining a working environment that is safe and without risk to health.

- **General Duties of Persons Employed**

- every person employed at an industrial undertaking must take reasonable care for the safety and health of himself and others; and
- co-operate with the proprietor of an industrial undertaking to enable any duty or requirement for securing the safety and health of persons employed at the industrial undertaking to be performed or complied with.

2.3 Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation

Purpose

- The purpose of the Regulation is to ensure gas welding and flame cutting work in industrial undertakings is carried out by persons who are trained and certified competent for carrying out such work.

Application

- The Regulation applies to any industrial undertaking.

Interpretation

- “gas welding and flame cutting” means welding or cutting work carried on in industrial undertakings with a flame produced by mixing a fuel gas and an oxidant gas in a blowpipe;
- “blowpipe” means the burner device in which separate supplies of fuel gas and oxidant gas are mixed in appropriate proportions to produce the required flame for welding or cutting work.

Duty of proprietor to ensure that gas welding and flame cutting work is performed by competent persons

A proprietor shall ensure that gas welding and flame cutting work is only performed by :

- a person who has attained the age of 18 years and holds a valid certificate; or
- a person who is undergoing training in performing gas welding and flame cutting work and the performance of such work is under the supervision of a person who has attained the age of 18 years and holds a valid certificate.

Duty of proprietor to provide training course

- A proprietor shall ensure the provision of a training course to each of his employees who is instructed (whether directly or indirectly) by him to perform gas welding and flame cutting work.
- In case the employee fails to obtain a certificate after attending the training course, the proprietor shall ensure the provision of an additional training course for the employee.

Duty of person to attend training course

- An employee is required to attend such training course as may be provided by the proprietor unless he holds a valid certificate.

Duty of person performing the work

Any person who performs gas welding and flame cutting work shall produce his valid certificate for inspection :

- Upon demand by an occupational safety officer; or
- Within such reasonable time and at such reasonable place as specified by the occupational safety officer, when he cannot produce his certificate upon demand by the officer.

2.4 Factories and Industrial Undertakings (Confined Spaces) Regulation

The proprietor or contractor shall appoint a competent person to carry out assessment of the working conditions in the confined space. Safety measures have to be taken before the work begins and when the work is being undertaken. Only certified worker is allowed to work in confined space.

2.5 Construction Sites (Safety) Regulations

These regulations control the construction, maintenance, use and operation of hoists, scaffolds and working platforms. There are also provisions for the use of personal protective equipment for protection against falling of person, falling objects and drowning in a construction site. There are miscellaneous safety requirements such as prevention of inhalation of dust and fumes, protection of eyes and the provision of first aid facilities.

Part VA of the Construction Sites (Safety) Regulations provides a greater degree of safety to persons working on construction sites, in particular in relation to preventing falls from heights. The contractors have the general duty to make and keep every place of work on a construction site safe, and in particular, to take suitable and adequate steps to prevent persons from falling from a height of 2 metres or more, such as provision, use and maintenance of working platforms, guard-rails, barriers, toe-boards and fences, coverings for openings, gangways and runs, etc.

2.6 The Factories and Industrial Undertakings (Fire Precautions in Notifiable Workplaces) Regulations

These regulations provide for the prevention of the outbreak of fire, the spread of fire and smoke in case of fire, the provision of fire fighting equipment and the maintenance of fire escapes in notifiable workplaces.

2.7 Factories and Industrial Undertakings (Protection of Eyes) Regulations

The proprietor has the duty to provide approved eye protector for every worker engaged in any of the specified processes listed in the Schedule of the regulations.

2.8 Factories and Industrial Undertakings (Dangerous Substances) Regulations

To standardize risk symbols and labelling system of dangerous substances and impose duties on proprietors and workers to take all reasonable safety measures in specified industrial undertakings where listed substances are used.

2.9 Code of Practice

The Code of Practice (hereinafter referred as the Code) is approved and issued by the Commissioner for Labour under Section 7A of the Factories and Industrial Undertakings Ordinance, Chapter 59 of the Laws of Hong Kong (hereinafter referred as the FIUO). It provides a practical guidance to proprietors of industrial

undertakings and the employees for compliance with the requirements under the provisions of the Sections 6A and 6B of FIUO concerning the general duties of proprietor and employee. It is important to note that compliance with the Code does not of itself confer immunity from legal obligations.

The Code has a special legal status. Although failure to observe any guidance contained in the Code is not in itself an offence that failure may be taken by a court in criminal proceedings as a relevant factor in determining whether or not a person has breached any of the provisions of the regulations to which the guidance relates.

Codes of practice that are often used include:

- Code of Practice : Safety and Health at Work for Gas Welding and Flame Cutting
- Code of Practice : Safety and Health at Work in Confined Spaces
- Code of Practice : Safety and Health at Work for Manual Electric Arc Welding

2.10 Dangerous Goods Ordinance

The Ordinance shall apply to all explosives, compressed gases, petroleum and other substances giving off inflammable vapours, substances giving off poisonous gas or vapour, corrosive substances, substances which become dangerous by interaction with water or air, substances liable to spontaneous combustion or of a readily combustible nature, radioactive material, etc.

3. Responsibilities of Various Duty Holders Connected with Gas Welding Process

[Reference teaching time for Section 3: 15 mins]

Securing safety and health at work in an industrial undertaking requires the full commitment and co-operation of everybody concerned, from the proprietor to the workers. It is the duty of the proprietor of an industrial undertaking to ensure, so far as is reasonably practicable, the safety and health at work of all persons employed by him at the industrial undertaking.

The proprietor often employs line management personnel to discharge his responsibilities for management or control of the industrial undertaking. In this regard, the authority and responsibility of each member of the line management should be precisely set down and made known to all persons concerned.

3.1 Responsibilities of proprietor and contractor

The proprietor, including contractor and top management, should demonstrate the commitment in managing safety and health and bear the final responsibility and accountability for the safety and health in the industrial undertaking. The responsibilities of the proprietor include:

- (a) providing a safe and healthy working environment;
- (b) providing the necessary resources for managing safety and health in the industrial undertaking;
- (c) issuing safety rules and safe working procedures, and ensuring that the rules and procedures comply with relevant legislation;
- (d) ensuring that the experience and training of the persons employed are commensurate with the assigned task;
- (e) ensuring that the responsibilities for managing safety and health are appropriately assigned, and the duties are effectively carried out by the staff concerned; and
- (f) ensuring that all accidents and dangerous occurrences are investigated and recommendations made are properly followed-up.

3.2 Responsibilities of line management personnel

The line management personnel, including managers, agents, engineers, safety personnel, foremen or supervisors, are responsible for managing safety and health in the industrial undertaking on a day-to-day basis, and should take up their supervisory role in discharging their duties. The responsibilities of the line management personnel include :

- (a) managing safety and health in the industrial undertaking;
- (b) assessing the risk in performing the gas welding or flame cutting operation, and establishing appropriate safety measures;
- (c) establishing safety rules and safe working procedures;
- (d) ensuring equipment to be regularly checked and properly maintained;
- (e) investigating accidents and dangerous occurrences, and undertaking follow-up actions;
- (f) establishing emergency response plans, and conducting drills whenever necessary; and
- (g) providing necessary information and instructions, as well as providing and arranging training to the workers and supervising them to follow safety rules and safe working procedures strictly.

3.3 Responsibilities of persons employed

The persons employed (“staff”), including workers and line management personnel, are required to take reasonable care for the safety and health of themselves and of others who may be affected by their acts or omissions at work. The responsibilities of the staff include :

- (a) understanding and acting in accordance with the safety rules, safe working procedures and emergency response procedures;
- (b) making full use of the safety equipment and personal protective equipment necessary to perform the assigned task, and reporting all equipment defects to the management immediately;
- (c) providing feedback on effectiveness of safety measures and emergency response plans; and

(d) reporting to the management all hazards or defects observed during daily operation, injury, accident or incidents at work.

4. Common Types of Hazards, Unsafe Conditions and Unsafe Acts, and Risk Assessment of Gas Welding

[Reference teaching time for Section 4: 30 mins]

4.1 Common types of hazards

4.1.1 Fire and explosion hazards

Fire and explosion hazards in gas welding and flame cutting are mainly caused by problems with the gas supply system, the high temperature of the flame used or the hot slag produced in the process. These hazards include :

- (a) fires and explosions resulted from the release of flammable fuel gases or oxygen into the atmosphere from damaged gas hose or piping, or from leaks at joints, hose connections or fittings of the gas supply system, or as a result of valves of the gas supply line or blowpipe being left open inadvertently;
- (b) fires and explosions in the gas supply system caused by:
 - flashback from the blowpipe due to fuel gas supply lines not completely purged before lighting up, or back-feeding of fuel gas into the oxygen line or vice versa,
 - decomposition or detonation of acetylene in the absence of oxygen or air due to flashback at the blowpipe or overheating of gas cylinder, or
 - high-pressure oxygen gas (without fuel gas) which promotes combustion of materials such as oil, grease, organic compounds, aluminium and its alloys, and elastomers used in valve seats and seals;
- (c) explosions from over-pressurisation of the gas supply system;
- (d) fires arising from the flammable or combustible residue in the workpiece; and
- (e) fires from the ignition of flammable or combustible materials in the vicinity by the flame of the blowpipe, hot surfaces of the workpiece or hot slag from the process.

4.1.2 Health hazards

Health hazards of gas welding and flame cutting are mainly due to the radiation and toxic fumes or gases emitted during the process. The resultant health problems include:

- (a) eye injuries, such as
 - eye discomfort and burns from the intense light and heat emitted from the operation,
 - heat cataract caused by radiation from molten metal, leading to inability to see things clearly, or
 - corneal ulcer and conjunctivitis from foreign particles e.g. slag and cutting sparks;
- (b) skin irritation and reddening due to over exposure to radiation;
- (c) illness due to inhalation of fumes or gases formed during the process, such as
 - metal fume fever from freshly formed metal oxide fumes,
 - illness from toxic fumes of metals such as lead, cadmium, beryllium,
 - bronchial and pulmonary irritation from toxic gases such as oxides of nitrogen and fluorides;
- (d) burns from the blowpipe flame, hot slag or hot surfaces of the workpiece;
- (e) heat-stroke from prolong operation with the flame, especially in confined space; and
- (f) personal injuries arising from handling gas cylinders or large workpieces.

4.1.3 Other hazards specific to the operation

- (a) loss of stability to structures;
- (b) Hazards associated with mechanical handling and conveyance of gas cylinders; and
- (c) Personal injuries due to manual handling of gas cylinders or large workpieces.

4.2 Unsafe conditions and unsafe acts

Many serious accidents have occurred in the industry due to misuse of oxygen, recharging of gas cylinders and warming up gas cylinders. These are unsafe acts.

4.2.1 Misuse of oxygen

When oxygen gas contacts combustible materials, it promotes combustion. Explosion may occur. Never use oxygen to:

- (a) provide a source of pressure or a substitute for compressed air, such as to clear blockages in pipelines, to power air-driven tools;
- (b) blow-down clothing, equipment or work areas to remove dust, etc.;
- (c) ventilate a confined space instead of air; or
- (d) sweeten the air of any work area or space.

4.2.2 Recharging of gas cylinders

Recharging gas cylinders by connecting them to other cylinders or a gas supply is extremely dangerous. Explosion may occur if:

- (a) the gas line or its connections or the gas cylinders cannot withstand the high pressure during recharging; or
- (b) the recharging involves mixing of incompatible gases, such as charging oxygen into an acetylene cylinder.

4.2.3 Warming up gas cylinders

Warming up gas cylinders by any means in order to increase gas flow or to extract the last bit of gas stored in the cylinder for use is extremely dangerous. Fire and explosion may occur due to:

- (a) the gas supply system not capable of withstanding the resulted increase in gas pressure; or
- (b) evaporation of the solvent (acetone in general) for storing acetylene in the gas cylinder by the heat, causing damage to the gas hose and

blowpipe and change in composition of the fuel/oxidant mixture for the flame.

4.2.4 Improper use of personal protective equipment

Personal protective equipment, if wrongly selected, or improperly used or maintained, may do more harm than good. The user may have a false sense of security and the risk of injury or ill health may be higher than in a situation where no personal protective equipment is used.

4.3 Risk assessment

- (a) Risk assessment in gas welding or flame cutting is an evaluation process to assess the likelihood of the hazards in gas welding and flame cutting causing harm and the severity of that harm. This provides the necessary information for establishing appropriate safety measures, safe working procedures and emergency response procedures before commencing the operation. The scale and depth of the risk assessment depend on the working environment and the complexity of the welding or cutting operation.
- (b) Risk assessment should be conducted by a person with the appropriate knowledge and experience and the relevant training to enable him to assess the risks arising from the operation. The person should have appropriate understanding of the welding or cutting operation as well as good knowledge of the safe practices and safety measures required. He may not be an expert in that area but should be aware of his own limitations and should know when he needs to seek expert advice.
- (c) The basic steps in risk assessment include:
 - identifying the hazards;
 - considering who may be affected and how;
 - evaluating the risks arising from the hazards, and considering

whether existing safety measures are adequate or more should be done;

- recording the findings; and
- reviewing the assessment from time to time and revising if necessary.

(d) Risk assessment should be specific to the required task. Factors to be considered in assessing risks associated with gas welding or flame cutting operation include:

- the fuel gas and oxidant gas required and the gas supply system;
- the working environment, such as
 - ventilation of the workplace,
 - working in specific environments, such as confined space, pressurized or oxygen-rich environment,
 - working space restricting body movement,
 - working nearby flammable or combustible materials, and
 - the possibility of slag or sparks reaching or coming into contact with combustible materials;
- particulars of the work, such as
 - duration and frequency of the welding or cutting operation,
 - operation on workpieces with possible flammable or combustible residues,
 - working at height, and
 - size, shape and weight of the workpieces.

(e) Risk assessment should be reviewed regularly and whenever there has been a significant change in the operation to which the assessment relates, such as changes in working environment or the particulars of the work.

5. Case Study and Analysis of Common Serious Accidents

[Reference teaching time for Section 5: 20 mins]

[This section must be conducted in an interactive manner through discussion with trainees]

Workplace accidents not only cause sufferings to the victims and their families, but also result in financial losses arising from stoppage of work, insurance claims, medical and rehabilitation expenses, etc. In fact, most of the workplace accidents are preventable. Very often, they share common scenarios and causes. These scenarios and causes should be properly understood in order that lessons are learnt and suitable measures implemented to prevent recurrence of such accidents.

5.1 Case analysis of serious gas welding accidents

Case 1

Flashback from oxy-acetylene blowpipe

Circumstances

When a worker was using oxy-acetylene equipment to cut an I-beam in a construction site, there was a flashback propagating from the blowpipe into the gas hoses and cylinders. As a result, the cylinders exploded and the worker was injured.



Case Analysis

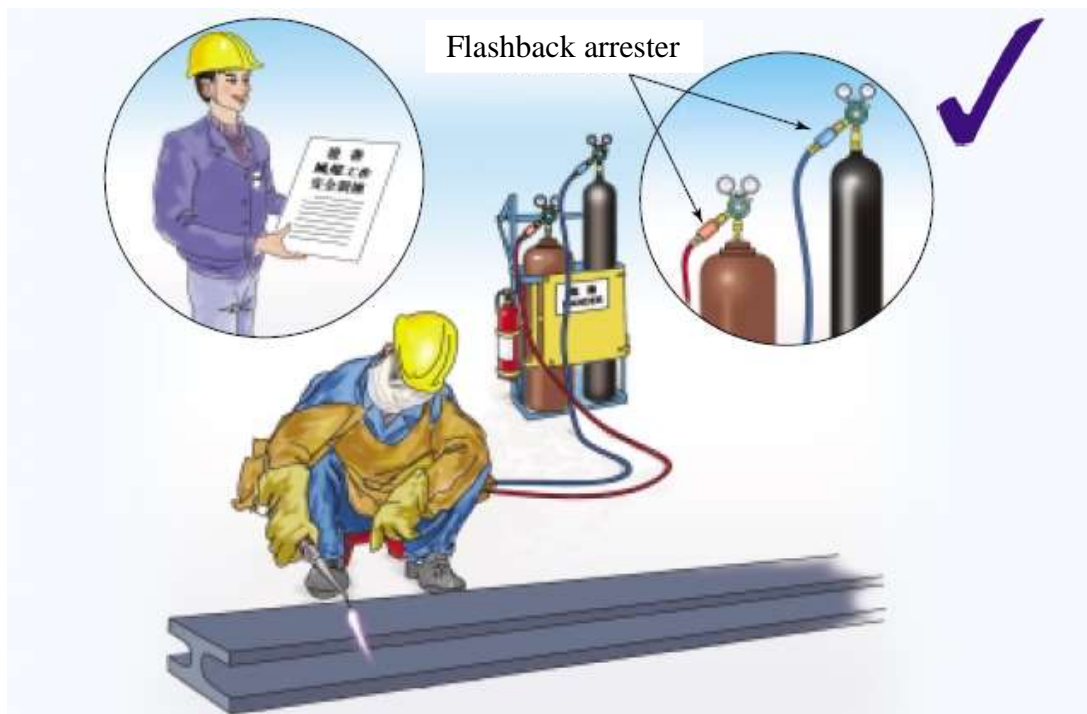
- The inappropriate pressures of acetylene and oxygen inside the blowpipe causing flashback.
- No installation of flashback arrester.

Lessons to Learn

- Oxy-acetylene equipment without flashback arrester should not be used.

Other Points to Note

- The proprietor and responsible person shall :
 - Ensure that flashback arrester and relevant safety devices are installed in the oxy-acetylene equipment.
 - Check frequently to ensure the oxy-acetylene equipment is in good condition. In case of idling for long, thorough examination should be conducted before reuse.
 - Ensure that gas welding and flame cutting work is only performed by a person who has attained the age of 18 years and holds a valid certificate.
 - Ensure all workers to use the safety devices of oxy-acetylene equipment.
- Worker shall :
 - Check hoses and relevant safety devices before the use of the oxy-acetylene equipment in order to ensure they are in good condition.
 - Properly adjust the pressures of acetylene and oxygen inside the blowpipe.
 - Use the oxy-acetylene equipment that is installed with flashback arrester.



Discussion

- The potential hazards associated with gas welding work.
- The mandatory requirements for the persons to conduct gas welding work.
- The safety measures for gas welding work.
- Difficulties encountered by the parties concerned (including the proprietors, the responsible persons, the contractors and the workers, etc.) and their responsibilities.

Case 2

Explosion happened during oxy-acetylene cutting of oil drum

Circumstances

A worker intended to use a batch of empty oil drums as water containers. When he was using oxy-acetylene equipment to cut an empty oil drum, the oil drum exploded suddenly. As a result, the worker was seriously injured.



Case Analysis

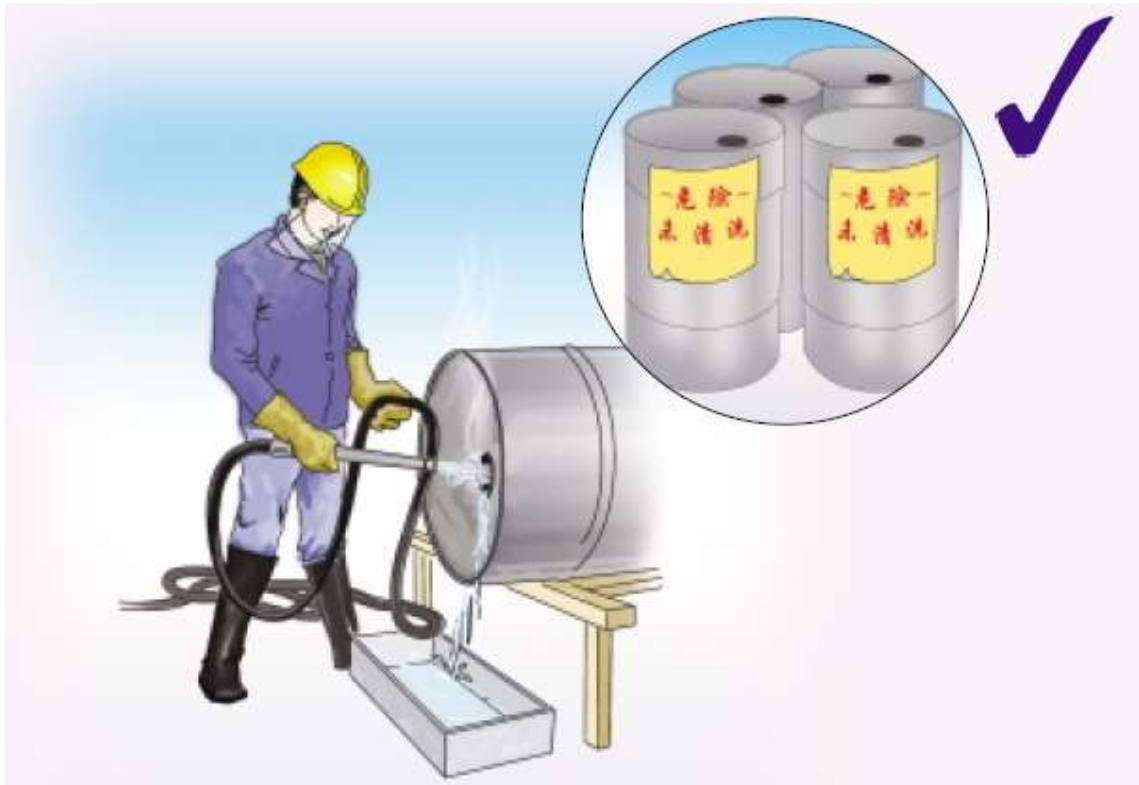
- The oil drum had been used to contain petroleum product before. Certain residues of the inflammable substances remained inside the drum.
- The high temperature produced by the oxy-acetylene equipment caused the explosion of the residues of the inflammable substances

Lessons to Learn

- Should not use oxy-acetylene equipment to cut oil drum without permission.

Other Points to Note

- The proprietor and responsible person shall :
 - Purge the residues of the inflammable substances inside the oil drum before permitting for the other purposes.
 - Display clear instructions for the purpose of the empty oil drum.
 - Ensure that gas welding and flame cutting work is only performed by a person who has attained the age of 18 years and holds a valid certificate.
 - Ensure all workers follow the instructions for using the empty oil drum.
- Worker shall :
 - Obtain the permission from the responsible person before alteration of the empty oil drum for other purpose.
 - Ensure the residues of the inflammable substances inside the oil drum have been completely purged before flame cutting.



Discussion

- The potential hazards associated with gas welding work.
- The mandatory requirements for the persons to conduct gas welding work.
- The safety measures for gas welding work.
- Difficulties encountered by the parties concerned (including the proprietors, the responsible persons, the contractors and the workers, etc.) and their responsibilities.

Case 3

[Training course provider should provide an accident case associated with gas welding (in particular those occurred during the five years preceding the conduct of the course) for case study and analysis in this section]

[Reference can be made to the “Safety Alert” provided by the Labour Department’s website]

Contents of case study and analysis should include:

Circumstances

- Brief description of the accident case.

Case Analysis

- Analyze the cause of the accident.

Lessons to Learn

- Precautionary measures to be taken to prevent recurrence of the accident.

Other Points to Note

- Points to note for the proprietor and responsible person.
- Points to note for the worker.

Discussion

- The potential hazards associated with gas welding work.
- The mandatory requirements for the persons to conduct gas welding work.
- The safety measures for gas welding work.
- Difficulties encountered by the parties concerned (including the proprietors, the responsible persons, the contractors and the workers, etc.) and their responsibilities.

6. Safety Measures for Gas Welding

[Reference teaching time for Section 6: 40 mins]

6.1 Overall strategy

6.1.1 The primary objective of adopting safety measures is to contain or reduce to as low as reasonably practicable the risks encountered in gas welding and flame cutting operations in protecting staff against injury or ill health. Based on the result of risk assessment, appropriate safety measures should be established, implemented and maintained. The primary consideration in selecting appropriate safety measures is to control hazards at source by control measures, whereas protective measures should be considered only as supplementary means in protecting staff against the hazards.

6.1.2 Control measures, such as using appropriate ventilation and safety devices for the gas supply system, are effective means in controlling hazards at source. Protective measures using personal protective equipment provide protection to the workers concerned against the hazards during the welding or cutting process. However, the use of personal protective equipment should be a supplement to, and not in lieu of, effective control measures and the equipment should be selected appropriate to the required protection.

6.1.3 Establishment, implementation and maintenance of safety measures should also include:

- (a) proper design, construction and installation of plant and equipment, such as ventilation system, gas installation and associated piping;
- (b) establishing safe work systems and procedures, including safety rules and safe working procedures;
- (c) provision of appropriate information, instruction and training to the staff;
- (d) measures to ensure that equipment are properly used and maintained, safety rules are complied with and safe working procedures are

followed by the staff, such as providing appropriate supervision to the workers; and

- (e) regularly reviewing the effectiveness of the safety measures, safety rules and safe working procedures and revising the measures, rules and procedures whenever necessary.

6.2 Ventilation

6.2.1 Ventilation is a means by which contaminated air is removed from and fresh air is supplied to the workplace, and is an effective control measure to control fire and explosion hazards as well as the health hazards. The major functions of ventilation in the workplace include:

- (a) removing gas from leakage, if any, so as to prevent accumulation of flammable/explosive mixtures in the atmosphere;
- (b) removing heat as well as hazardous fumes and gases such as metal and metal oxide fumes, oxides of nitrogen, fluorides arising from the welding or cutting operation; and
- (c) supplying fresh air to meet the respiratory needs of persons inside the workplace.

6.2.2 For a workplace involving gas welding or flame cutting operations, the major types of ventilation are:

- (a) general dilution ventilation in which fresh air is introduced into the workplace by mechanical means and is mixed thoroughly with the contaminants in the air before removing the contaminants out of the workplace; and
- (b) local exhaust ventilation in which air contaminants are captured and removed by forced air current through hood and duct near the point of emission and discharged to the atmosphere outside the workplace.

6.2.3 A ventilation system appropriate to the workplace as well as to the welding or cutting activities should be selected and designed. Factors to be considered in selecting and designing the appropriate ventilation

system include:

- (a) natural air movement if the workplace is in the open air, otherwise the enclosed nature of the workplace such as the effectiveness of air moving in and out, height and floor dimensions of the workplace;
- (b) the required air movement to prevent accumulation of flammable/explosive mixture in localized regions in the air as a result of gas leakage, taking into account of matters including the location of the gas supply line and the gas cylinders; and
- (c) the quantity and toxicity of the fumes generated from the welding or cutting operation, and the location of the emission source.

6.2.4 General dilution ventilation

General dilution ventilation is required for a workplace in a building or structure where gas welding or flame cutting activity is involved. The dilution ventilation should effect air movement both at high level and at low level of the workplace in order to prevent accumulation of flammable/explosive mixture in localized regions in the air as a result of gas leakage. Regarding health hazards, general dilution ventilation may be adequate for infrequent and short duration welding or cutting operations which do not emit toxic fumes and which are performed in the open air or in large well-ventilated workshops. Toxic fumes include those derived from metals such as lead, cadmium, beryllium and zinc.

6.2.5 Local exhaust ventilation

Notwithstanding that general dilution ventilation is used in the workplace, local exhaust ventilation is required for welding or cutting operations that emit toxic fumes or gases, or which involve heavy in-door production work. The local exhaust hood should be placed as close as possible to the work for effective removal of the fumes before the fumes disperse to other parts of the workplace.

6.3 Gas supply system and associated safety devices

[Training course provider should describe new technological advancements and developments in work procedure or equipment usage associated with gas welding (particularly those that occurred during the five years preceding the conduct of the course)]

6.3.1 In general, each one of the two gases (the fuel gas or the oxidant gas) for gas welding or flame cutting is supplied from a single gas cylinder. Basically, gas from the cylinder is supplied through a gas hose to the blowpipe where the fuel and oxidant gases are mixed in an appropriate proportion and combusted to form the required flame. The gas supply should be adjusted and monitored by a pressure regulator with pressure gauge connected to each gas cylinder. Other associated safety devices, incorporated in the gas supply system for reducing the risk of fire and explosion in the gas supply system, should include:

- (a) a non-return valve at each gas inlet of the blowpipe to prevent back-feeding of oxidant gas to the fuel gas line and vice versa; and
- (b) flashback arrester incorporating pressure or temperature cut-off valve to prevent propagation of flashback from the blowpipe and gas supply lines into the cylinders.

6.3.2 The typical equipment and related safety devices for oxy-acetylene flame are illustrated in Figure 1. The equipment and associated safety devices should meet national or international standards.

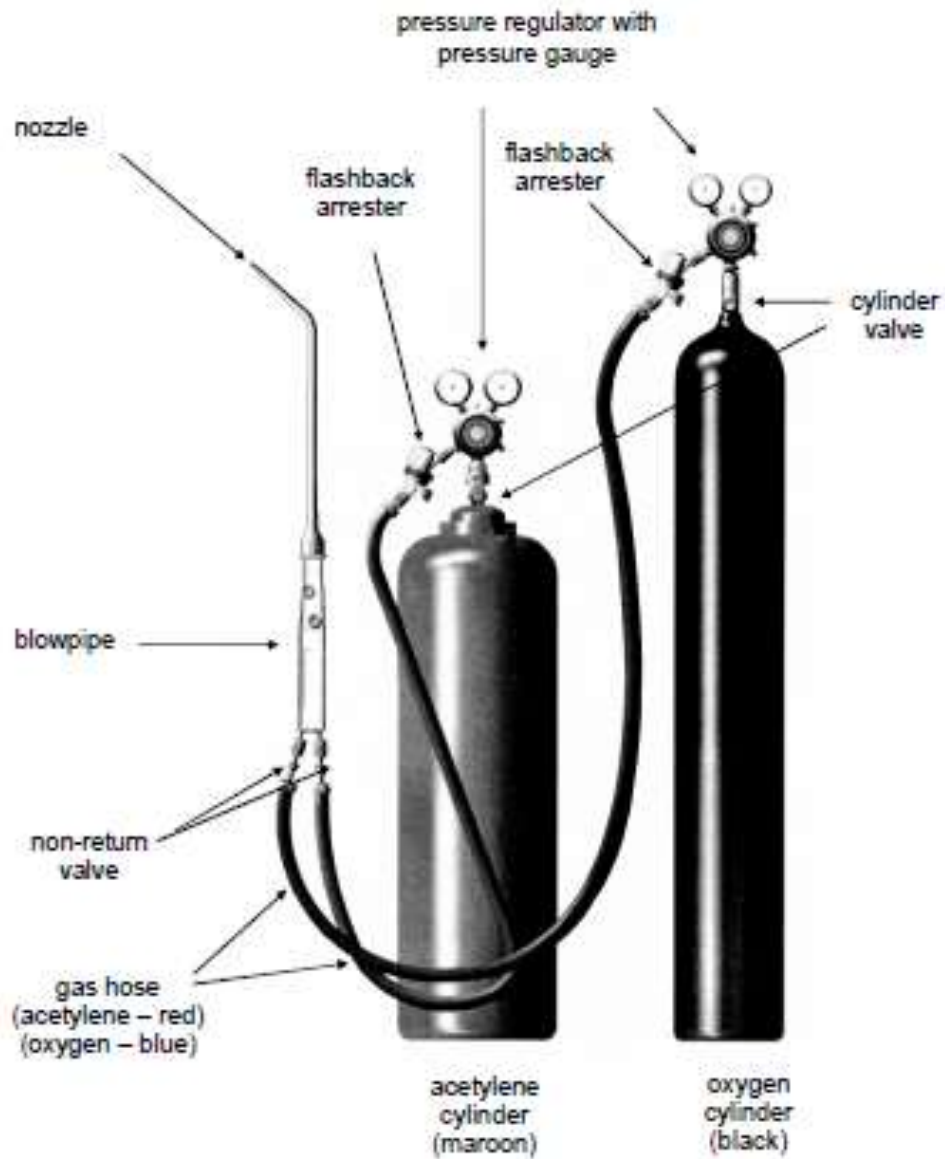


Figure 1: Typical equipment for welding and cutting using oxy-acetylene flame

6.3.3 Alternatively, a gas installation may be used in which each gas is supplied from several cylinders connected in a manifold or from a bulk supply through pressure regulator with pressure gauge, associated piping and gas hose to the blowpipe. Such gas installation and associated piping should comply with relevant legislation, such as the Dangerous Goods

Ordinance (Chapter 295), Gas Safety Ordinance (Chapter 51).

6.3.4 Gas installation and the associated piping should be designed by a professional engineer with the appropriate training and experience in gas safety. Factors to be considered in designing and installing gas installations and associated piping include:

- (a) the provision of appropriate ventilation to prevent localized accumulation of flammable mixture in the air due to minor gas leakage, if any, from the gas installation and associated piping;
- (b) the choice of appropriate materials for the gas installation and associated piping to prevent formation of explosive mixtures (note: copper is not compatible with acetylene, while aluminium and its alloy are not suitable for conveying oxygen);
- (c) the use of safety devices to prevent fire and explosion, including flashback arrester, non-return valve, pressure relief device, vent and purge device;
- (d) the provision of appropriate gas leakage detecting devices, fire alarm and fire-fighting equipment to cope with the large quantity of fuel and oxidant gases involved;
- (e) the protection of the gas installation and associated piping against corrosion and other physical damage; and
- (f) the arrangement of the gas installation and associated piping to facilitate routine inspection and maintenance.

The proprietor should ensure that the gas installation and associated piping are properly installed and tested before use.

6.3.5 Gas cylinders in use and outlet valves of the gas installation should be located in a convenient place, easily accessible to the worker so that the gas supplies can be shut off immediately in case of emergency.

6.3.6 Gas hoses should be as short and hose connections should be as few as reasonably practicable to reduce the chance of gas leakage. Staff should pay attention to the following points when placing the gas hoses:

- (a) Gas hoses should be easily inspected and should not be easily damaged by other activities in the workplace, such as being run over or struck by heavy equipment.
- (b) Gas hoses should not be placed in sleeves, or should not be permanently hidden in grooves, pipe ducts or in other structures. Hoses in sleeves or hiding the hose hinders checking for possible damage and may create voids for localized accumulation of flammable/explosive mixtures in the event of gas leakage.
- (c) Gas leakage from hoses, if any, can be easily and effectively removed by the ventilation of the workplace and will not accumulate in localized regions in the air.
- (d) Gas hoses should not be coiled around the gas cylinder or the pressure regulator. A fire in a coiled hose is very difficult to extinguish. The gas hose should be positioned behind the operator to keep them clear of slag or sparks, and arranged in a tidy manner so as not to create tripping hazard to other persons.

6.3.7 Gas cylinders should be suitably labelled and/or coloured in accordance with the relevant legislation, such as the Dangerous Goods Ordinance (Cap. 295), Factories and Industrial Undertakings (Dangerous Substances) Regulations (Cap. 59 sub. leg.). Gas hoses and piping should also be appropriately coloured for easy identification (Please refer to Figure 1).

6.3.8 Other points to note

- (a) Gas cylinders :
 - When high pressure oxygen comes into contact with oil or grease, it will burn vigorously and even explode. Therefore, any items that come into contact with the oxygen cylinder, including clothes, hands, tools, etc., should not be stained with oil or grease.
 - The thread of all devices used for oxygen cylinder (e.g. oxygen cylinder valve, pressure gauge, flashback arrester, etc.) are right

handed thread, whereas all devices used for acetylene cylinder (e.g. acetylene cylinder valve, pressure gauge, flashback arrester, etc.) are left handed thread. If the device is too tight to be opened, the correct tools should be used. Hammering or lubricant should not be applied.

- For safe storage and handling of gas cylinders, please refer to section 7.5.

6.4 Personal protective equipment

[Demonstrate by means of video or real object of the correct use of PPE including eye protection equipment, fall protection equipment, protective clothing, gloves and safety shoes]

6.4.1 In gas welding and flame cutting, the primary objective of using personal protective equipment is to provide protection to the workers against the risk of injury from hot objects and radiation as well as ill health from inhaling hazardous fumes, as a supplement to control measures. Suitable personal protective equipment should be selected appropriate to the hazards encountered, and should be properly used and maintained. Personal protective equipment, if wrongly selected, or improperly used or maintained, may do more harm than good. The user may have a false sense of security and the risk of injury or ill health may be higher than in a situation where no personal protective equipment is used. Suitable training should be provided to workers for the proper use of personal protective equipment before they start the operation.

6.4.2 Eye protection

Eye protection equipment protects the eye from injuries by radiation and foreign objects such as slag and sparks arising from the welding or cutting operation. Welding or cutting of metals by means of oxy-acetylene flame is a specified process under the Factories and Industrial Undertakings (Protection of Eyes) Regulations (Cap. 59 sub. leg.). Workers engaged in the process and other persons that may be affected shall be provided with, as appropriate:

(a) approved eye protectors such as goggles, visors, spectacles, face

screens;

- (b) approved shield such as hand shield; or
- (c) approved fixed shield such as screen.

6.4.3 Fall protection (Safety harnesses attached to independent lifeline and fall arresting device)

- (a) Full body harness (commonly known as parachute type) :
 - The most suitable way to use a safety belt is to attach its snap-hook to a level higher than the user's waist.
 - Before using a safety belt, the following should be checked: any defects on the safety belt, any suitable anchorage, independent lifeline and fall arresting device, and whether the standard is met or not.
 - When using a safety belt for fall protection, the safety belt should be attached to a fixed anchorage point or a fall arrester of an independent lifeline.

6.4.4 Skin and body protection

Skin and body protection includes protection to the face, hands, feet, body and personal clothing. The major objective is to protect workers against burns by the flame of the blowpipe, hot slag or workpiece. Appropriate gears should be made of fire retardant materials and should be selected according to the nature, volume and location of the welding or cutting work. These include facemasks, aprons, gloves, gauntlets, safety shoes and spats.

6.4.5 Respiratory protection

Respirators provide additional protection to workers from inhaling toxic fumes, and should be used in supplement to, but not in lieu of, the use of an efficient ventilation system. When welding or cutting is performed in a confined space, workers may be required to wear respirators. In such circumstances, the worker should be physically fit before working with a

respirator.

6.5 Emergency Preparedness

6.5.1 Emergency preparedness is vital, as quick and correct response is necessary in case of emergencies to reduce injuries, ill health and other damages. In gas welding and flame cutting, common emergency situations include gas leakage, fire and explosion.

6.5.2 The proprietor of an industrial undertaking, with assistance from the staff, should:

- (a) identify the effect and impact of all possible emergency situations in the industrial undertaking;
- (b) establish emergency procedures;
- (c) provide and maintain emergency equipment and other resources; and
- (d) ensure that the staff familiarize themselves with the arrangements in case of emergencies, such as providing instruction and training to the staff, organizing drills.

6.5.3 Emergency response procedures should be established for the staff to follow in the event of a situation presenting serious and imminent danger. The procedures should include guidance for the staff explaining when and how they should stop work and move to a safe location, or even fully evacuate the workplace.

6.5.4 Appropriate emergency equipment should be provided for handling emergency situations. Such equipment include:

- (a) fire alarm;
- (b) fire-fighting equipment, such as fire hose, fire extinguishers, buckets of dry sand; and
- (c) first aid facilities, such as first aid kit.

All emergency equipment should be properly maintained. The equipment should be regularly checked for proper performance. Expired items

should be disposed of or replaced. Location of emergency equipment in the industrial undertaking should be made known to the staff.

6.5.5 Gas leakage

If gas leakage is found in the gas supply line,

- (a) isolate the gas supplies by closing the valves of the gas cylinders or the gas supply systems;
- (b) inform all persons in the workplace;
- (c) isolate all ignition sources, such as distinguishing flames; and
- (d) evacuate the workplace and call the Fire Services Department.

6.5.6 Sustained backfire

If there is a sustained backfire in the blowpipe,

- (a) first close the oxygen valve of the blowpipe, followed by the fuel valve;
- (b) complete the shutting down procedure;
- (c) investigate the cause and rectify the fault; and
- (d) re-light the blowpipe only after it is completely cooled down.

6.5.7 Flashback or fire in the gas hose

If there is a flashback into the gas hose and equipment, or a hose fire or explosion, or a fire at the pressure regulator connections,

- (a) isolate the fuel gas and oxygen supplies by closing the cylinder valves only when this can be done safely;
- (b) may attempt to control the fire by fire-fighting equipment only when there is no undue risk of personal injury; and
- (c) activate the fire alarm and call the Fire Services Department.

All staff should be evacuated if the fire is beyond control and inform the firemen of the situation when they arrive

6.5.8 Fire involving acetylene cylinder

Any fire involving acetylene cylinder always poses a risk of cylinder explosion, and should be dealt with by the Fire Services Department. However, under safe circumstances, the following initial measures may be suitably adopted:

- (a) cool the cylinder by spraying with water only if it is safe to do so;
- (b) close the cylinder valve to control the fire only if it is safe to do so;
and
- (c) evacuate the building by activating the fire alarm or by any other means.

Never attempt to remove an acetylene cylinder that has been involved in a fire, or move one which has been affected by heat from a nearby fire even if it appears to have been cooled down. Moving the cylinder may lead to explosion!

7. General Safe Practices of Gas Welding

[Reference teaching time for Section 7: 60 mins]

7.1 Permit-to-work system

7.1.1 A permit-to-work system in respect of some high risk work and working environments (such as confined spaces, hot work and work on electrical equipment) should be implemented. The system uses a certificate (“permit-to-work certificate”) to set out the work to be done and items to be checked before starting the work and the necessary precautions to be taken to ensure safety and health at work.

7.1.2 To issue a certificate (“permit-to-work certificate”) stating that all necessary precautions have been taken and specifying the period during which worker may remain safely in the workplace before a worker enters a workplace.

7.2 Preparation before commencement of welding or cutting

[Demonstrate by means of video or real object of the pre-use gas welding equipment check, including the contents of section 7.2.1(e)]

7.2.1 The risks associated with a gas welding or flame cutting operation should be assessed and appropriate safety measures established and implemented before commencing the operation. Preparation before the operation should appropriately include:

- (a) assessing the risks associated with the operation, and establishing appropriate safety measures, safe working procedures and emergency procedures, paying special attention to specific work conditions such as handling of large workpieces, working at height, working in confined spaces;
- (b) ensuring that appropriate equipment and safety devices are used, necessary control measures are implemented (such as turning on the ventilation system) and personal protective equipment is ready in hand;

- (c) providing appropriate information, instructions and training to the workers;
- (d) ensuring cleanliness of the work area and that measures have been taken to prevent fire; and
- (e) conducting pre-use equipment check including :
 - ensuring that each gas cylinder is fitted with regulator of the correct type and is correctly connected to the blowpipe;
 - checking for defective or damaged pressure gauges; replacing or repairing the gauges as appropriate;
 - ensuring that there is no gas leakage in the gas supply lines, such as by pressure test, or by checking hose connections for leakage using soapy water;
 - checking for defective or damaged gas hoses such as cuts, cracks, abrasion, animal bites or hardening of the gas hose material due to aging, and replacing or repairing the hose as appropriate; and
 - ensuring that the routing of the gas hoses will not cause severe bending of the hose or will not be run over by other heavy equipment so as to prevent gas flow being obscured or hose being damaged.

7.3 During and after welding or cutting

[Demonstrate by means of video or real object of the use of gas welding equipment and safety devices, including the contents of section 7.3.4]

7.3.1 During the gas welding or flame cutting operation, safe working procedures should be strictly followed, and appropriate personal protective equipment should be used.

7.3.2 Care should be taken in lighting up and shutting down the blowpipe to prevent flashback and backfire. Lit blowpipes should be handled carefully and should not be hung on a gas cylinder shroud or left unattended even for a short period of time.

7.3.3 After the gas welding or flame cutting operation, the blowpipe should be shut down and the valves of the gas supplies should be turned off. It is necessary to ensure that slag, sparks and workpiece are completely cooled down before leaving the work area.

7.3.4 Procedure for lighting up and shutting down the blowpipe

(a) Lighting up procedure :

- Ensure that gas cylinder valves (or the outlet valves of the gas supplies), the adjustable outlet valves of the pressure regulators and the blowpipe valves are closed.
- Slowly open the gas cylinder valves (or the outlet valves of the gas supplies) using the correct tools, and adjust the pressure regulators to the correct outlet pressure.
- Open the oxygen valve at the blowpipe and allow the flow of oxygen to purge air out of the oxygen gas supply line and equipment.
- Close the oxygen valve of the blowpipe.
- Open the fuel gas valve at the blowpipe and allow the flow of fuel gas to purge air or oxygen out of the fuel gas supply line and equipment.
- Immediately light the fuel gas, preferably with a spark lighter.
- Open the oxygen valve at the blowpipe, and adjust the oxygen and fuel valves to provide the required flame setting.

(b) Shutting down procedure :

- Close the fuel gas valve at the blowpipe.
- Immediately close the oxygen valve at the blowpipe.
- Close the cylinder valves or gas supply outlet valves for both oxygen and fuel gas.
- Open both valves at the blowpipe to vent the pressure in the equipment.
- Close the outlets of the adjustable pressure regulators for both oxygen and fuel gas.
- Close both valves at the blowpipe.

7.4 Fire prevention and protection

7.4.1 Fire and explosion may arise from leakage in the gas supply line. Gas leakage causes accumulation of fuel gas or oxygen in the atmosphere. Precautionary measures should include:

- (a) appropriate ventilation to prevent gas accumulation in the workplace;
- (b) appropriate gas supply line; and
- (c) regular and pre-use equipment check for gas leakage.

7.4.2 During the welding or cutting process, fire may arise from ignition of flammable or combustible materials not only by direct contact with the flame, but also by contact with hot slag or workpiece that may take a considerable time to cool down. Good housekeeping in the workplace is very important in preventing fire. The following precautions prior to the commencement of the welding or cutting operation are necessary to prevent fires:

- (a) Keep the working area clean and tidy. Move all flammable or combustible materials to a safe place away from the working area. Use suitable means to protect combustible materials that cannot be moved from close contact with flame, heat, hot slag or sparks such as covering with fire resistant materials.
- (b) Ensure that adjacent areas or compartments, which may be affected by the heat generated by the operation, are free from flammable or combustible materials and fire hazards. Remove or protect the flammable or combustible materials as appropriate.
- (c) Use suitable means to prevent slag or sparks from reaching combustible materials along or down ducts, channels and through holes in walls and floors, such as covering the openings by fire resistant materials.
- (d) For welding or cutting operations in open area, implement measures to prevent slag or sparks from being carried away by wind and igniting combustible materials in the vicinity.

- (e) Prevent the equipment used in gas welding or flame cutting from being contaminated with oil or grease.
- (f) Ensure that the workpiece is free from any flammable or combustible material, such as oil, grease, paint, dirt or other residue.

After the work, it is necessary to ensure that the blowpipe has been properly shut down, and sparks and slag from the work are extinguished and the workpiece cooled down before leaving the work area.

7.4.3 Suitable fire-fighting equipment such as fire extinguishers, buckets of sand should be provided nearby the work area. When there is an enhanced risk of fire from combustible materials that cannot be moved, it may be necessary to appoint “fire watchers” to detect and extinguish incipient fires and sound the alarm if necessary. They are needed during the operation and for a sufficient period afterwards. It may be necessary to use buckets of water to wet and cool the area surrounding the workplace.

7.5 Safe storage and handling of gas cylinders

7.5.1 Acetylene is supplied as a gas dissolved under pressure in a solvent, usually acetone, and is contained in a porous mass inside the gas cylinder. Propane is supplied as a liquefied gas in cylinders. Hydrogen, oxygen and air are stored under high pressure in gas cylinders. Acetylene, propane and hydrogen are flammable gases. In case of oxygen, combustible materials ignite more easily and burn faster generating higher temperatures in an oxygen-rich atmosphere. Moreover, acetylene is potentially unstable and may decompose violently. Mechanical shock to acetylene gas cylinder due to mishandling or overheating under high pressure may cause decomposition giving rise to high temperatures and possible detonation even in the absence of oxygen or air. Gas cylinders should be handled carefully.

7.5.2 Safe practices in storing and handling of gas cylinders include the following:

- (a) Ensure that gas cylinders upon receipt are appropriately coloured and/or labelled, and have no sign of gas leakage.
- (b) Store gas cylinders in a cool and well-ventilated place, away from direct sunlight, or any heat or ignition source. Keep gas cylinders in use away from the welding or cutting work. All cylinders not in use must be removed from the working area and stored in appropriate storage.
- (c) Always keep gas cylinders in an upright position and securely anchored to strong supports, irrespective of whether they are in storage, during transportation or in use. This is particularly important for acetylene cylinders to prevent the solvent in the cylinder from getting into the gas supply line.
- (d) Keep the quantity of gas cylinders in storage to a practical minimum and in compliance with the requirements under the Dangerous Goods Ordinance (Chapter 295).
- (e) Handle gas cylinders with care. Do not throw or bump the cylinders heavily. Do not roll the cylinders or use them as support for loads even when they are empty. Inform the supplier immediately if the gas cylinder is found to be physically damaged.
- (f) Move gas cylinders in wheeled trolleys designed for the purpose and ensure that they are securely fastened to the trolley during movement to prevent damaging the cylinder valves and to minimise the risk of injury.

7.5.3 Whenever possible, appropriate mechanical equipment, such as cranes, cradles, platforms or slings should be used for handling gas cylinders. Factors to be considered include the following:

- (a) The use of magnets, chains or ropes may be dangerous unless the gas cylinders are properly secured.
- (b) Gas cylinders may be moved by fork-lift truck but the cylinders should be fixed securely in a frame or other carrying structure suitable for the purpose. The method of freely balancing cylinders on the forks of the truck causes the risks of dropping them and damaging

the valves, and should not be adopted.

- (c) Gas cylinders should not be lifted by the valve or valve shroud.

7.6 Welding or cutting in a confined space

7.6.1 The requirements under the Factories and Industrial Undertakings (Confined Spaces) Regulation (Cap. 59 sub. leg.) shall be complied with. Special attention should be paid to the following factors in assessing the risks associated with gas welding or flame cutting in a confined space:

- (a) limited means of access and egress;
- (b) greater risk of asphyxiation;
- (c) greater likelihood of accumulation of gases from leaks;
- (d) hazards from welding fumes more significant; and
- (e) consequences of a fire or explosion likely to be more serious.

7.6.2 Special safe practices for gas welding or flame cutting operations in a confined space should include the following:

- (a) Adopt a permit-to-work system to ensure that appropriate risk assessment is made and necessary safety measures are implemented.
- (b) Provide a system for fresh air ventilation and fume extraction. Depending on the result of risk assessment, it may be necessary to provide workers working in a confined space with supplied-air type respirator.
- (c) Do not take gas cylinders into a confined space as far as reasonably practicable. If this cannot be avoided, keep the number and size of the cylinders to be taken into the confined space to a practical minimum. The cylinders should be closely monitored during use to prevent gas leakage, and removed from the confined space when work stops.

7.7 Welding or cutting in maintenance and dismantling of plant

7.7.1 Gas welding or flame cutting on containers or piping containing

combustible fluids poses great risk of fire. Under the heat of the flame, the combustible fluid may become volatile or may eject out as fine aerosol if the container or piping is pressurized, forming flammable mixture with air. Safe practice in welding or cutting during maintenance and dismantling of plant and equipment include the following:

- (a) Obtain full information about the plant and equipment to see whether combustible fluid is involved.
- (b) Drain off combustible fluids, including flammable ones.
- (c) Remove combustible residue from the containers or piping by washing with suitable solvents and purging with inert gas, or by using hydraulic or hot water/steam wash.

7.7.2 It is also important to ensure that before commencing the gas welding or flame cutting operation, used containers or piping are free from any residue that may emit flammable or toxic vapours upon heating. Preparation before the operation includes removing the residue by washing with suitable solvents and purging with inert gas, or by using hydraulic or hot water/steam wash. Gas monitoring should be conducted whenever necessary.

7.7.3 It should be noted that solvent wash or steam wash may give rise to other hazards associated with toxic or hot vapours. Additional safety measures should be taken as appropriate.

7.8 Checking and Maintenance of Plant and Equipment

[Demonstrate by means of video or real object of the assembly and general examination of gas welding equipment, including the contents of section 7.8.3]

7.8.1 All plant and equipment engaged in gas welding or flame cutting operations, including ventilation system, gas supply system, safety devices and personal protective equipment should be regularly checked for performance and maintained in good working condition. The proprietor should assign persons with appropriate training and experience

to undertake the checking and maintenance work. Performance check includes general examination of plant and equipment as well as pre-use equipment check.

7.8.2 All defective or damaged plant or equipment should be taken out of service immediately and replaced by appropriate ones, and should be repaired or disposed of as appropriate. Plant or equipment under maintenance or found defective should be properly labelled, marked or otherwise highlighted to warn staff not to use it. Plant or equipment which has been repaired or maintained should be checked to ensure proper performance before it is used.

7.8.3 General examination of plant and equipment

(a) All plant and equipment should be regularly examined for defects and malfunctions. The frequency of examination depends on the frequency of use of the plant or equipment and the conditions in which it is used, such as the aggressive nature of the working environment. Records of the examination should be maintained as far as reasonably practicable for the purpose of providing information to facilitate maintenance work.

(b) The ventilation system of the workplace should be regularly checked to ensure its proper performance. Regular examination of equipment should include inspection for the following defects:

- physical damage, corrosion and gas leakage of the piping, gas hoses and connections;
- internal gas leakage in pressure regulators;
- incorrect operation of pressure gauges;
- build-up of deposits of combustion products in flashback arresters, resulting in low gas flow rates;
- incorrect operation of non-return valves, resulting in reverse flow not shutting off; and
- defective blowpipe such as internal gas leakage, blockage at the

nozzle.

- 7.8.4 Notwithstanding that equipment are regularly checked for performance, it is necessary to check that equipment and safety devices are correctly installed and in good working condition each time before starting a welding or cutting operation. Please refer to section 7.2.1(e) for pre-use equipment check.

8. Explanation, Display, Demonstration and Practice

[Reference teaching time for Section 8: 150 mins]

[Demonstrate and practice by means of a full set of gas welding equipment and a full set of PPE]

8.1 Practice on pre-use gas welding equipment check

- Trainer should demonstrate the practice procedure.
- Every trainee should use a set of gas welding equipment to conduct the practice of pre-use equipment check.
- Practice procedure :
 - (a) ensuring that each gas cylinder is fitted with regulator of the correct type and is correctly connected to the blowpipe;
 - (b) checking for defective or damaged pressure gauges; replacing or repairing the gauges as appropriate;
 - (c) ensuring that there is no gas leakage in the gas supply lines, such as by pressure test, or by checking hose connections for leakage using soapy water;
 - (d) checking for defective or damaged gas hoses such as cuts, cracks, abrasion, animal bites or hardening of the gas hose material due to aging, and replacing or repairing the hose as appropriate; and
 - (e) ensuring that the routing of the gas hoses will not cause severe bending of the hose or will not be run over by other heavy equipment so as to prevent gas flow being obscured or hose being damaged.

8.2 Practice on the use of gas welding equipment and safety devices

(Procedure for lighting up and shutting down the blowpipe)

- Trainer should demonstrate the practice procedure.
- Every trainee should use a set of gas welding equipment to conduct the practice of the procedure for lighting up and shutting down the blowpipe.
- Practice procedure :
 1. Lighting up procedure
 - (a) Ensure that gas cylinder valves (or the outlet valves of the

gas supplies), the adjustable outlet valves of the pressure regulators and the blowpipe valves are closed.

- (b) Slowly open the gas cylinder valves (or the outlet valves of the gas supplies) using the correct tools, and adjust the pressure regulators to the correct outlet pressure.
- (c) Open the oxygen valve at the blowpipe and allow the flow of oxygen to purge air out of the oxygen gas supply line and equipment.
- (d) Close the oxygen valve of the blowpipe.
- (e) Open the fuel gas valve at the blowpipe and allow the flow of fuel gas to purge air or oxygen out of the fuel gas supply line and equipment.
- (f) Immediately light the fuel gas, preferably with a spark lighter.
- (g) Open the oxygen valve at the blowpipe, and adjust the oxygen and fuel valves to provide the required flame setting.

2. Shutting down procedure

- (a) Close the fuel gas valve at the blowpipe.
- (b) Immediately close the oxygen valve at the blowpipe.
- (c) Close the cylinder valves or gas supply outlet valves for both oxygen and fuel gas.
- (d) Open both valves at the blowpipe to vent the pressure in the equipment.
- (e) Close the outlets of the adjustable pressure regulators for both oxygen and fuel gas.
- (f) Close both valves at the blowpipe.

- (Note : (i) Always light up and operate the flame in a well-ventilated area.
- (ii) Must adopt adequate measures to ensure the fire safety of training venue.
 - (iii) Perform the purging in 1(c) and 1(e) for a few seconds to a minute depending on the length of the supply line and the gas flow rate.)



**Occupational Safety and Health Branch
Labour Department**

Annex 5

**Course Contents for Gas Welding Safety Training Revalidation
Course**

**Course Contents for
Gas Welding Safety Training
Revalidation Course**

Factories and Industrial Undertakings
(Gas Welding and Flame Cutting) Regulation



**Occupational Safety and Health Branch
Labour Department**

**The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department**

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1. Introduction to Arrangements of the Course

[Reference teaching time for Section 1: 5 mins]

1.1 Training Venue, Training Equipment and Examination Requirements

- To introduce briefly about the training venue, training equipment and the examination requirements

1.2 Introduction to the Course Contents

- To introduce briefly about the course structure and contents

1.3 Objectives of the Course

Gas welding and flame cutting (“gas welding”) is a hazardous trade process. Gas welding operators in the trade should receive proper gas welding skills training and gas welding safety training to safeguard themselves and others during welding processes. Therefore, the Labour Department has introduced a safety training and certification scheme under the Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation, Cap 59AI, to ensure that every worker conducting gas welding in industrial undertaking has undergone appropriate safety training and held valid certificate.

The objective of the “Gas Welding Safety Training Revalidation Course” is to provide basic knowledge on occupational safety and health for workers engaged in gas welding processes. The trainees will be issued with a “Certificate for Gas Welding Safety Training Course” upon successful completion of the course.

2. Relevant Occupational Safety and Health Legislation Applicable to Gas Welding

[Reference teaching time for Section 2: 20 mins]

2.1 Occupational Safety and Health Ordinance (Chapter 509)

Purposes

- To ensure the safety and health of employees when they are at work
- To prescribe the occupational safety and health measures
- To improve the safety and health standards applicable to workplaces
- To improve the safety and health aspects of working environments of employees

Coverage

- This ordinance covers almost all workplaces - places where employees work, including offices, shopping arcades, supermarkets, hospitals, construction sites, etc.
- However, there are a few exceptions, including places where only self-employed persons work and domestic premises where the only employees are domestic servants.
- Every employer must, so far as reasonably practicable, ensure the safety and health at work of all his employees.

The Roles of the Duty Holders

Under this ordinance, everyone has a role to play in creating a safe and healthy workplace.

- **Employers** should contribute to safety and health in their workplaces by:
 - providing and maintaining plant and work systems that do not endanger safety or health;
 - making arrangement for ensuring safety and health in connection with the use, handling, storage or transport of plant or substances;
 - providing all necessary information, instruction, training and supervision for ensuring safety and health;
 - providing and maintaining safe access to and egress from the workplaces;

and

- providing and maintaining a safe and healthy work environment.
- **Employees** should also contribute to safety and health in the workplaces by:
 - taking care for the safety of himself and other persons;
 - taking care for the safety and health of persons at the workplace; and
 - using any equipment or following any system or work practices provided by their employers.

2.2 Factories and Industrial Undertakings Ordinance (Chapter 59)

- Provide for the safety and health protection to workers in the industrial sector
- Coverage
 - factories
 - construction sites
 - catering establishments
 - cargo and container handling undertakings
 - repair workshops and other industrial workplaces
- **General Duties of Proprietors**

Every proprietor of an industrial undertaking must, so far as is reasonably practicable, ensure the safety and health at work of all persons employed by him. The matters to which that duty extends include:

 - providing and maintaining plant and work systems that do not endanger safety or health;
 - making arrangements for ensuring safety and health in connection with the use, handling, storage or transport of plant or substances;
 - providing all necessary information, instruction, training and supervision for ensuring safety and health;
 - providing and maintaining all parts of the workplace and means of access to and egress from the workplace that is safe and without risk to health; and
 - providing and maintaining a working environment that is safe and without risk to health.

- **General Duties of Persons Employed**

- every person employed at an industrial undertaking must take reasonable care for the safety and health of himself and others; and
- co-operate with the proprietor of an industrial undertaking to enable any duty or requirement for securing the safety and health of persons employed at the industrial undertaking to be performed or complied with.

2.3 Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation

Purpose

- The purpose of the Regulation is to ensure gas welding and flame cutting work in industrial undertakings is carried out by persons who are trained and certified competent for carrying out such work.

Application

- The Regulation applies to any industrial undertaking.

Interpretation

- “gas welding and flame cutting” means welding or cutting work carried on in industrial undertakings with a flame produced by mixing a fuel gas and an oxidant gas in a blowpipe;
- “blowpipe” means the burner device in which separate supplies of fuel gas and oxidant gas are mixed in appropriate proportions to produce the required flame for welding or cutting work.

Duty of proprietor to ensure that gas welding and flame cutting work is performed by competent persons

A proprietor shall ensure that gas welding and flame cutting work is only performed by :

- a person who has attained the age of 18 years and holds a valid certificate; or
- a person who is undergoing training in performing gas welding and flame cutting work and the performance of such work is under the supervision of a person who has attained the age of 18 years and holds a valid certificate.

Duty of proprietor to provide training course

- A proprietor shall ensure the provision of a training course to each of his employees who is instructed (whether directly or indirectly) by him to perform gas welding and flame cutting work.
- In case the employee fails to obtain a certificate after attending the training course, the proprietor shall ensure the provision of an additional training course for the employee.

Duty of person to attend training course

- An employee is required to attend such training course as may be provided by the proprietor unless he holds a valid certificate.

Duty of person performing the work

Any person who performs gas welding and flame cutting work shall produce his valid certificate for inspection :

- Upon demand by an occupational safety officer; or
- Within such reasonable time and at such reasonable place as specified by the occupational safety officer, when he cannot produce his certificate upon demand by the officer.

2.4 Factories and Industrial Undertakings (Confined Spaces) Regulation

The proprietor or contractor shall appoint a competent person to carry out assessment of the working conditions in the confined space. Safety measures have to be taken before the work begins and when the work is being undertaken. Only certified worker is allowed to work in confined space.

2.5 Construction Sites (Safety) Regulations

These regulations control the construction, maintenance, use and operation of hoists, scaffolds and working platforms. There are also provisions for the use of personal protective equipment for protection against falling of person, falling objects and drowning in a construction site. There are miscellaneous safety requirements such as prevention of inhalation of dust and fumes, protection of eyes and the provision of first aid facilities.

Part VA of the Construction Sites (Safety) Regulations provides a greater degree of safety to persons working on construction sites, in particular in relation to preventing falls from heights. The contractors have the general duty to make and keep every place of work on a construction site safe, and in particular, to take suitable and adequate steps to prevent persons from falling from a height of 2 metres or more, such as provision, use and maintenance of working platforms, guard-rails, barriers, toe-boards and fences, coverings for openings, gangways and runs, etc.

2.6 The Factories and Industrial Undertakings (Fire Precautions in Notifiable Workplaces) Regulations

These regulations provide for the prevention of the outbreak of fire, the spread of fire and smoke in case of fire, the provision of fire fighting equipment and the maintenance of fire escapes in notifiable workplaces.

2.7 Factories and Industrial Undertakings (Protection of Eyes) Regulations

The proprietor has the duty to provide approved eye protector for every worker engaged in any of the specified processes listed in the Schedule of the regulations.

2.8 Factories and Industrial Undertakings (Dangerous Substances) Regulations

To standardize risk symbols and labelling system of dangerous substances and impose duties on proprietors and workers to take all reasonable safety measures in specified industrial undertakings where listed substances are used.

2.9 Code of Practice

The Code of Practice (hereinafter referred as the Code) is approved and issued by the Commissioner for Labour under Section 7A of the Factories and Industrial Undertakings Ordinance, Chapter 59 of the Laws of Hong Kong (hereinafter referred as the FIUO). It provides a practical guidance to proprietors of industrial

undertakings and the employees for compliance with the requirements under the provisions of the Sections 6A and 6B of FIUO concerning the general duties of proprietor and employee. It is important to note that compliance with the Code does not of itself confer immunity from legal obligations.

The Code has a special legal status. Although failure to observe any guidance contained in the Code is not in itself an offence that failure may be taken by a court in criminal proceedings as a relevant factor in determining whether or not a person has breached any of the provisions of the regulations to which the guidance relates.

Codes of practice that are often used include:

- Code of Practice : Safety and Health at Work for Gas Welding and Flame Cutting
- Code of Practice : Safety and Health at Work in Confined Spaces
- Code of Practice : Safety and Health at Work for Manual Electric Arc Welding

2.10 Dangerous Goods Ordinance

The Ordinance shall apply to all explosives, compressed gases, petroleum and other substances giving off inflammable vapours, substances giving off poisonous gas or vapour, corrosive substances, substances which become dangerous by interaction with water or air, substances liable to spontaneous combustion or of a readily combustible nature, radioactive material, etc.

3. Responsibilities of Various Duty Holders Connected with Gas Welding Process

[Reference teaching time for Section 3: 15 mins]

Securing safety and health at work in an industrial undertaking requires the full commitment and co-operation of everybody concerned, from the proprietor to the workers. It is the duty of the proprietor of an industrial undertaking to ensure, so far as is reasonably practicable, the safety and health at work of all persons employed by him at the industrial undertaking.

The proprietor often employs line management personnel to discharge his responsibilities for management or control of the industrial undertaking. In this regard, the authority and responsibility of each member of the line management should be precisely set down and made known to all persons concerned.

3.1 Responsibilities of proprietor and contractor

The proprietor, including contractor and top management, should demonstrate the commitment in managing safety and health and bear the final responsibility and accountability for the safety and health in the industrial undertaking. The responsibilities of the proprietor include:

- (a) providing a safe and healthy working environment;
- (b) providing the necessary resources for managing safety and health in the industrial undertaking;
- (c) issuing safety rules and safe working procedures, and ensuring that the rules and procedures comply with relevant legislation;
- (d) ensuring that the experience and training of the persons employed are commensurate with the assigned task;
- (e) ensuring that the responsibilities for managing safety and health are appropriately assigned, and the duties are effectively carried out by the staff concerned; and
- (f) ensuring that all accidents and dangerous occurrences are investigated and recommendations made are properly followed-up.

3.2 Responsibilities of line management personnel

The line management personnel, including managers, agents, engineers, safety personnel, foremen or supervisors, are responsible for managing safety and health in the industrial undertaking on a day-to-day basis, and should take up their supervisory role in discharging their duties. The responsibilities of the line management personnel include :

- (a) managing safety and health in the industrial undertaking;
- (b) assessing the risk in performing the gas welding or flame cutting operation, and establishing appropriate safety measures;
- (c) establishing safety rules and safe working procedures;
- (d) ensuring equipment to be regularly checked and properly maintained;
- (e) investigating accidents and dangerous occurrences, and undertaking follow-up actions;
- (f) establishing emergency response plans, and conducting drills whenever necessary; and
- (g) providing necessary information and instructions, as well as providing and arranging training to the workers and supervising them to follow safety rules and safe working procedures strictly.

3.3 Responsibilities of persons employed

The persons employed (“staff”), including workers and line management personnel, are required to take reasonable care for the safety and health of themselves and of others who may be affected by their acts or omissions at work. The responsibilities of the staff include :

- (a) understanding and acting in accordance with the safety rules, safe working procedures and emergency response procedures;
- (b) making full use of the safety equipment and personal protective equipment necessary to perform the assigned task, and reporting all equipment defects to the management immediately;
- (c) providing feedback on effectiveness of safety measures and emergency response plans; and

(d) reporting to the management all hazards or defects observed during daily operation, injury, accident or incidents at work.

4. Common Types of Hazards, Unsafe Conditions and Unsafe Acts, and Risk Assessment of Gas Welding

[Reference teaching time for Section 4: 25 mins]

4.1 Common types of hazards

4.1.1 Fire and explosion hazards

Fire and explosion hazards in gas welding and flame cutting are mainly caused by problems with the gas supply system, the high temperature of the flame used or the hot slag produced in the process. These hazards include :

- (a) fires and explosions resulted from the release of flammable fuel gases or oxygen into the atmosphere from damaged gas hose or piping, or from leaks at joints, hose connections or fittings of the gas supply system, or as a result of valves of the gas supply line or blowpipe being left open inadvertently;
- (b) fires and explosions in the gas supply system caused by:
 - flashback from the blowpipe due to fuel gas supply lines not completely purged before lighting up, or back-feeding of fuel gas into the oxygen line or vice versa,
 - decomposition or detonation of acetylene in the absence of oxygen or air due to flashback at the blowpipe or overheating of gas cylinder, or
 - high-pressure oxygen gas (without fuel gas) which promotes combustion of materials such as oil, grease, organic compounds, aluminium and its alloys, and elastomers used in valve seats and seals;
- (c) explosions from over-pressurisation of the gas supply system;
- (d) fires arising from the flammable or combustible residue in the workpiece; and
- (e) fires from the ignition of flammable or combustible materials in the vicinity by the flame of the blowpipe, hot surfaces of the workpiece or hot slag from the process.

4.1.2 Health hazards

Health hazards of gas welding and flame cutting are mainly due to the radiation and toxic fumes or gases emitted during the process. The resultant health problems include:

- (a) eye injuries, such as
 - eye discomfort and burns from the intense light and heat emitted from the operation,
 - heat cataract caused by radiation from molten metal, leading to inability to see things clearly, or
 - corneal ulcer and conjunctivitis from foreign particles e.g. slag and cutting sparks;
- (b) skin irritation and reddening due to over exposure to radiation;
- (c) illness due to inhalation of fumes or gases formed during the process, such as
 - metal fume fever from freshly formed metal oxide fumes,
 - illness from toxic fumes of metals such as lead, cadmium, beryllium,
 - bronchial and pulmonary irritation from toxic gases such as oxides of nitrogen and fluorides;
- (d) burns from the blowpipe flame, hot slag or hot surfaces of the workpiece;
- (e) heat-stroke from prolong operation with the flame, especially in confined space; and
- (f) personal injuries arising from handling gas cylinders or large workpieces.

4.1.3 Other hazards specific to the operation

- (a) loss of stability to structures;
- (b) Hazards associated with mechanical handling and conveyance of gas cylinders; and
- (c) Personal injuries due to manual handling of gas cylinders or large workpieces.

4.2 Unsafe conditions and unsafe acts

Many serious accidents have occurred in the industry due to misuse of oxygen, recharging of gas cylinders and warming up gas cylinders. These are unsafe acts.

4.2.1 Misuse of oxygen

When oxygen gas contacts combustible materials, it promotes combustion. Explosion may occur. Never use oxygen to:

- (a) provide a source of pressure or a substitute for compressed air, such as to clear blockages in pipelines, to power air-driven tools;
- (b) blow-down clothing, equipment or work areas to remove dust, etc.;
- (c) ventilate a confined space instead of air; or
- (d) sweeten the air of any work area or space.

4.2.2 Recharging of gas cylinders

Recharging gas cylinders by connecting them to other cylinders or a gas supply is extremely dangerous. Explosion may occur if:

- (a) the gas line or its connections or the gas cylinders cannot withstand the high pressure during recharging; or
- (b) the recharging involves mixing of incompatible gases, such as charging oxygen into an acetylene cylinder.

4.2.3 Warming up gas cylinders

Warming up gas cylinders by any means in order to increase gas flow or to extract the last bit of gas stored in the cylinder for use is extremely dangerous. Fire and explosion may occur due to:

- (a) the gas supply system not capable of withstanding the resulted increase in gas pressure; or
- (b) evaporation of the solvent (acetone in general) for storing acetylene in the gas cylinder by the heat, causing damage to the gas hose and blowpipe and change in composition of the fuel/oxidant mixture for

the flame.

4.2.4 Improper use of personal protective equipment

Personal protective equipment, if wrongly selected, or improperly used or maintained, may do more harm than good. The user may have a false sense of security and the risk of injury or ill health may be higher than in a situation where no personal protective equipment is used.

4.3 Risk assessment

- (a) Risk assessment should be conducted by a person with the appropriate knowledge and experience and the relevant training to enable him to assess the risks arising from the operation. The person should have appropriate understanding of the welding or cutting operation as well as good knowledge of the safe practices and safety measures required. He may not be an expert in that area but should be aware of his own limitations and should know when he needs to seek expert advice.
- (b) The basic steps in risk assessment include:
- identifying the hazards;
 - considering who may be affected and how;
 - evaluating the risks arising from the hazards, and considering whether existing safety measures are adequate or more should be done;
 - recording the findings; and
 - reviewing the assessment from time to time and revising if necessary.
- (c) Risk assessment should be specific to the required task. Factors to be considered in assessing risks associated with gas welding or flame cutting operation include:

- the fuel gas and oxidant gas required and the gas supply system;
- the working environment, such as
 - ventilation of the workplace,
 - working in specific environments, such as confined space, pressurized or oxygen-rich environment,
 - working space restricting body movement,
 - working nearby flammable or combustible materials, and
 - the possibility of slag or sparks reaching or coming into contact with combustible materials;
- particulars of the work, such as
 - duration and frequency of the welding or cutting operation,
 - operation on workpieces with possible flammable or combustible residues,
 - working at height, and
 - size, shape and weight of the workpieces.

(d) Risk assessment should be reviewed regularly and whenever there has been a significant change in the operation to which the assessment relates, such as changes in working environment or the particulars of the work.

5. Case Study and Analysis of Common Serious Accidents

[Reference teaching time for Section 5: 20 mins]

[This section must be conducted in an interactive manner through discussion with trainees]

Workplace accidents not only cause sufferings to the victims and their families, but also result in financial losses arising from stoppage of work, insurance claims, medical and rehabilitation expenses, etc. In fact, most of the workplace accidents are preventable. Very often, they share common scenarios and causes. These scenarios and causes should be properly understood in order that lessons are learnt and suitable measures implemented to prevent recurrence of such accidents.

5.1 Case analysis of serious gas welding accidents

Case 1

Flashback from oxy-acetylene blowpipe

Circumstances

When a worker was using oxy-acetylene equipment to cut an I-beam in a construction site, there was a flashback propagating from the blowpipe into the gas hoses and cylinders. As a result, the cylinders exploded and the worker was injured.



Case Analysis

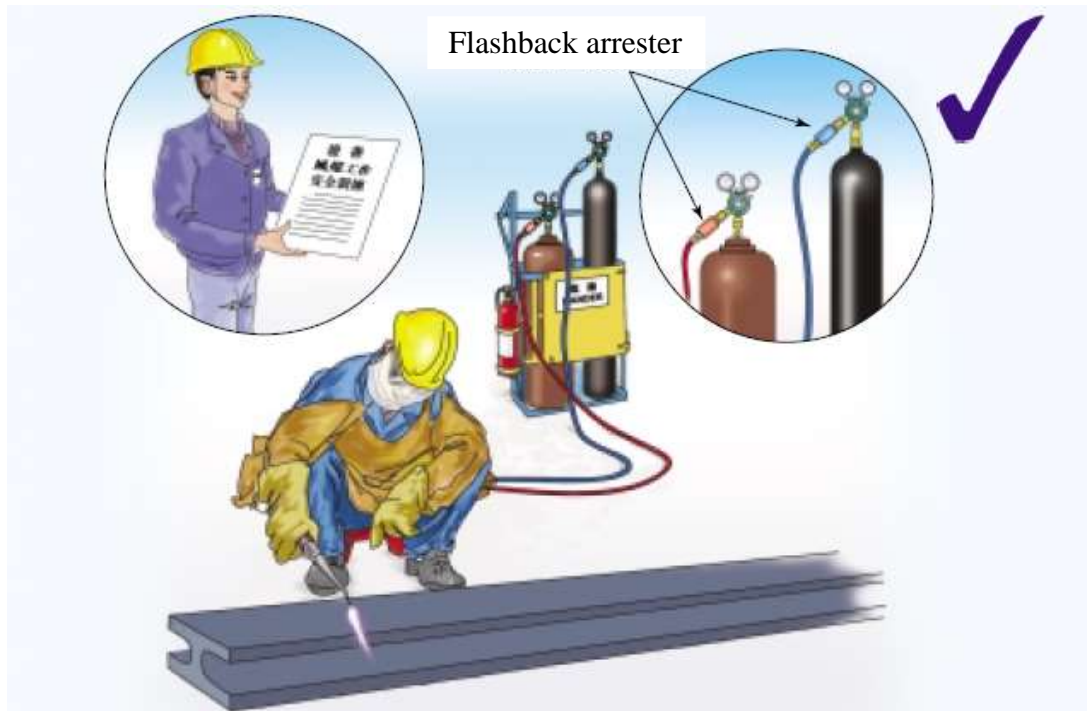
- The inappropriate pressures of acetylene and oxygen inside the blowpipe causing flashback.
- No installation of flashback arrester.

Lessons to Learn

- Oxy-acetylene equipment without flashback arrester should not be used.

Other Points to Note

- The proprietor and responsible person shall :
 - Ensure that flashback arrester and safety devices are installed in the oxy-acetylene equipment.
 - Check frequently to ensure the oxy-acetylene equipment is in good condition. In case of idling for long, thorough examination should be conducted before reuse.
 - Ensure that gas welding and flame cutting work is only performed by a person who has attained the age of 18 years and holds a valid certificate.
 - Ensure all workers to use the safety devices of oxy-acetylene equipment.
- Worker shall :
 - Check hoses and safety devices before the use of the oxy-acetylene equipment in order to ensure they are in good condition.
 - Properly adjust the pressures of acetylene and oxygen inside the blowpipe.
 - Use the oxy-acetylene equipment that is installed with flashback arrester.



Discussion

- The potential hazards associated with gas welding work.
- The mandatory requirements for the persons to conduct gas welding work.
- The safety measures for gas welding work.
- Difficulties encountered by the parties concerned (including the proprietors, the responsible persons, the contractors and the workers, etc.) and their responsibilities.

Case 2

Explosion happened during oxy-acetylene cutting of oil drum

Circumstances

A worker intended to use a batch of empty oil drums as water containers. When he was using oxy-acetylene equipment to cut an empty oil drum, the oil drum exploded suddenly. As a result, the worker was seriously injured.



Case Analysis

- The oil drum had been used to contain petroleum product before. Certain residues of the inflammable substances remained inside the drum.
- The high temperature produced by the oxy-acetylene equipment caused the explosion of the residues of the inflammable substances

Lessons to Learn

- Should not use oxy-acetylene equipment to cut oil drum without permission.

Other Points to Note

- The proprietor and responsible person shall :
 - Purge the residues of the inflammable substances inside the oil drum before permitting for the other purposes.
 - Display clear instructions for the purpose of the empty oil drum.
 - Ensure that gas welding and flame cutting work is only performed by a person who has attained the age of 18 years and holds a valid certificate.
 - Ensure all workers follow the instructions for using the empty oil drum.
- Worker shall :
 - Obtain the permission from the responsible person before alteration of the empty oil drum for other purpose.
 - Ensure the residues of the inflammable substances inside the oil drum have been completely purged before flame cutting.



Discussion

- The potential hazards associated with gas welding work.
- The mandatory requirements for the persons to conduct gas welding work.
- The safety measures for gas welding work.
- Difficulties encountered by the parties concerned (including the proprietors, the responsible persons, the contractors and the workers, etc.) and their responsibilities.

Case 3

[Training course provider should provide an accident case associated with gas welding (in particular those occurred during the five years preceding the conduct of the course) for case study and analysis in this section]

[Reference can be made to the “Safety Alert” provided by the Labour Department’s website]

Contents of case study and analysis should include:

Circumstances

- Brief description of the accident case.

Case Analysis

- Analyze the cause of the accident.

Lessons to Learn

- Precautionary measures to be taken to prevent recurrence of the accident.

Other Points to Note

- Points to note for the proprietor and responsible person.
- Points to note for the worker.

Discussion

- The potential hazards associated with gas welding work.
- The mandatory requirements for the persons to conduct gas welding work.
- The safety measures for gas welding work.
- Difficulties encountered by the parties concerned (including the proprietors, the responsible persons, the contractors and the workers, etc.) and their responsibilities.

6. Safety Measures for Gas Welding

[Reference teaching time for Section 6: 35 mins]

6.1 Overall strategy

6.1.1 Control measures, such as using appropriate ventilation and safety devices for the gas supply system, are effective means in controlling hazards at source. Protective measures using personal protective equipment provide protection to the workers concerned against the hazards during the welding or cutting process. However, the use of personal protective equipment should be a supplement to, and not in lieu of, effective control measures and the equipment should be selected appropriate to the required protection.

6.1.2 Establishment, implementation and maintenance of safety measures should also include:

- (a) proper design, construction and installation of plant and equipment, such as ventilation system, gas installation and associated piping;
- (b) establishing safe work systems and procedures, including safety rules and safe working procedures;
- (c) provision of appropriate information, instruction and training to the staff;
- (d) measures to ensure that equipment are properly used and maintained, safety rules are complied with and safe working procedures are followed by the staff, such as providing appropriate supervision to the workers; and
- (e) regularly reviewing the effectiveness of the safety measures, safety rules and safe working procedures and revising the measures, rules and procedures whenever necessary.

6.2 Ventilation

6.2.1 Ventilation is a means by which contaminated air is removed from and fresh air is supplied to the workplace, and is an effective control

measure to control fire and explosion hazards as well as the health hazards. The major functions of ventilation in the workplace include:

- (a) removing gas from leakage, if any, so as to prevent accumulation of flammable/explosive mixtures in the atmosphere;
- (b) removing heat as well as hazardous fumes and gases such as metal and metal oxide fumes, oxides of nitrogen, fluorides arising from the welding or cutting operation; and
- (c) supplying fresh air to meet the respiratory needs of persons inside the workplace.

6.2.2 For a workplace involving gas welding or flame cutting operations, the major types of ventilation are:

- (a) general dilution ventilation in which fresh air is introduced into the workplace by mechanical means and is mixed thoroughly with the contaminants in the air before removing the contaminants out of the workplace; and
- (b) local exhaust ventilation in which air contaminants are captured and removed by forced air current through hood and duct near the point of emission and discharged to the atmosphere outside the workplace.

6.2.3 A ventilation system appropriate to the workplace as well as to the welding or cutting activities should be selected and designed. Factors to be considered in selecting and designing the appropriate ventilation system include:

- (a) natural air movement if the workplace is in the open air, otherwise the enclosed nature of the workplace such as the effectiveness of air moving in and out, height and floor dimensions of the workplace;
- (b) the required air movement to prevent accumulation of flammable/explosive mixture in localized regions in the air as a result of gas leakage, taking into account of matters including the location of the gas supply line and the gas cylinders; and
- (c) the quantity and toxicity of the fumes generated from the welding or

cutting operation, and the location of the emission source.

6.2.4 General dilution ventilation

General dilution ventilation is required for a workplace in a building or structure where gas welding or flame cutting activity is involved. The dilution ventilation should effect air movement both at high level and at low level of the workplace in order to prevent accumulation of flammable/explosive mixture in localized regions in the air as a result of gas leakage. Regarding health hazards, general dilution ventilation may be adequate for infrequent and short duration welding or cutting operations which do not emit toxic fumes and which are performed in the open air or in large well-ventilated workshops. Toxic fumes include those derived from metals such as lead, cadmium, beryllium and zinc.

6.2.5 Local exhaust ventilation

Notwithstanding that general dilution ventilation is used in the workplace, local exhaust ventilation is required for welding or cutting operations that emit toxic fumes or gases, or which involve heavy in-door production work. The local exhaust hood should be placed as close as possible to the work for effective removal of the fumes before the fumes disperse to other parts of the workplace.

6.3 Gas supply system and associated safety devices

[Training course provider should describe new technological advancements and developments in work procedure or equipment usage associated with gas welding (particularly those that occurred during the five years preceding the conduct of the course)]

6.3.1 In general, each one of the two gases (the fuel gas or the oxidant gas) for gas welding or flame cutting is supplied from a single gas cylinder. Basically, gas from the cylinder is supplied through a gas hose to the blowpipe where the fuel and oxidant gases are mixed in an appropriate

proportion and combusted to form the required flame. The gas supply should be adjusted and monitored by a pressure regulator with pressure gauge connected to each gas cylinder. Other associated safety devices, incorporated in the gas supply system for reducing the risk of fire and explosion in the gas supply system, should include:

- (a) a non-return valve at each gas inlet of the blowpipe to prevent back-feeding of oxidant gas to the fuel gas line and vice versa; and
- (b) flashback arrester incorporating pressure or temperature cut-off valve to prevent propagation of flashback from the blowpipe and gas supply lines into the cylinders.

6.3.2 The typical equipment and related safety devices for oxy-acetylene flame are illustrated in Figure 1. The equipment and associated safety devices should meet national or international standards.

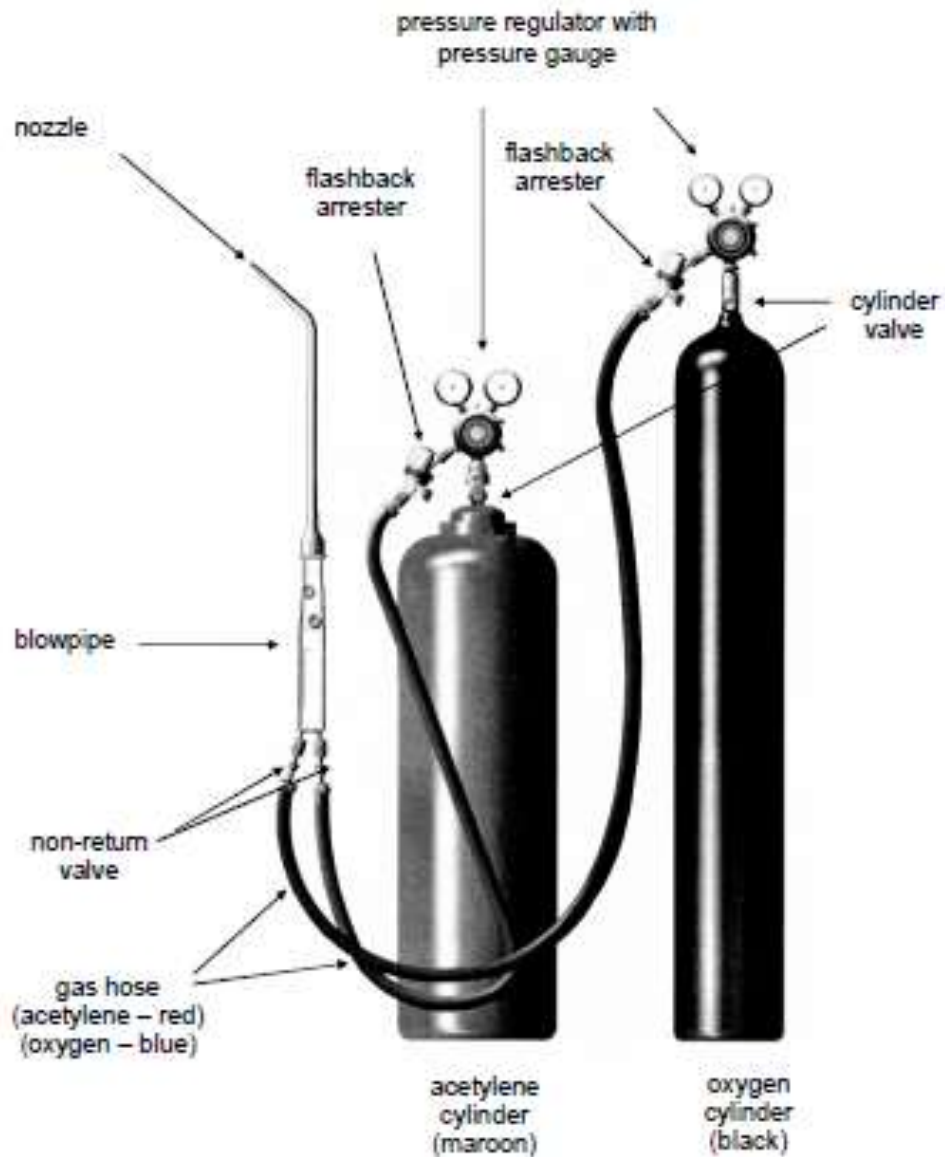


Figure 1: Typical equipment for welding and cutting using oxy-acetylene flame

6.3.3 Alternatively, a gas installation may be used in which each gas is supplied from several cylinders connected in a manifold or from a bulk supply through pressure regulator with pressure gauge, associated piping and gas hose to the blowpipe. Such gas installation and associated piping should comply with relevant legislation, such as the Dangerous Goods

Ordinance (Chapter 295), Gas Safety Ordinance (Chapter 51).

6.3.4 Gas installation and the associated piping should be designed by a professional engineer with the appropriate training and experience in gas safety. Factors to be considered in designing and installing gas installations and associated piping include:

- (a) the provision of appropriate ventilation to prevent localized accumulation of flammable mixture in the air due to minor gas leakage, if any, from the gas installation and associated piping;
- (b) the choice of appropriate materials for the gas installation and associated piping to prevent formation of explosive mixtures (note: copper is not compatible with acetylene, while aluminium and its alloy are not suitable for conveying oxygen);
- (c) the use of safety devices to prevent fire and explosion, including flashback arrester, non-return valve, pressure relief device, vent and purge device;
- (d) the provision of appropriate gas leakage detecting devices, fire alarm and fire-fighting equipment to cope with the large quantity of fuel and oxidant gases involved;
- (e) the protection of the gas installation and associated piping against corrosion and other physical damage; and
- (f) the arrangement of the gas installation and associated piping to facilitate routine inspection and maintenance.

The proprietor should ensure that the gas installation and associated piping are properly installed and tested before use.

6.3.5 Gas cylinders in use and outlet valves of the gas installation should be located in a convenient place, easily accessible to the worker so that the gas supplies can be shut off immediately in case of emergency.

6.3.6 Gas hoses should be as short and hose connections should be as few as reasonably practicable to reduce the chance of gas leakage. Staff should pay attention to the following points when placing the gas hoses:

- (a) Gas hoses should be easily inspected and should not be easily damaged by other activities in the workplace, such as being run over or struck by heavy equipment.
- (b) Gas hoses should not be placed in sleeves, or should not be permanently hidden in grooves, pipe ducts or in other structures. Hoses in sleeves or hiding the hose hinders checking for possible damage and may create voids for localized accumulation of flammable/explosive mixtures in the event of gas leakage.
- (c) Gas leakage from hoses, if any, can be easily and effectively removed by the ventilation of the workplace and will not accumulate in localized regions in the air.
- (d) Gas hoses should not be coiled around the gas cylinder or the pressure regulator. A fire in a coiled hose is very difficult to extinguish. The gas hose should be positioned behind the operator to keep them clear of slag or sparks, and arranged in a tidy manner so as not to create tripping hazard to other persons.

6.3.7 Gas cylinders should be suitably labelled and/or coloured in accordance with the relevant legislation, such as the Dangerous Goods Ordinance (Cap. 295), Factories and Industrial Undertakings (Dangerous Substances) Regulations (Cap. 59 sub. leg.). Gas hoses and piping should also be appropriately coloured for easy identification (Please refer to Figure 1).

6.3.8 Other points to note

- (a) Gas cylinders :
 - When high pressure oxygen comes into contact with oil or grease, it will burn vigorously and even explode. Therefore, any items that come into contact with the oxygen cylinder, including clothes, hands, tools, etc., should not be stained with oil or grease.
 - The thread of all devices used for oxygen cylinder (e.g. oxygen cylinder valve, pressure gauge, flashback arrester, etc.) are right

handed thread, whereas all devices used for acetylene cylinder (e.g. acetylene cylinder valve, pressure gauge, flashback arrester, etc.) are left handed thread. If the device is too tight to be opened, the correct tools should be used. Hammering or lubricant should not be applied.

- For safe storage and handling of gas cylinders, please refer to section 7.5.

6.4 Personal protective equipment

[Demonstrate by means of video or real object of the correct use of PPE including eye protection equipment, fall protection equipment, protective clothing, gloves and safety shoes]

6.4.1 In gas welding and flame cutting, the primary objective of using personal protective equipment is to provide protection to the workers against the risk of injury from hot objects and radiation as well as ill health from inhaling hazardous fumes, as a supplement to control measures. Suitable personal protective equipment should be selected appropriate to the hazards encountered, and should be properly used and maintained. Personal protective equipment, if wrongly selected, or improperly used or maintained, may do more harm than good. The user may have a false sense of security and the risk of injury or ill health may be higher than in a situation where no personal protective equipment is used. Suitable training should be provided to workers for the proper use of personal protective equipment before they start the operation.

6.4.2 Eye protection

Eye protection equipment protects the eye from injuries by radiation and foreign objects such as slag and sparks arising from the welding or cutting operation. Welding or cutting of metals by means of oxy-acetylene flame is a specified process under the Factories and Industrial Undertakings (Protection of Eyes) Regulations (Cap. 59 sub. leg.). Workers engaged in the process and other persons that may be affected shall be provided with, as appropriate:

- (a) approved eye protectors such as goggles, visors, spectacles, face

screens;

- (b) approved shield such as hand shield; or
- (c) approved fixed shield such as screen.

6.4.3 Fall protection (Safety harnesses attached to independent lifeline and fall arresting device)

- (a) Full body harness (commonly known as parachute type) :
 - The most suitable way to use a safety belt is to attach its snap-hook to a level higher than the user's waist.
 - Before using a safety belt, the following should be checked: any defects on the safety belt, any suitable anchorage, independent lifeline and fall arresting device, and whether the standard is met or not.
 - When using a safety belt for fall protection, the safety belt should be attached to a fixed anchorage point or a fall arrester of an independent lifeline.

6.4.4 Skin and body protection

Skin and body protection includes protection to the face, hands, feet, body and personal clothing. The major objective is to protect workers against burns by the flame of the blowpipe, hot slag or workpiece. Appropriate gears should be made of fire retardant materials and should be selected according to the nature, volume and location of the welding or cutting work. These include facemasks, aprons, gloves, gauntlets, safety shoes and spats.

6.4.5 Respiratory protection

Respirators provide additional protection to workers from inhaling toxic fumes, and should be used in supplement to, but not in lieu of, the use of an efficient ventilation system. When welding or cutting is performed in a confined space, workers may be required to wear respirators. In such circumstances, the worker should be physically fit before working with a

respirator.

6.5 Emergency Preparedness

6.5.1 Emergency preparedness is vital, as quick and correct response is necessary in case of emergencies to reduce injuries, ill health and other damages. In gas welding and flame cutting, common emergency situations include gas leakage, fire and explosion.

6.5.2 The proprietor of an industrial undertaking, with assistance from the staff, should:

- (a) identify the effect and impact of all possible emergency situations in the industrial undertaking;
- (b) establish emergency procedures;
- (c) provide and maintain emergency equipment and other resources; and
- (d) ensure that the staff familiarize themselves with the arrangements in case of emergencies, such as providing instruction and training to the staff, organizing drills.

6.5.3 Emergency response procedures should be established for the staff to follow in the event of a situation presenting serious and imminent danger. The procedures should include guidance for the staff explaining when and how they should stop work and move to a safe location, or even fully evacuate the workplace.

6.5.4 Appropriate emergency equipment should be provided for handling emergency situations. Such equipment include:

- (a) fire alarm;
- (b) fire-fighting equipment, such as fire hose, fire extinguishers, buckets of dry sand; and
- (c) first aid facilities, such as first aid kit.

All emergency equipment should be properly maintained. The equipment should be regularly checked for proper performance. Expired items

should be disposed of or replaced. Location of emergency equipment in the industrial undertaking should be made known to the staff.

6.5.5 Gas leakage

If gas leakage is found in the gas supply line,

- (a) isolate the gas supplies by closing the valves of the gas cylinders or the gas supply systems;
- (b) inform all persons in the workplace;
- (c) isolate all ignition sources, such as distinguishing flames; and
- (d) evacuate the workplace and call the Fire Services Department.

6.5.6 Sustained backfire

If there is a sustained backfire in the blowpipe,

- (a) first close the oxygen valve of the blowpipe, followed by the fuel valve;
- (b) complete the shutting down procedure;
- (c) investigate the cause and rectify the fault; and
- (d) re-light the blowpipe only after it is completely cooled down.

6.5.7 Flashback or fire in the gas hose

If there is a flashback into the gas hose and equipment, or a hose fire or explosion, or a fire at the pressure regulator connections,

- (a) isolate the fuel gas and oxygen supplies by closing the cylinder valves only when this can be done safely;
- (b) may attempt to control the fire by fire-fighting equipment only when there is no undue risk of personal injury; and
- (c) activate the fire alarm and call the Fire Services Department.

All staff should be evacuated if the fire is beyond control and inform the firemen of the situation when they arrive

6.5.8 Fire involving acetylene cylinder

Any fire involving acetylene cylinder always poses a risk of cylinder explosion, and should be dealt with by the Fire Services Department. However, under safe circumstances, the following initial measures may be suitably adopted:

- (a) cool the cylinder by spraying with water only if it is safe to do so;
- (b) close the cylinder valve to control the fire only if it is safe to do so;
and
- (c) evacuate the building by activating the fire alarm or by any other means.

Never attempt to remove an acetylene cylinder that has been involved in a fire, or move one which has been affected by heat from a nearby fire even if it appears to have been cooled down. Moving the cylinder may lead to explosion!

7. General Safe Practices of Gas Welding

[Reference teaching time for Section 7: 60 mins]

7.1 Permit-to-work system

7.1.1 A permit-to-work system in respect of some high risk work and working environments (such as confined spaces, hot work and work on electrical equipment) should be implemented. The system uses a certificate (“permit-to-work certificate”) to set out the work to be done and items to be checked before starting the work and the necessary precautions to be taken to ensure safety and health at work.

7.1.2 To issue a certificate (“permit-to-work certificate”) stating that all necessary precautions have been taken and specifying the period during which worker may remain safely in the workplace before a worker enters a workplace.

7.2 Preparation before commencement of welding or cutting

[Demonstrate by means of video or real object of the pre-use gas welding equipment check, including the contents of section 7.2.1(e)]

7.2.1 The risks associated with a gas welding or flame cutting operation should be assessed and appropriate safety measures established and implemented before commencing the operation. Preparation before the operation should appropriately include:

- (a) assessing the risks associated with the operation, and establishing appropriate safety measures, safe working procedures and emergency procedures, paying special attention to specific work conditions such as handling of large workpieces, working at height, working in confined spaces;
- (b) ensuring that appropriate equipment and safety devices are used, necessary control measures are implemented (such as turning on the ventilation system) and personal protective equipment is ready in hand;

- (c) providing appropriate information, instructions and training to the workers;
- (d) ensuring cleanliness of the work area and that measures have been taken to prevent fire; and
- (e) conducting pre-use equipment check including :
 - ensuring that each gas cylinder is fitted with regulator of the correct type and is correctly connected to the blowpipe;
 - checking for defective or damaged pressure gauges; replacing or repairing the gauges as appropriate;
 - ensuring that there is no gas leakage in the gas supply lines, such as by pressure test, or by checking hose connections for leakage using soapy water;
 - checking for defective or damaged gas hoses such as cuts, cracks, abrasion, animal bites or hardening of the gas hose material due to aging, and replacing or repairing the hose as appropriate; and
 - ensuring that the routing of the gas hoses will not cause severe bending of the hose or will not be run over by other heavy equipment so as to prevent gas flow being obscured or hose being damaged.

7.3 During and after welding or cutting

[Demonstrate by means of video or real object of the use of gas welding equipment and safety devices, including the contents of section 7.3.4]

7.3.1 During the gas welding or flame cutting operation, safe working procedures should be strictly followed, and appropriate personal protective equipment should be used.

7.3.2 Care should be taken in lighting up and shutting down the blowpipe to prevent flashback and backfire. Lit blowpipes should be handled carefully and should not be hung on a gas cylinder shroud or left unattended even for a short period of time.

7.3.3 After the gas welding or flame cutting operation, the blowpipe should be shut down and the valves of the gas supplies should be turned off. It is necessary to ensure that slag, sparks and workpiece are completely cooled down before leaving the work area.

7.3.4 Procedure for lighting up and shutting down the blowpipe

(a) Lighting up procedure :

- Ensure that gas cylinder valves (or the outlet valves of the gas supplies), the adjustable outlet valves of the pressure regulators and the blowpipe valves are closed.
- Slowly open the gas cylinder valves (or the outlet valves of the gas supplies) using the correct tools, and adjust the pressure regulators to the correct outlet pressure.
- Open the oxygen valve at the blowpipe and allow the flow of oxygen to purge air out of the oxygen gas supply line and equipment.
- Close the oxygen valve of the blowpipe.
- Open the fuel gas valve at the blowpipe and allow the flow of fuel gas to purge air or oxygen out of the fuel gas supply line and equipment.
- Immediately light the fuel gas, preferably with a spark lighter.
- Open the oxygen valve at the blowpipe, and adjust the oxygen and fuel valves to provide the required flame setting.

(b) Shutting down procedure :

- Close the fuel gas valve at the blowpipe.
- Immediately close the oxygen valve at the blowpipe.
- Close the cylinder valves or gas supply outlet valves for both oxygen and fuel gas.
- Open both valves at the blowpipe to vent the pressure in the equipment.
- Close the outlets of the adjustable pressure regulators for both oxygen and fuel gas.
- Close both valves at the blowpipe.

7.4 Fire prevention and protection

7.4.1 Fire and explosion may arise from leakage in the gas supply line. Gas leakage causes accumulation of fuel gas or oxygen in the atmosphere. Precautionary measures should include:

- (a) appropriate ventilation to prevent gas accumulation in the workplace;
- (b) appropriate gas supply line; and
- (c) regular and pre-use equipment check for gas leakage.

7.4.2 During the welding or cutting process, fire may arise from ignition of flammable or combustible materials not only by direct contact with the flame, but also by contact with hot slag or workpiece that may take a considerable time to cool down. Good housekeeping in the workplace is very important in preventing fire. The following precautions prior to the commencement of the welding or cutting operation are necessary to prevent fires:

- (a) Keep the working area clean and tidy. Move all flammable or combustible materials to a safe place away from the working area. Use suitable means to protect combustible materials that cannot be moved from close contact with flame, heat, hot slag or sparks such as covering with fire resistant materials.
- (b) Ensure that adjacent areas or compartments, which may be affected by the heat generated by the operation, are free from flammable or combustible materials and fire hazards. Remove or protect the flammable or combustible materials as appropriate.
- (c) Use suitable means to prevent slag or sparks from reaching combustible materials along or down ducts, channels and through holes in walls and floors, such as covering the openings by fire resistant materials.
- (d) For welding or cutting operations in open area, implement measures to prevent slag or sparks from being carried away by wind and igniting combustible materials in the vicinity.

- (e) Prevent the equipment used in gas welding or flame cutting from being contaminated with oil or grease.
- (f) Ensure that the workpiece is free from any flammable or combustible material, such as oil, grease, paint, dirt or other residue.

After the work, it is necessary to ensure that the blowpipe has been properly shut down, and sparks and slag from the work are extinguished and the workpiece cooled down before leaving the work area.

7.4.3 Suitable fire-fighting equipment such as fire extinguishers, buckets of sand should be provided nearby the work area. When there is an enhanced risk of fire from combustible materials that cannot be moved, it may be necessary to appoint “fire watchers” to detect and extinguish incipient fires and sound the alarm if necessary. They are needed during the operation and for a sufficient period afterwards. It may be necessary to use buckets of water to wet and cool the area surrounding the workplace.

7.5 Safe storage and handling of gas cylinders

7.5.1 Acetylene is supplied as a gas dissolved under pressure in a solvent, usually acetone, and is contained in a porous mass inside the gas cylinder. Propane is supplied as a liquefied gas in cylinders. Hydrogen, oxygen and air are stored under high pressure in gas cylinders. Acetylene, propane and hydrogen are flammable gases. In case of oxygen, combustible materials ignite more easily and burn faster generating higher temperatures in an oxygen-rich atmosphere. Moreover, acetylene is potentially unstable and may decompose violently. Mechanical shock to acetylene gas cylinder due to mishandling or overheating under high pressure may cause decomposition giving rise to high temperatures and possible detonation even in the absence of oxygen or air. Gas cylinders should be handled carefully.

7.5.2 Safe practices in storing and handling of gas cylinders include the following:

- (a) Ensure that gas cylinders upon receipt are appropriately coloured and/or labelled, and have no sign of gas leakage.
- (b) Store gas cylinders in a cool and well-ventilated place, away from direct sunlight, or any heat or ignition source. Keep gas cylinders in use away from the welding or cutting work. All cylinders not in use must be removed from the working area and stored in appropriate storage.
- (c) Always keep gas cylinders in an upright position and securely anchored to strong supports, irrespective of whether they are in storage, during transportation or in use. This is particularly important for acetylene cylinders to prevent the solvent in the cylinder from getting into the gas supply line.
- (d) Keep the quantity of gas cylinders in storage to a practical minimum and in compliance with the requirements under the Dangerous Goods Ordinance (Chapter 295).
- (e) Handle gas cylinders with care. Do not throw or bump the cylinders heavily. Do not roll the cylinders or use them as support for loads even when they are empty. Inform the supplier immediately if the gas cylinder is found to be physically damaged.
- (f) Move gas cylinders in wheeled trolleys designed for the purpose and ensure that they are securely fastened to the trolley during movement to prevent damaging the cylinder valves and to minimise the risk of injury.

7.5.3 Whenever possible, appropriate mechanical equipment, such as cranes, cradles, platforms or slings should be used for handling gas cylinders. Factors to be considered include the following:

- (a) The use of magnets, chains or ropes may be dangerous unless the gas cylinders are properly secured.
- (b) Gas cylinders may be moved by fork-lift truck but the cylinders should be fixed securely in a frame or other carrying structure suitable for the purpose. The method of freely balancing cylinders on the forks of the truck causes the risks of dropping them and damaging

the valves, and should not be adopted.

- (c) Gas cylinders should not be lifted by the valve or valve shroud.

7.6 Welding or cutting in a confined space

7.6.1 The requirements under the Factories and Industrial Undertakings (Confined Spaces) Regulation (Cap. 59 sub. leg.) shall be complied with. Special attention should be paid to the following factors in assessing the risks associated with gas welding or flame cutting in a confined space:

- (a) limited means of access and egress;
- (b) greater risk of asphyxiation;
- (c) greater likelihood of accumulation of gases from leaks;
- (d) hazards from welding fumes more significant; and
- (e) consequences of a fire or explosion likely to be more serious.

7.6.2 Special safe practices for gas welding or flame cutting operations in a confined space should include the following:

- (a) Adopt a permit-to-work system to ensure that appropriate risk assessment is made and necessary safety measures are implemented.
- (b) Provide a system for fresh air ventilation and fume extraction. Depending on the result of risk assessment, it may be necessary to provide workers working in a confined space with supplied-air type respirator.
- (c) Do not take gas cylinders into a confined space as far as reasonably practicable. If this cannot be avoided, keep the number and size of the cylinders to be taken into the confined space to a practical minimum. The cylinders should be closely monitored during use to prevent gas leakage, and removed from the confined space when work stops.

7.7 Welding or cutting in maintenance and dismantling of plant

7.7.1 Gas welding or flame cutting on containers or piping containing

combustible fluids poses great risk of fire. Under the heat of the flame, the combustible fluid may become volatile or may eject out as fine aerosol if the container or piping is pressurized, forming flammable mixture with air. Safe practice in welding or cutting during maintenance and dismantling of plant and equipment include the following:

- (a) Obtain full information about the plant and equipment to see whether combustible fluid is involved.
- (b) Drain off combustible fluids, including flammable ones.
- (c) Remove combustible residue from the containers or piping by washing with suitable solvents and purging with inert gas, or by using hydraulic or hot water/steam wash.

7.7.2 It is also important to ensure that before commencing the gas welding or flame cutting operation, used containers or piping are free from any residue that may emit flammable or toxic vapours upon heating. Preparation before the operation includes removing the residue by washing with suitable solvents and purging with inert gas, or by using hydraulic or hot water/steam wash. Gas monitoring should be conducted whenever necessary.

7.7.3 It should be noted that solvent wash or steam wash may give rise to other hazards associated with toxic or hot vapours. Addition safety measures should be taken as appropriate.

7.8 Checking and Maintenance of Plant and Equipment

[Demonstrate by means of video or real object of the assembly and general examination of gas welding equipment, including the contents of section 7.8.3]

7.8.1 All plant and equipment engaged in gas welding or flame cutting operations, including ventilation system, gas supply system, safety devices and personal protective equipment should be regularly checked for performance and maintained in good working condition. The proprietor should assign persons with appropriate training and experience

to undertake the checking and maintenance work. Performance check includes general examination of plant and equipment as well as pre-use equipment check.

7.8.2 All defective or damaged plant or equipment should be taken out of service immediately and replaced by appropriate ones, and should be repaired or disposed of as appropriate. Plant or equipment under maintenance or found defective should be properly labelled, marked or otherwise highlighted to warn staff not to use it. Plant or equipment which has been repaired or maintained should be checked to ensure proper performance before it is used.

7.8.3 General examination of plant and equipment

(a) All plant and equipment should be regularly examined for defects and malfunctions. The frequency of examination depends on the frequency of use of the plant or equipment and the conditions in which it is used, such as the aggressive nature of the working environment. Records of the examination should be maintained as far as reasonably practicable for the purpose of providing information to facilitate maintenance work.

(b) The ventilation system of the workplace should be regularly checked to ensure its proper performance. Regular examination of equipment should include inspection for the following defects:

- physical damage, corrosion and gas leakage of the piping, gas hoses and connections;
- internal gas leakage in pressure regulators;
- incorrect operation of pressure gauges;
- build-up of deposits of combustion products in flashback arresters, resulting in low gas flow rates;
- incorrect operation of non-return valves, resulting in reverse flow not shutting off; and
- defective blowpipe such as internal gas leakage, blockage at the

nozzle.

- 7.8.4 Notwithstanding that equipment are regularly checked for performance, it is necessary to check that equipment and safety devices are correctly installed and in good working condition each time before starting a welding or cutting operation. Please refer to section 7.2.1(e) for pre-use equipment check.



**Occupational Safety and Health Branch
Labour Department**

Answer Sheet for Gas Welding Safety Training

Answer Sheet for Gas Welding Safety Training

Name of Course Provider : _____

Class Ref. (TRC1): _____

Examination Paper Code : _____

Date of Examination : _____

Examination Start Time : _____

Name of Trainee : _____

Mark : _____

Instructions to Trainees

1. The examination paper consists of 20 multiple choice questions. Each correct answer carries 5 marks. Please answer all questions.
2. The passing mark of the examination is 75. The examination must be finished in 30 minutes.
3. Please read the questions carefully and put a tick in the answer box you choose for the question.
4. If you tick more than one answer box for one question, no marks will be awarded.
5. Please initial next to your final answer whenever amendment is made.
6. If you have any questions, please raise your hand and ask the examiner or invigilator.

Question	Answer			
	A	B	C	D
1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Answer			
	A	B	C	D
11	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Please tick only one box to denote if the trainee has used the question paper reading service and also if it is read in English.

Not required

Read in English

Read in language other than English

Signature of Trainee : _____

Date: _____

Name and Signature of Invigilator : _____

Date: _____