

Code of Practice

**SAFETY AND HEALTH AT WORK FOR
MANUAL ELECTRIC ARC WELDING**



Code of Practice

Safety and Health at Work for Manual Electric Arc Welding



**Occupational Safety and Health Branch
Labour Department**

This Code of Practice is prepared by the Occupational Safety and Health
Labour Department

First Edition July 2002

This Code of Practice is issued free of charge and can be obtained from offices of the Occupational Safety and Health Branch or downloaded from website of the Labour Department at <http://www.info.gov.hk/labour/eng/public/index.htm>. Addresses and telephone numbers of the offices can be found in the website of the Department at <http://www.info.gov.hk/labour/eng/tele/index.htm>.

This Code of Practice may be freely reproduced except for advertising, endorsement or commercial purposes. Please acknowledge the source as "Code of Practice - Safety and Health at Work for Manual Electric Arc Welding", published by the Labour Department.

Contents

1. Introduction	1
1.1 Purpose	1
1.2 Scope and application	2
1.3 Interpretation	2
2. Responsibilities	4
2.1 Overview	4
2.2 Responsibilities of proprietor	4
2.3 Responsibilities of persons employed	6
3. Hazards and Risk Assessment	7
3.1 The hazards	7
3.2 Risk assessment	10
4. Precautionary Safety and Health Measures	13
4.1 Overall strategy	13
4.2 Ventilation	14
4.3 Welding equipment and power supply	16
4.4 Safe working environment	20
4.5 Personal protective equipment	21
5. General Safety Practices	24
5.1 Overview	24
5.2 Before commencement of welding operation	25
5.3 During and after welding operation	26
5.4 Prevention of fire and explosion	26
5.5 Prevention of electric shock	28
5.6 Welding in a confined space	33
5.7 Welding during maintenance or dismantling of plant and equipment	35

6. Checking and Maintenance of Equipment	37
6.1 Overview	37
6.2 General examination of equipment	38
6.3 Pre-use equipment check	39
6.4 After-use equipment check	40
7. Emergency Preparedness	41
7.1 Overview	41
7.2 Emergency response procedures and equipment	42
7.3 Response to some possible emergency situations	43
8. Information, Instruction and Training	44
8.1 Overview	44
8.2 General safety and health training	46
8.3 Task-specific training	47
Appendix I Typical Setup of Manual Electric Arc	48
Welding Operation	
Appendix II Unsafe Acts and Unsafe Conditions	51
References	54
Useful Information	56

1. Introduction

1.1 Purpose

- 1.1.1 This Code of Practice (the "COP") recommends safe practices in manual electric arc welding operations. It also describes the steps and measures to be taken in protecting workers from the hazards arising from the work, and in reducing injuries and damage caused by fire and electric shock. The COP is intended to be read by proprietors, contractors, management personnel, safety personnel and workers of industrial undertakings where manual electric arc welding operation is carried out.
- 1.1.2 This COP is issued by the Commissioner for Labour under Section 7A(1) of the Factories and Industrial Undertakings Ordinance (Chapter 59) ("the Ordinance"). It provides practical guidance to proprietors of industrial undertakings and to persons employed therein who are required to comply with the requirements set out in Section 6A and 6B of the Ordinance for the protection of the safety and health of persons at work. It is important to note that compliance with the COP does not itself confer immunity from legal obligations in Hong Kong. The statutory provisions referred to or cited in the COP are those in force as at 1ST July 2002.
- 1.1.3 This COP has a special legal status. Although failure to observe any guidance given in the COP is not in itself an offence, such failure may be taken into account by a court in criminal proceedings in determining whether or not a person has breached the relevant safety and health provision under the Ordinance.

1.2 Scope and application

- 1.2.1 This COP covers manual electric arc welding operations which include the common manual metal arc welding (also commonly known as MMA welding) (*Note 1*), gas shielded metal arc welding (also commonly known as MIG welding) (*Note 2*) and gas shielded tungsten arc welding (also commonly known as TIG welding) (*Note 3*). It identifies the risks that may arise when these types of equipment are used, and advises on safety precautions and control measures which will minimize these risks.
- 1.2.2 This COP will not pertain to the design or manufacturing of welding equipment, nor to special or unusual welding operations such as underwater welding.

1.3 Interpretation

- 1.3.1 The terms used in this COP shall have the same meaning as those in the Factories and Industrial Undertakings Ordinance and its subsidiary legislation.
- 1.3.2 For the purpose of this COP,
- "**electric arc welding**" is a process that unites pieces of metal at joint faces melted by the heat from an electric arc burning between the electrode and the workpiece.
- "**manual electric arc welding operation**" is an electric arc welding operation in which either electrode material or welding rod material is manually fed in the arc. Common manual electric arc welding operations include MMA welding, MIG welding and TIG welding, etc.
- "**welding cables**" means the welding lead and welding return.
- "**welding equipment**" means the equipment used in manual electric arc

welding operation, including, but not limited to, welding transformer, welding cables, electrode holder.

"**welding lead**" is an electric cable between an output terminal of the welding transformer and the electrode holder.

"**welding return**" is an electric cable between an output terminal of the welding transformer and the workpiece.

- Note:-*
- (1) *MMA welding is also known as STICK, ELECTRIC ARC, or shield metal arc welding(SMAW).*
 - (2) *MIG(metal inert gas) welding is also known as gas metal arc welding (GMAW), or metal arc gas-shielded welding (MAGS welding).*
 - (3) *TIG(tungsten inert gas) welding is also known as gas tungsten arc welding(GTAW), or tungsten arc gas-shielded welding(TAGS welding).*

2. Responsibilities

2.1 Overview

2.1.1 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.

2.2 Responsibilities of proprietor

2.2.1 It is the duty of every 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 in the industrial undertaking. The proprietor, including contractor and top management, of an industrial undertaking 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.

2.2.2 The responsibilities of the proprietor include:

- (a) providing a safe and healthy working environment;
- (b) managing safety and health in the industrial undertaking, and providing the necessary resources;
- (c) ensuring that the responsibilities for managing safety and health are appropriately assigned, and the duties are effectively carried out by the staff concerned;
- (d) assessing the risk in performing the manual electric arc welding operations, and establishing appropriate safety measures for the work;
- (e) providing suitable and safe plant and equipment for the work, and ensuring the plant and equipment is regularly checked and properly maintained;

- (f) establishing, issuing and ensuring the practice of safety rules and safe working procedures;
- (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;
- (h) ensuring that the experience and training of the persons employed are commensurate with the requirements of the assigned task;
- (i) establishing emergency response plans, and conducting drills whenever necessary; and
- (j) ensuring that all accidents and dangerous occurrences are investigated and recommendations for their prevention are properly followed up.

2.2.3 The proprietor often employs management personnel, including managers, engineers, safety personnel, foremen or supervisors to act on his behalf for managing safety and health in the industrial undertaking on a day-to-day basis. The management personnel should take up their supervisory role in discharging their duties too. In this regard, the authority and responsibility of each member of the management should be precisely set out and made known to all persons concerned.

2.3 Responsibilities of persons employed

- 2.3.1 The persons employed 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 persons employed are required to co-operate with the proprietor or management personnel so far as is necessary to enable them to perform or comply with the legal duties or requirements imposed on them.
- 2.3.2 The responsibilities of these persons include:
- (a) understanding of 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, accidents or incidents at work, or in connection with injuries.

3. Hazards and Risk Assessment

3.1 The hazards

3.1.1 The hazards in manual electric arc welding operation can be broadly grouped into the following major categories:

- (a) fire and explosion hazards;
- (b) electrical hazards;
- (c) physical hazards;
- (d) respiratory hazards; and
- (e) other related hazards.

3.1.2 ***Fire and explosion hazards***

Fire and explosion hazards in manual electric arc welding operation are mainly caused by the high temperature of the electric arc used or the hot slag and sparks of molten metal produced in the process. These hazards include:

- (a) fires caused by sparks or globules of molten metal generated during the welding work igniting the combustible material in the vicinity of the work;
- (b) fires caused by the hot welding electrode that igniting the combustible material in the vicinity of the work;
- (c) fires and explosions caused by the ignition of critical mixtures of gases, volatile flammable liquids or combustible dusts with air;
- (d) fires and explosions arising from the ignition of the combustible/flammable residue in the workpiece; and
- (e) fires caused by bad contact or loose connections of cables and welding equipment, and faulty electrical connections or insulation.

3.1.3 **Electrical hazards**

In manual electric arc welding operations, the major electrical hazard is electric shock. The exposed welding electrode that becomes live when the welding equipment is in use poses obvious electric shock hazard to the welding worker. Any defective welding equipment or improper electrical wiring also poses electric shock hazard to the welding worker or other workers in the vicinity.

3.1.4 **Physical hazards**

Physical hazards of manual electric arc welding operation are mainly:

(a) Thermal

- (i) skin or eye burns from the arc, sparks and spatter;
- (ii) thermal stress from prolonged arc welding operation especially in confined spaces or in hot and humid environment.

(b) Radiations

- (i) ultraviolet(UV), visible light and infrared(IR) exposure can cause "Welder's flash", eye burn, skin burns(sun burns) and skin cancer;
- (ii) TIG welding electrodes may contain small quantities of thorium which is a radioactive material and may give rise to both a small external radiation hazard and an internal hazard from ingestion or inhalation.

3.1.5 **Respiratory hazards**

(a) Fumes and other particulates

Welding produces fumes that may contain fluorides and oxides of metals, including lead, cadmium, manganese, zinc, iron, molybdenum, cobalt, vanadium, nickel, chromium, beryllium, aluminium, copper,

magnesium, tin, titanium and tungsten. Inhalation of some metal oxides may give rise to metal fume fever and others to irritation of the respiratory tract.

- (i) Fumes generally contain particles from the electrode and the material being welded;
- (ii) Fumes from other finishes or coatings that have been applied to the metal.

(b) Gases

A number of toxic gases such as carbon monoxide, nitrogen oxides, ozone and various decomposition products of halogenated hydrocarbons are present or produced during welding.

- (i) asphyxiation due to lack of oxygen or accumulation of shielding gases such as argon, carbon dioxide, helium and nitrogen in confined work environment;
- (ii) hazardous substances such as phenol, formaldehyde, acrolein, isocyanates and hydrogen cyanide from thermal decomposition of resins used in primers and paints on welding surfaces;
- (iii) the toxic gas phosgene and other irritant gases may be formed when welding is carried out in the presence of chlorinated solvent vapours (for example, trichloroethylene, trichloroethane and perchloroethylene) escaping from a nearby degreasing tank or the solvent left behind after degreasing.

3.1.6 ***Other related hazards***

These are hazards specific to an individual manual electric arc welding operation. These include, but not limited to,

- (a) hazards related to the access to and working at high levels such as falling from height and the loss of stability of structures used to access high levels;
- (b) tripping hazards due to tangling welding cables;
- (c) hazards due to the exhaust fumes from engine-driven electric generator and the storage of fuel;
- (d) hazards from changes in weather conditions when welding in the open ground;
- (e) noise hazards from high pitch screaming or hissing from power source or associated equipment, and banging noise from grinding and chipping, etc.; and
- (f) musculoskeletal problems resulting lifting heavy objects, repetitive motions and long periods of customary postures.

3.2 Risk assessment

3.2.1 Risk assessment in manual electric arc welding operation is an evaluation process to assess the likelihood of causing harm by the hazards mentioned in section 3.1 and the severity of that harm. This provides the necessary information of 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 operation.

3.2.2 The basic steps in risk assessment include:

- (a) identifying the hazards;
- (b) considering who may be affected and how;
- (c) evaluating the risks arising from the hazards, and considering whether existing safety measures are adequate or more should be done;
- (d) recording the findings unless they are easily explicable; and
- (e) reviewing the assessment from time to time and revising if necessary.

3.2.3 Risk assessment should be specific to the required task. Factors to be considered in assessing risks associated with manual electric arc welding operation include:

- (a) the type of arc welding equipment required and the electricity source available;
- (b) the working environment, such as
 - (i) ventilation and lighting of the workplace,
 - (ii) working in the presence of flammable vapours or airborne substances which would decompose into toxic materials at high temperature and in specific environments, such as confined space, pressurized or oxygen-rich environment, damp or slightly flooded workplaces,
 - (iii) working space restricting body movement,
 - (iv) working together with other welding workers,
 - (v) working near combustible/ flammable materials, and
 - (vi) the possibility of slag or sparks reaching to or coming into contact with combustible materials;

- (c) particulars of the work, such as
 - (i) duration and frequency of the welding operation,
 - (ii) operation on workpieces and vessels with possible combustible/flammable residues,
 - (iii) working at height,
 - (iv) working posture, and
 - (v) size, shape, weight and construction of the workpieces.

3.2.4 The risk assessment should be conducted by a competent person with the appropriate knowledge and experience and the relevant training to enable him to assess the risks arising from the welding operation. The person should have appropriate understanding of the welding 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.

3.2.5 Risk assessment should be reviewed regularly. 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, risk assessment should be re-conducted.

4. Precautionary Safety and Health Measures

4.1 Overall strategy

- 4.1.1 The primary objective of adopting precautionary measures in manual electric arc welding operation is to contain or to reduce safety and health risks to levels as low as reasonably practicable. Based on the result of risk assessment, suitable and adequate safety and health measures should be established, implemented and maintained. Primary consideration should be given to controlling the hazards at source, whereas personal protective measures should be considered only as supplementary means in protecting the welding workers against the hazards.
- 4.1.2 Control measures such as the use of mechanical ventilation, suitable welding equipment and safe power supply arrangement and ensuring a safe working environment are effective means to control the hazards. The use of personal protective equipment would also protect the workers concerned against the hazards during the welding operations. However, the use of personal protective equipment should be supplementary to, and not in lieu of, effective control measures and the equipment should be appropriate to the required protection.
- 4.1.3 Establishment, implementation and maintenance of safety measures should include:
- (a) proper design, selection, installation and maintenance of plant and equipment, such as ventilation system, electricity supply system and the associated wiring and protective devices;
 - (b) establishment of safe working system, rules and procedures for manual electric arc welding operation, and work arrangement for incompatible processes such as paint spraying;
 - (c) provision of appropriate information, instruction and training to the welding workers and their supervisors on the proper use of the welding equipment and the safety rules and procedures of welding work;

- (d) measures to ensure that the welding equipment are properly used and maintained, safety rules are complied with and safe working procedures are followed by welding workers, including the provision of adequate supervision to the workers; and
- (e) regularly reviewing the changes in working environment, effectiveness of the safety measures, safety rules and safe working procedures and revising the measures, rules and procedures as appropriate whenever necessary.

4.2 Ventilation

4.2.1 Proper and effective ventilation can be an effective means to remove air contaminants or excessive heat, to control fire and explosion hazards as well as the health hazards arising from the welding operation. The major functions of ventilation in the workplace include:

- (a) removing excessive heat as well as hazardous fumes and gases such as metal and metal oxide fumes, oxides of nitrogen and fluorides arising from the welding operation;
- (b) removing shielding gas such as argon or carbon dioxide; and
- (c) supplying fresh air to meet the respiratory needs of persons inside the workplace.

4.2.2 Ventilation at the workplace should be so arranged as to remove fumes and smoke at the emission source. The workers' exposure to the airborne contaminants should be within limits as listed in the *Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace*.

4.2.3 (a) General dilution ventilation

Sufficient amount of fresh air is introduced into the workplace by mechanical means to reduce air contaminants to acceptable levels. General dilution ventilation is not as effective as local exhaust ventilation for the control of atmospheric contaminants. This method is usually applicable to processes with emission sources contain relatively less toxic materials. In work environment with natural ventilation, dilution ventilation requires skilled and experienced design to achieve success. In particular, the effects of thermal air movements require special considerations.

(b) Local exhaust ventilation

Hazardous airborne contaminants can often be captured and removed effectively at their source by means of a local exhaust system. Local exhaust system usually comprises a hood entrance close to the welding spot and a duct system with an exhaust fan providing appropriate airflow to capture the contaminant at its point of generation. Where appropriate, the extracted air should be discharged to the open air outside the workplace and an air cleaning system should be installed to prevent pollution of the general atmosphere.

4.2.4 A ventilation system appropriate to the workplace as well as to the welding 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 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 shielding gases mixture in localized regions in the air; and

- (c) the quantity and toxicity of the fumes generated from the welding operation, and the location of the emission source.

4.2.5 Mechanical ventilation design

In designing a mechanical ventilation system where such contamination occurs, particular attention should again be given to fan selection and to the placement of air extractors and fresh air supply openings. In particular, fresh air intake points should be located away from all contamination sources, and the movement of air should be arranged so that clean air streams are drawn past workers and contaminated air led away from them. Such systems require rigorous control over all sources of natural ventilation and air movement which may disturb planned air movement, for example, the operation of air conditioning systems or the opening and closing of doors and windows.

- #### 4.2.6 Routine maintenance is required to ensure the proper and effective functioning of the dilution and local exhaust ventilation systems.

4.3 Welding equipment and power supply

- #### 4.3.1 Prior to the installation of electric arc welding equipment, it is necessary to check that the capacity of the power supply source is adequate to handle the load demand of the welding operation.

- #### 4.3.2 In general, the installation should include, but not limited to, the following features:

- (a) the frame or case of the welding equipment should be properly earthed;
- (b) a suitable disconnecting switch or controller should be located near the welding equipment; and

- (c) the welding equipment should be protected by a suitable fuse or circuit breaker on a separate circuit.

4.3.3 The residual current device (RCD) installed at the power source, if there is any, would give protection against electric shock that occurs at the input side of the welding transformer only. It should be noted that if the electric shock incident occurs at the output side of the transformer, e.g. the transformer output terminals, the welding cables, the electrode holder, the welding electrode and workpiece etc., the RCD will not function automatically to cut off the power supply due to the isolation effect of the transformer.

4.3.4 Welding equipment should conform to the appropriate national or international standards. In particular, the following points should be considered:

- (a) Electrode holders should be properly insulated to avoid any undesirable exposure of live conductor (other than the welding electrode) that can be inadvertently touched by the welding worker.
- (b) Welding cables should be insulated, of robust construction and of sufficient size to carry the welding current safely. Welding cables connections should be suitably insulated to avoid the exposure of conductive parts.
- (c) In general, the welding return should be firmly connected to the workpiece as close to the point of welding operation as possible to avoid any uncontrollable and undesirable stray current flow that would cause electric shock hazard and fire hazard.

(d) The requirement as stipulated in (c) above may be deviated only in some special situations where the welding return of the welding circuit is connected to a suitable and effectively bonded common conductor. For example in large fabrication workshops, the welding return is connected to the properly and effectively bonded steel plates covering the shop floor and the workpiece is simply put on the steel plates/ shop floor during welding. In the fabrication/ maintenance of the ship structure, the welding return is connected to the metal hull of the ship. In those special situations, the following additional safety precautions are necessary:

- (i) to prevent electric shock hazard, all workers in the workplace should be protected from making direct contact with the common bonded structure. They should not sit on or lean on the bonded structure and the workpieces. Insulated mat/ stands should be provided and used as appropriate. They should also wear insulated footwear and proper clothing;
- (ii) to prevent fire hazard due to loose joint/ connection, the bonding, joints and connections of the bonded structure should be regularly maintained to ensure that the bonding is always secure, proper and effective.

4.3.5 In general, the workpiece should be connected to earth effectively. The earthing conductor should be robust or be adequately protected against mechanical damage. It should be securely connected to the workpiece by bolted lugs, screw clamps or other effective means.

- 4.3.6 If the circumstances of use or the system of work could not be relied upon to ensure that the casing of welding equipment is effectively earthed, supplementary protective devices such as suitable residual current devices should be installed in the mains power supply. Alternatively, welding transformers of double or reinforced insulation which do not require earthing should be used.
- 4.3.7 When the welding workers work close to each other such that they are liable to touch the exposed live parts of more than one welding equipment simultaneously, the welding equipment should be so connected as follows to minimize the electric shock hazard:
- (a) all d.c. welding equipment should be connected with the same polarity;
 - (b) all single-phase a.c. welding equipment in the vicinity of the workplace should be connected to the same phase of the power supply source; and
 - (c) if the a.c. welding equipment in the workplace and its vicinity are connected to different phases of the power supply, the welding worker and other persons in the vicinity should be instructed not to make contact with the exposed live parts of more than one welding equipment. Other control measures should be taken to segregate the welding equipment/ workpieces from each other, e.g. provisions of effective barriers.
- 4.3.8 For the case of MIG welding and TIG welding, compressed gases are used. The gas installation and associated piping should comply with relevant legislation, such as the Dangerous Goods Ordinance(Chapter 295), Gas Safety Ordinance (Chapter 51). Gas cylinders should be suitably labelled and/ or coloured in accordance with the relevant legislation. Gas hoses and piping should also be appropriately coloured for easy identification.

4.4 Safe working environment

4.4.1 It is the duty of a proprietor or an employer to provide a safe and healthy working environment for the employees. Failure to provide a safe working environment for the welding workers is often the fundamental cause of accidents or health problems to them. It is essential to always maintain a high standard of housekeeping at the workplace. A tidy workplace can substantially reduce the risks of accidents. The points to note in providing a safe working environment for manual electric arc welding operations include:

- (a) welding equipment, cables, and other equipment should be suitably placed to avoid imposing hazards, e.g. electric shock, tripping, etc., on the welding workers and other workers;
- (b) proper warning signs and notices should be displayed at the welding equipment and the workplace as appropriate to alert the welding workers the DOs and DON'Ts, e.g. use of personal protective equipment, fire hazard, etc;
- (c) the welding worker and other workers in the vicinity of welding workplace should be protected from the heat, radiation, sparks and welding spatters by suitable screens and shields;
- (d) fire fighting equipment, e.g. portable fire extinguishers, sand buckets, etc., should be provided in the welding workplace and its vicinity;
- (e) any combustible/ flammable materials, e.g. grease/ oil, fuel, paint, wooden materials, etc. being used or stored in the welding workplace or its vicinity should either be removed or be suitably and adequately covered by non-combustible or flame retardant materials; and
- (f) any water ponding, flooding or dripping/ splashing of water in the welding workplace and its vicinity should be avoided.

4.5 Personal protective equipment

- 4.5.1 Engineering and administrative controls should be the primary method used to control the hazards. Personal protective equipment should be considered as the last line of defence. Personal protective equipment should be used to provide the following types of protection:
- (a) electric shock protection;
 - (b) eye and face protection;
 - (c) respiratory protection;
 - (d) skin and body protection; and
 - (e) hearing protection.
- 4.5.2 To ensure the safety and health of the workers,
- (a) suitable personal protective equipment should be selected and provided to workers to cater for the different hazards encountered;
 - (b) proper and adequate training on proper use of the personal protective equipment should be provided to workers; and
 - (c) personal protective equipment should be properly cleaned, stored and maintained to ensure its effectiveness.

Personal protective equipment, if wrongly selected, improperly used or badly maintained, may do more harm than good because the user would get a false sense of protection.

4.5.3 ***Electric shock protection***

Personal protective equipment that help to reduce the risk of electric shock during manual electric arc welding operation would include protective clothing, insulated welding gloves, safety shoes or boots, and insulation mats. The equipment should always be kept dry.

4.5.4 ***Eye and face protection***

Suitable eye and face protectors should be provided to and used by the welding worker and other affected workers. Goggles, welding helmets, handheld shields, or other suitable eye protectors having the proper lens shade for the welding work being done should be worn or used by workers during the welding operations. Electric arc welding usually produces intense electromagnetic radiations, filters of high shade levels are usually required. Welding helmet is preferred to handheld screen as the latter may be improperly held.

Welding of metals by means of an electric arc is a specified process under the Factories and Industrial Undertakings (Protection of Eyes) Regulations (Cap. 59 sub. leg. S). Regulation 4 of the said Regulations empowers the Commissioner for Labour to approve specifications for eye protective equipment by notice in the Gazette. The approved specifications should be referred to in selecting eye protective equipment.

4.5.5 ***Respiratory protection***

The primary defence against respiratory hazards is to control the contamination at source and prevent it from entering the breathing zone of workers. Respiratory protection should only be used when engineering controls are not feasible to control exposure to airborne contaminants. For selecting an appropriate respirator, an exposure assessment should be conducted to determine the type and amount of hazardous exposure, with factors such as the welding task, the worker characteristics, the working environment, and the equipment characteristics and its limitations taken into account. As wearing of non-powered filtering type respiratory protective equipment would pose a physical burden, the proprietor should ensure that the wearer is fit for the purpose.

4.5.6 ***Skin and body protection***

Skin and body protection includes protection to the head, face, hands, feet, body and personal clothing. The major objective is to provide workers protection against burns by the flame, hot slag, spatters or workpiece. The protective gears should be made of flame retardant materials and should be selected according to the nature, volume and location of the welding work. These include facemasks, hats/ helmets, aprons, gloves, gauntlets, spats, safety shoes, etc.

4.5.7 ***Hearing protection***

In manual electric arc welding operations, high level of noise may come from associated work processes such as cutting, grinding and chipping. The Factories and Industrial Undertakings (Noise at Work) Regulation (Cap. 59 sub. leg. T) aims at protecting the hearing of workers who are exposed or likely to be exposed to hazardous noise levels while at work. Noise should be controlled at the source whenever feasible. If the noise hazard cannot be reduced to acceptable levels by engineering control methods, such as shielding the noise source, approved ear protectors should be provided to and used by all affected workers.

5. General Safety Practices

5.1 Overview

- 5.1.1 Safety rules and safe working procedures, covering general safety practices in the industrial undertaking and specific safety practices in specialized operations, are to provide instructions to workers in ensuring safety and health at work. Important rules and procedures in the form of notices, posters and signage should be displayed in the works area to arouse special attention. However, the display of such notices, posters and signage should not replace the provision of proper and sufficient training to the workers. Section 8 of this COP is relevant.
- 5.1.2 The safety practices outlined below serve as a guide for establishing safety rules and safe working procedures on the general safety aspects regarding manual electric arc welding operations. The rules and procedures should be tailor-made according to the range of welding activities carried out in the industrial undertaking. The management of the industrial undertaking should ensure that the workers fully understand and comply with the rules and strictly follow the procedures.
- 5.1.3 Metal cutting by using an electric arc welding set is not allowed in this COP in view of that the excessive current adopted for the cutting operation and the generation of excessive molten metal during the cutting process pose severe fire hazard. Under exceptional circumstances, only dedicated electric arc / plasma cutting equipment should be used with all necessary precautionary measures taken to avoid the risk to the safety and health of the workers and fire hazard.

5.2 Before commencement of welding operation

- 5.2.1 The risks associated with a manual electric arc welding operation should be assessed and appropriate safety measures should be established and implemented before commencing the operation. Preparation before the operation should include the following:
- (a) to assess the risks associated with the operation, to establish appropriate safety measures, safe working procedures and emergency response procedures, and to pay special attention to specific work conditions such as handling of large and/ or heavy workpieces, working at height, working in confined spaces;
 - (b) to ensure that appropriate equipment and safety devices are used, necessary control measures are implemented and suitable personal protective equipment is available and in use;
 - (c) to provide appropriate information, instructions and training to the welding workers and supervisors;
 - (d) to ensure cleanliness of the work area and that measures have been taken to prevent outbreak of fire;
 - (e) to conduct pre-use equipment check; and
 - (f) to ensure that no work that gives off flammable gases, vapours, liquids or dust would be conducted in the vicinity.

5.3 During and after welding operation

- 5.3.1 During the manual electric arc welding operation, safe working procedures should be strictly followed, and appropriate personal protective equipment should be used.
- 5.3.2 Care should be taken when switching on and off the welding equipment. Energized welding equipment should be handled carefully and should not be left unattended even for a short period of time.
- 5.3.3 After the arc welding operation, the welding equipment should be shut down completely. It is necessary to ensure that slag, sparks and workpiece are completely cooled down before leaving the work area.

5.4 Prevention of fire and explosion

- 5.4.1 No welding operation should be conducted in an environment having a flammable atmosphere or having flammable materials in the vicinity.
- 5.4.2 During the welding process, fire may arise from ignition of combustible/flammable materials by the electric arc direct, the immense heat generated from the welding process and also the hot slag or the hot workpiece that may take some 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 operation are necessary to prevent fires:

- (a) Always keep the work area clean and tidy. Remove any combustible/flammable materials from the work area. Use suitable means, such as covering with flame retardant materials, to protect combustible materials that cannot be removed from close contact with the hot slag or sparks.

- (b) Ensure that adjacent areas or compartments, which may be affected by the heat, sparks and slag generated by the welding operation, are free from combustible/ flammable materials and fire hazards. Remove or protect the combustible/ flammable materials as appropriate.
- (c) Use effective means, such as blanking off by flame retardant materials, to prevent hot slag or sparks from reaching combustible materials along or down ducts, channels, and through openings in walls and floors.
- (d) For welding operations in open area, implement effective measures to prevent hot slag or sparks from being carried away by wind and igniting combustible materials in the vicinity.
- (e) Ensure that the workpiece is free from any combustible/ flammable material, such as oil, grease and paint, and dirt or other residue that may release toxic or harmful materials during welding operation.
- (f) Ensure that the vicinity of the welding area is free from oil deposits. Cleanliness is essential because the heat generated by welding may cause residual pockets of oil remaining in the vicinity to give off vapour which may subsequently be ignited by the heat source.
- (g) If situation warrants, proper measures, such as fixing a collection trough (made of flame retardant materials) below the welding location to collect and hold the sparks, weld spatters and molten droplets, etc. should be implemented during arc welding operation.
- (h) Spent electrodes that are still hot should be properly disposed of in a proper container (made of flame retardant materials) in the welding workplace to prevent fire, getting underfoot or falling on working personnel below.

After the work, it is necessary to ensure that the welding equipment has been completely shut down, remains of the welding electrodes have cooled down and are properly disposed of, sparks and hot slag from the work have been extinguished and the workpiece has cooled down before leaving the work area.

- 5.4.3 Suitable fire-fighting equipment such as fire extinguishers, buckets of sand should be provided near the work area and be ready for use. In case there are combustible materials in the vicinity of work but cannot be removed as far as reasonably practicable, it should be necessary to appoint fire watchers. They should be present during the welding operation and for a suitable period afterwards. In particular, a fire watcher is required for the hot work processes when any electric arc welding operation is carried out in lift and escalator works.

In some cases, it may be necessary to wet and cool down the workpiece, the workplace or the surrounding area as soon as possible following the welding operation to prevent fire. However, in doing so, due care has to be taken to avoid electric shock hazard.

5.5 Prevention of electric shock

- 5.5.1 There is inherent electric shock hazard for carrying out manual electric arc welding operation.

One may get an electric shock hazard if incidentally his hands or other part of his body bridge between the welding supply (e.g. the live welding electrode) and the welding return (e.g. the workpiece) of the welding circuit/equipment.

The welding worker working close to the live welding electrode and the workpiece is vulnerable to an electric shock hazard. The welding worker may also get an electric shock when he replaces the welding electrode with a bare hand, or with a wet welding glove. He should avoid staying in a congested workplace in an awkward posture whilst carrying out welding work.

- 5.5.2 During a manual electric arc welding operation, it is necessary to take precautions to prevent electric shock and to minimize the damage or injury in case such an accident does happen. The necessary precautions include:
- (a) avoiding direct contact with the live parts of welding equipment and the workpiece;
 - (b) rendering the overall resistance/ impedance of the leakage current path as large as possible; and
 - (c) keeping the output open circuit voltage of the welding equipment, i.e. the voltage between the welding electrode and the workpiece at no load condition, the lowest possible as far as reasonably practicable.
- 5.5.3 To reduce the risk of an electric shock during arc welding operation, the following areas should be examined:
- (a) working environment;
 - (b) working practices;
 - (c) welding equipment; and
 - (d) personal protective equipment.

5.5.4 ***Working environment***

The welding equipment should be suitable for the working environment. Where it is intended to weld outdoors, the equipment in use should be suitably protected against ingress of rainwater, water spray, foreign objects and dust, preferably have an enclosure protection of splash proofing, or be suitably sheltered for protection. Also, the following safety precautions should be considered:

- (a) Do not weld in open space when it is raining, or in indoor workplace where there is water dripping.
- (b) Do not stay in water pit or seriously flooded workplace to weld.
- (c) Stay on insulation mat, dry wooden board or other non-conductive stand in a damp or slightly flooded workplace.
- (d) Avoid touching the electrically conductive parts in the vicinity of the welding area, especially when welding work is carried out in congested areas.
- (e) When welding on large steel structures, the welding worker is liable to make contact with the workpiece, i.e. the steel structure. In that respect, the welding worker should wear insulated footwear, and insulation stands, insulation mats and other suitable device should be used as appropriate to avoid making direct contact with the workpiece.

5.5.5 ***Working practices***

The following safe work practices should be followed to control electric shock hazard during manual electric arc welding operation:

- (a) During the welding operation, the welding worker should always keep the hands and the body dry.

- (b) Welding workers should avoid making direct contact with any exposed conductive parts of the electrode holder, the welding electrode clamped on the holder and the exposed conductive part of the workpiece with their bare hands or bodies.
- (c) The welding transformer should be placed right at the welding area or its close vicinity, such that in case of need or accident, the welding transformer can be switched off quickly to cut off the power source. In general, the welding transformer should not be located at another room or another floor away from the welding area.
- (d) Welding workers and supervisors should know clearly the location of the welding transformer. The welding transformer should bear clear indications on its switch and on the "ON" and "OFF" positions.
- (e) When the welding operation is to be suspended temporarily to take breaks for rest, tea or meal, the welding transformer should be switched off, with the remaining welding electrode on the electrode holder properly detached before leaving the welding area.
- (f) The electrode holder should be properly placed, preferably on a container made of insulating material, to avoid any accidental contact with the conductive live part, in particular when the welding electrode is in place.
- (g) Unless the welding transformer has been switched off, do not hold or move the welding electrode holder and the welding return cable simultaneously when moving from one working position to another.
- (h) When carrying out welding work at high level, the workers should stay on a safe working platform, or if it is not practicable to do so, be wearing suitable personal protective equipment to prevent fall. Safety measures so adopted should be able to prevent the worker from falling down even when he unfortunately gets an electric shock.

5.5.6 ***Welding equipment***

To ensure the safety of operators, the electric arc welding equipment should be well designed and constructed and properly maintained. The following are crucial:

- (a) Only proper and safe welding equipment should be selected for and used in the welding operations. It should ensure that the current rating chosen is adequate to handle the job to avoid overheating of welding equipment and other problems. Welding equipment should not be operated above the rated current rating and the corresponding rated duty cycles as specified by the manufacturer. Furthermore it should not be used for applications other than those specified by the manufacturer.
- (b) The welding transformer should be provided with a robust steel casing for mechanical protection. The steel casing should be properly and effectively earthed by connecting with a separate earth wire of suitable size to the power supply source.
- (c) The welding cables should be properly placed and protected to avoid any accidental damage to the insulation cover of the cables, such as excessive bending of the cables and laying the cables over sharp objects. The cables should also be chemical resistant, and be protected against damage by oil and grease, UV light and ageing.
- (d) Proper cable connectors should be used for extension of the cables. The maximum rating of the welding current set should match with the welding electrode in use. Applying excessive current over the rating of the electrode should be avoided.

- (e) In situations where the risk of getting an electric shock is high, e.g. welding in a confined conductive workplace, staying on the workpiece to weld, etc., apart from the control measures, it is strongly recommended to fix an automatic voltage regulator in the welding transformer to reduce the open-circuit no-load voltage of the transformer output to less than 50V a.c.
- (f) The welding equipment should be regularly inspected, maintained and tested by competent personnel, and any damaged equipment should be clearly labelled as such and taken out of service immediately until repair can be undertaken. The inspection and maintenance records of the welding equipment should be kept properly.

5.5.7 ***Personal protective equipment***

Welding workers should be provided with and use the necessary personal protective equipment to prevent electric shock. Section 4.5.3 of this COP is also relevant.

5.6 Welding in a confined space

- 5.6.1 Owing to the intrinsic hazardous nature of a confined working environment, manual electric arc welding operation should be avoided in a confined space as far as reasonably practicable.
- 5.6.2 If it is unavoidable to carry out manual electric arc welding operation in a confined space, similar to that for any other work, the requirements in Factories and Industrial Undertakings (Confined Spaces) Regulation (Cap. 59 sub. leg. AE) shall be complied with. The *Code of Practice for Safety and Health at Work in Confined Spaces* is also relevant.

5.6.3 Special attention should be paid to the following factors in assessing the risks associated with manual electric arc welding operation in a confined space:

- (a) limited means of access and egress;
- (b) higher risk of asphyxiation;
- (c) higher risk of excessive rise in temperature as intense heat evolves during welding;
- (d) increased risk of electric shock due to congested space and awkward working position, and sometimes conductive environment;
- (e) accumulation of welding fumes and other harmful emissions; and
- (f) more serious consequences of fire and explosion.

5.6.4 Special safe practices for manual electric arc welding operation in a confined space should include, but not limited to, the following:

- (a) Adopt a permit-to-work system to ensure that appropriate risk assessment is made and necessary safety measures are devised and implemented.
- (b) Provide a forced ventilation system for fresh air supply and fume extraction.
- (c) Depending on the result of risk assessment, it may be necessary to provide workers working in a confined space with supplied-air type breathing apparatus.
- (d) Where practicable, place the welding transformer and regulator outside the confined working space.

- (e) In confined conductive locations, the freedom of movement is restricted. Accidental contact with conductive elements by the worker is likely and the risk of electric shock is high. Welding equipment specially designed for that application (e.g. complying with the appropriate requirements of EN 50060) is recommended.
- (f) As far as reasonably practicable, an automatic voltage regulator should be fixed in the welding transformer to reduce the open-circuit no-load voltage of the transformer output to less than 50V a.c.

5.7 Welding during maintenance or dismantling of plant and equipment

- 5.7.1 Do not carry out welding on those containers, compartments, tanks or pipework containing combustible/ flammable fluid as it poses high risk of fire or explosion, in particular if the container/ pipework is under pressure. Under the immense heat of the electric arc, the combustible/ flammable fluid may vapourise and splash the fluid out as fine aerosol under pressure, forming flammable mixture with air.

When carrying out welding work during maintenance or dismantling of plant and equipment, special attention has to be given to the fire and explosion hazard caused by the combustible/ flammable fluid, vapour and residue remained in the containers, compartments, tanks, pipework, etc. of the plant and equipment.

5.7.2 Safe practices in welding during maintenance and dismantling of plant and equipment include, but not limited to, the following:

- (a) Obtain full information about the plant and equipment to see whether combustible/ flammable fluid is involved.
- (b) Fully drain off the combustible/ flammable fluids.
- (c) Remove combustible/ flammable residue from the containers or pipework by washing with suitable solvents and purging with inert gas, or by using hydraulic or hot water/ steam wash as appropriate.
- (d) Ventilate the container for prolonged period or force ventilate it as appropriate to remove any combustible/ flammable residue.

5.7.3 It is also important to ensure that before commencing the welding operation on used containers or piping, the 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.

5.7.4 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.

6. Checking and Maintenance of Equipment

6.1 Overview

- 6.1.1 All equipment used in manual electric arc welding operations, including power supply system, welding equipment, ventilation system, the associated safety devices, and personal protective equipment, should be regularly checked for performance and maintained in good working condition. The proprietor should assign competent persons with appropriate training and experience to undertake the checking and maintenance work. Performance check includes general examination of the equipment as well as pre-use equipment check.

- 6.1.2 All defective or damaged equipment should be taken out of service immediately and replaced by suitable ones, and should be repaired or disposed of as appropriate. Equipment or system under maintenance/repair or found defective should be properly labelled, marked or otherwise highlighted to warn workers not to use it. Equipment or system which has been repaired or maintained should be checked to ensure proper performance before it is used.

6.2 General examination of equipment

- 6.2.1 The examinations should be carried out by competent persons having the appropriate training and experience to undertake the checking and maintenance of electric arc welding equipment and the associated engineering control measures for the welding operation.
- 6.2.2 All equipment involved in manual electric arc welding operation should be regularly examined according to manufacturer's recommendations for defects and malfunctions and with records kept for the purpose of providing information to facilitate maintenance work. The frequency of examination depends on the frequency of use and the conditions in which it is used, such as the aggressive nature of the working environment.
- 6.2.3 The ventilation system of the workplace should be regularly checked to ensure its proper performance, such as the rate of air change in the workplace and quality of air supply.
- 6.2.4 Regular examination of the welding equipment includes the inspection for the following defects:
 - (a) physical damage to electrode holder, welding cables, cable terminations and connections, welding transformer, primary power supply cables and the power supply system;
 - (b) improper connection of welding equipment including the welding cables, the primary supply cables and all earthing connections; and
 - (c) faulty or defective equipment of the power supply system, switch, circuit breaker, fuse unit, power socket, RCD, etc.

6.3 Pre-use equipment check

- 6.3.1 Notwithstanding that welding equipment and power supply system are regularly checked for proper performance, it is necessary to check that the equipment and safety devices are in good conditions every time before starting a welding operation.
- 6.3.2 The pre-use equipment check should be carried out by a competent person or the welding worker involved in the welding operation or his supervisor; all should be suitably trained and possess the necessary knowledge and experience to ensure safety and health at the welding work.
- 6.3.3 The pre-use equipment check includes the following:
- (a) to ensure that the welding equipment including the welding transformer, the welding cables, the electrode holder and their connections/ terminations are in good conditions;
 - (b) to ensure that all welding equipment are properly connected up;
 - (c) to ensure that all necessary cable and earthing connections/ terminations are firmly made and properly insulated;
 - (d) to ensure that all necessary protective equipment including personal protective equipment required for the welding operation, are available and in good conditions; and
 - (e) for the case of MIG welding and TIG welding, to ensure that all gas cylinders and associated instruments including pressure gauges, regulators and gas hoses are in good working conditions.

6.4 After-use equipment check

- 6.4.1 After the welding operation, the worker should:
- (a) properly shut down the power supply to the welding equipment;
 - (b) disassemble all welding equipment connections;
 - (c) check that the welding equipment including the welding cables are in good conditions and ready for future use;
 - (d) return all welding equipment and personal protective equipment to the store;
 - (e) report to the supervisor or storekeeper should there be defects found in the welding equipment, protective equipment and the personal protective equipment; and
 - (f) ensure that the workpiece is cooled down and no hot slag, globules of molten metal or other similar hot residues remain before leaving the welding workplace.

7. Emergency Preparedness

7.1 Overview

- 7.1.1 Emergency preparedness is vital because the quick and correct response would help to prevent accident and property damage, avoid or lessen the extent of injury to workers, and to reduce health hazards to workers. In manual electric arc welding operation, common emergency situations include electric shock, fire and explosion.
- 7.1.2 The proprietor of an industrial undertaking should:
- (a) identify the effect and impact of all possible emergency situations in the industrial undertaking involved in the welding operation;
 - (b) establish emergency response procedures and review the procedures regularly in light of a significant change in some emergency situations or technological advancement of emergency equipment, and when the situation warrants;
 - (c) provide and maintain emergency equipment and other resources; and
 - (d) ensure that all workers have familiarized themselves with the arrangements in case of emergencies, such as providing instruction, information and training to the workers and organizing drills regularly.

7.2 Emergency response procedures and equipment

- 7.2.1 Emergency response procedures should be established for the workers and other staff to follow in the event of a situation presenting serious and imminent danger. The procedures should include guidance for the workers that explains when and how they should react and move to a safe location, or even fully evacuate the workplace.
- 7.2.2 Appropriate emergency equipment, such as fire-fighting equipment, first aid facilities, emergency communication equipment and alarm announcing equipment, should be provided for handling emergency situations.
- 7.2.3 All emergency equipment should be properly maintained. The equipment should be regularly checked for proper performance, with records properly kept. Expired items should be disposed of and replaced. Location of emergency equipment in the industrial undertaking should be made known to the workers and the supervisors by the use of location plans and proper indication signs.
- 7.2.4 Workers and supervisors should be trained on the proper use of the emergency equipment including hand-on training.
- 7.2.5 Drills for the emergency response procedures should be conducted periodically for the testing and practising of the emergency response procedures and the use of emergency equipment.

7.3 Response to some possible emergency situations

7.3.1 *Fire or explosion*

In case there is a fire or explosion in the workplace during the manual electric arc welding operation, immediately switch off the power supply to the welding equipment, and other power supply and fuel supply to the workplace if necessary. If the fire is small and it is safe to do so, try to extinguish the fire using suitable portable fire extinguishers or other fire fighting equipment. Otherwise, call the emergency services at once for assistance. Inform others in the workplace and evacuate if necessary.

7.3.2 *Electric shock*

In case a welding worker receives, or is suspected to have received an electric shock during the welding operation, switch off the power supply to the welding equipment immediately. Call for first-aider if there is any in the workplace and/ or summon the emergency services at once for assistance.

8. Information, Instruction and Training

8.1 Overview

- 8.1.1 The proprietor should ensure that the training and experience of the workers undertaking manual electric arc welding operation are commensurate with the assigned task. The training and experience should cover the welding technique, selection and use of equipment as well as the safety and health aspects of the operation.

- 8.1.2 The safety and health training should include general induction and more specific training, and may be met by a mixture of on-the-job and off-the-job training, and should involve demonstrations and practical exercises. It should embrace practices, constituents of a safe workplace and information on the particular working conditions. When there are significant changes in the working environment, the proprietor should review the new situation and provide sufficient information, instruction and appropriate training to workers to perform the task in the new environment in a safe and healthy manner.

- 8.1.3 Notwithstanding that the workers have been trained on the general safety and health aspects of manual electric arc welding operation, the proprietor should provide appropriate information, instruction and training to the workers on the safety and health aspects specific to the assigned task.

- 8.1.4 The information, instruction and training should appropriately cover:
- (a) safety and health rules established in the industrial undertaking;
 - (b) safe working procedures for the assigned task;
 - (c) proper selection and use of the equipment;
 - (d) proper selection, proper use and limitations of engineering controls and personal protective equipment;
 - (e) emergency response procedures and evacuation plan;
 - (f) specific safety and health consideration, such as working at height, operation in a confined space, operation on workpieces with combustible/ flammable residue, manual handling of large workpieces, etc.

8.2 General safety and health training

- 8.2.1 All persons involved in manual electric arc welding operation should be fully trained in the safety and health aspects of the work under normal operation as well as in emergencies. The general safety and health training should cover:
- (a) hazards in manual electric arc welding operation;
 - (b) relevant legislation and responsibilities of the persons concerned;
 - (c) equipment and safety devices for manual electric arc welding operation, including their uses and limitations;
 - (d) safety measures, including proper selection and use of the ventilation system and personal protective equipment, and their limitations;
 - (e) fire prevention and protection measures;
 - (f) general safety practices in manual electric arc welding operation;
 - (g) emergency response and procedures including evacuation plan;
 - (h) general examination and maintenance of equipment, and pre-use and after-use equipment checks; and
 - (i) build up good co-ordination with other workers and the awareness of taking care of other persons during their course of work.

8.3 Task-specific training

8.3.1 In addition to the general safety and health training in manual electric arc welding operations, task-specific training should be provided to the workers to enable them to:

- (a) understand and identify all potential hazards in the working environment and the necessary precautions to be taken; and
- (b) identify factors affecting their individual capabilities in the work.

Appendix I

Typical Setup of Manual Electric Arc Welding Operation

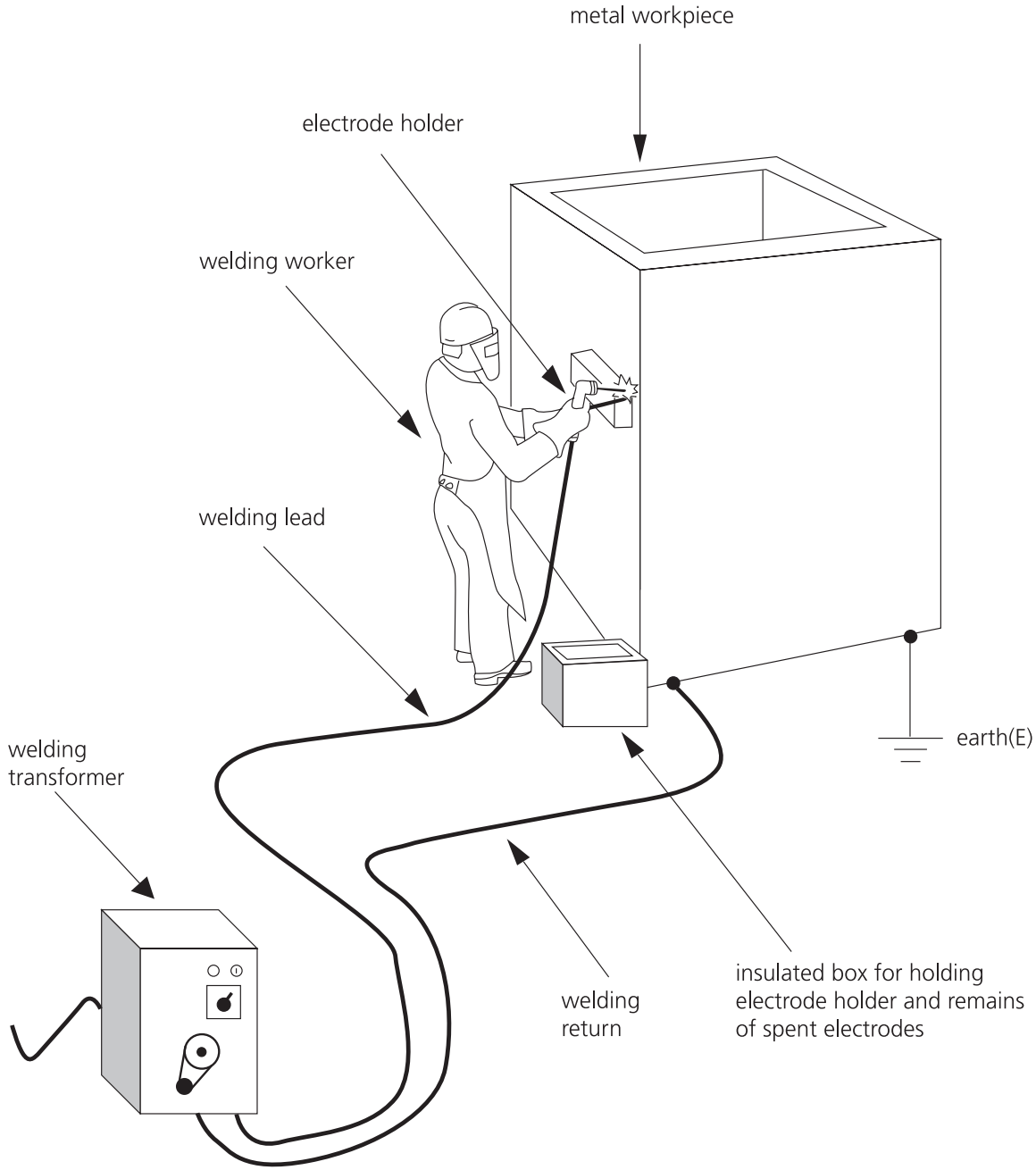


Figure 1 A general working arrangement of manual electric arc welding operation

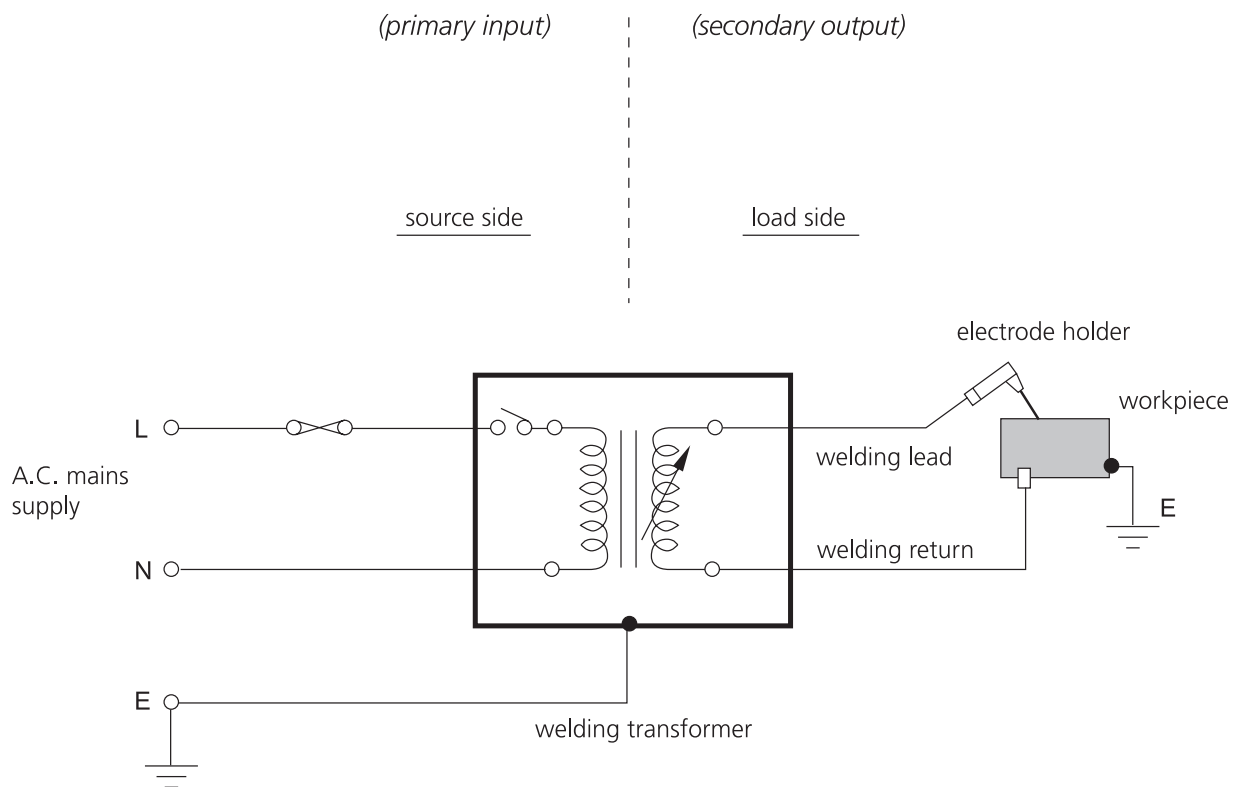
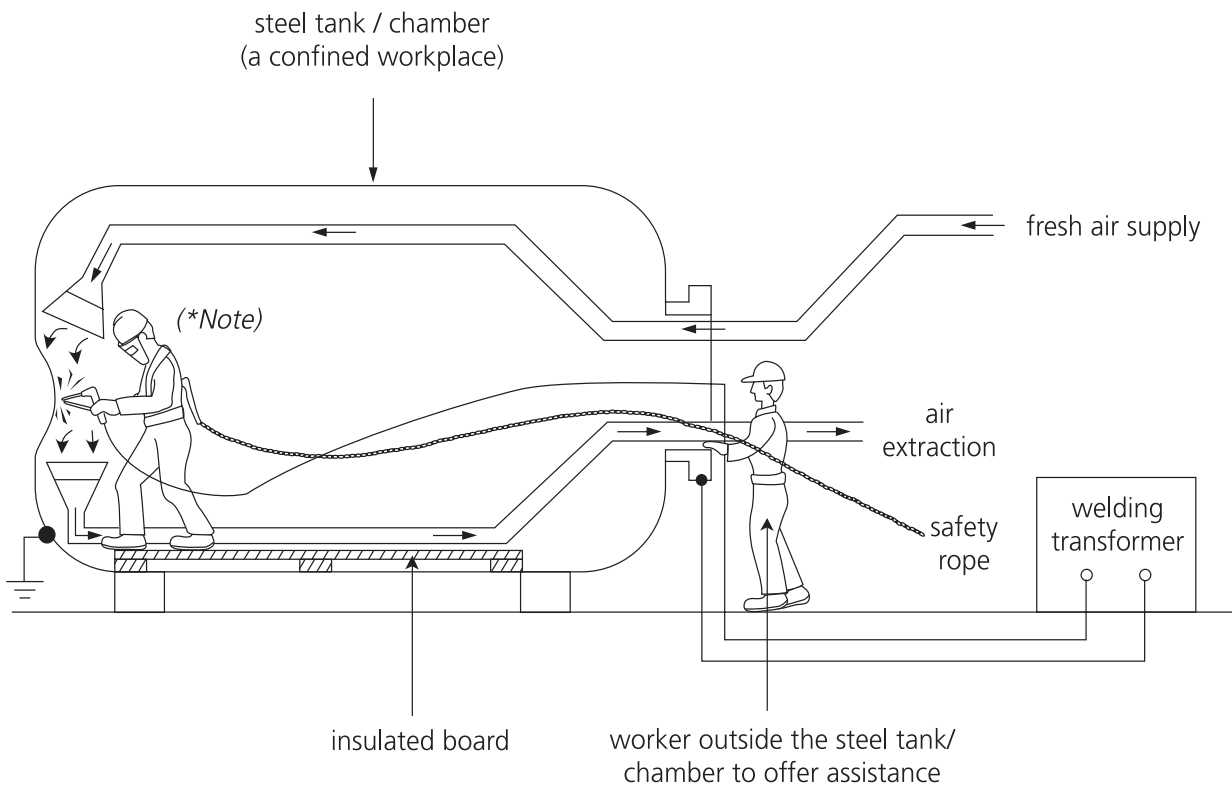


Figure 2 Typical single-phase alternating current welding circuit of manual metal arc welding



**Note:* Depending on the result of risk assessment, it may be necessary to provide workers working in a confined space with supplied-air type breathing apparatus. The proprietor should observe the *Factories & Industrial Undertakings (Confined Spaces) Regulation and Code of Practice - Safety and Health at Work in Confined Spaces*.

Figure 3 A typical arrangement for manual electric arc welding operation in a conductive confined space

Appendix II

Unsafe Acts and Unsafe Conditions

There were many serious, some even fatal, accidents occurred that involved the manual electric arc welding operation. Accident investigation and analysis indicate that unsafe acts and unsafe work practices of the welding worker are the common causes of accident or ill-health to the welding worker. The following paragraphs highlight those common unsafe acts and unsafe work practices in manual electric arc welding operation. The proprietor, the management personnel and the welding worker himself should try their best to eliminate those unsafe act and practices.

1. *Unsafe practice in replacing the welding electrode*

It is dangerous to replace the welding electrode with the bare hand or hand in a wet welding glove without first switching off the welding transformer. When a welding worker touches the live welding electrode, he might receive an electric shock. The welding transformer should be switched off or the supply to the electrode holder be isolated before the worker replaces the welding electrode.

2. *Welding/ cutting on vessels containing combustible/ flammable residue*

It is extremely dangerous to weld or cut by means of electric arc welding on containers or vessels which contain residue of combustible/ flammable substances. The spark or heat generated by the arc could ignite the combustible/ flammable residue and cause fire and explosion. It has to ensure that the containers or vessels are fully drained, washed and purged as appropriate to remove any residue of combustible/ flammable substances before carrying out the welding or cutting work.

3. *Welding in rainy day, in a flooded area or in a place with ditches of water*

It is dangerous to carry out electric welding work in open space during raining, in a flooded area or in place with ditches of water. The workers will easily get wet and are vulnerable to receive electric shock.

4. *Welding inside conductive enclosure with limiting/ restrictive space*

It is very hazardous to carry out manual electric arc welding operation inside a conductive enclosure with limiting/ restrictive spaces such as steel vessel or tank. Take due care to avoid electric shock by using suitable personal protective equipment, insulation stand and insulation mat, and taking other necessary safety precautions if it is unavoidable to weld inside those spaces.

5. *Inadequate ventilation during manual electric arc welding operation*

The fumes generated during manual electric arc welding operation are hazardous to the health of welding workers or others in close vicinity. The situation is even worse if the welding work is conducted in a confined or badly ventilated space. Effective mechanical ventilation should be provided and maintained throughout the welding period to prevent the accumulation of fumes. The appropriate respiratory protective equipment should be used by the welding worker and the others affected. In no way should the respiratory protective equipment be used to replace the provision of mechanical ventilation.

6. *Incompatibility of manual electric arc welding process and other processes in the vicinity of the workplace*

It is dangerous to carry out electric arc welding operation in the vicinity of an incompatible process such as flammable paint spraying process. The electric arc could become an ignition source to the explosive or flammable atmosphere or surroundings of the workplace.

7. *Misuse of eye protectors*

During manual electric arc welding operations, many workers use ordinary sunglasses or general type eye-goggles or shield to protect their eyes from injuries. However, these eye protectors are not purposely designed for such welding operations and thus could not effectively and simultaneously protect the eyes from injuries by radiations, slag and sparks arising from the welding operation. Suitable type eye-protectors of approved specifications in accordance with the Factories and Industrial Undertakings (Protection of Eyes) Regulations shall be used by workers who are engaged in welding or cutting work by means of an electric arc.

References

1. Guide for Safety at Work
Electric Shock Hazard of Manual Electric Arc Welding Work
(Labour Department, HKSAR)
2. Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace
(Labour Department, HKSAR)
3. Industrial Chemicals and You (Metals and Solvents)
(Labour Department, HKSAR)
4. Guidance Notes on Ventilation and Maintenance of Ventilation Systems
(Labour Department, HKSAR)
5. Code of Practice
Safety and Health at Work for Gas Welding and Flame Cutting
(Labour Department, HKSAR)
6. Code of Practice for the Electricity (Wiring) Regulations (1997 Edition)
(Electrical & Mechanical Services Department, HKSAR)
7. Electrical Safety in Arc Welding, HS(G) 118
(Health & Safety Executive, United Kingdom)
8. Welding
Guidance Note, MS15
(Health & Safety Executive, United Kingdom)
9. ANSI/ ASC Z49.1-94: Safety in Welding, Cutting and Allied Processes.
(American National Standards Institute, USA)
10. BS638-4:1996: Arc Welding power sources, equipment and accessories.
Specification for welding cables.
(British Standard Institution, United Kingdom)
11. BS638-5:1988: Arc Welding power sources, equipment and accessories.
Specification for accessories.
(British Standard Institution, United Kingdom)

12. BS638-7:1984: Arc Welding power sources, equipment and accessories.
Specification for safety requirements for installation and use.
(British Standard Institution, United Kingdom)
13. BS638-9:1990: Arc Welding power sources, equipment and accessories.
Specification for power sources for manual arc welding with limited duty.
(British Standard Institution, United Kingdom)
14. BS EN 175:1997: Personal Protection
Equipment for eye and face protection during welding and allied processes.
(British Standard Institution, United Kingdom)
15. BS EN 60529:1992: Specification for degrees of protection provided by
enclosure (IP code)
(British Standard Institution, United Kingdom)
16. EN 50060:1989: Power sources for manual arc welding with limited duty.
(European Committee for Electrotechnical Standardization (CENELEC))
17. IEC 60974-1(1998-09): Arc Welding Equipment-Part 1
Welding power sources
(International Electrotechnical Commission, Geneva, Switzerland)
18. IEC 60974-7(2000-03): Arc Welding Equipment-Part 7
Torches
(International Electrotechnical Commission, Geneva, Switzerland)
19. IEC 60974-11(1992-12): Arc Welding Equipment-Part 11
Electrode holders
(International Electrotechnical Commission, Geneva, Switzerland)
20. IEC 60974-12(1992-12): Arc Welding Equipment-Part 12
Coupling devices for welding cables
(International Electrotechnical Commission, Geneva, Switzerland)
21. IEC/ TS 62081(1999-05): Arc Welding Equipment
Installation and use
(International Electrotechnical Commission, Geneva, Switzerland)

Useful Information

If you wish to enquire about this Code of Practice or require advice on occupational safety and health, please contact the Occupational Safety and Health Branch of the Labour Department through:

Telephone: 2559 2297 (auto-recording after office hours)

Fax : 2915 1410

E-mail : laboureq@labour.gcn.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page in the Internet. Address of our Home Page is <http://www.info.gov.hk/labour>.



**Occupational Safety and Health Branch
Labour Department**