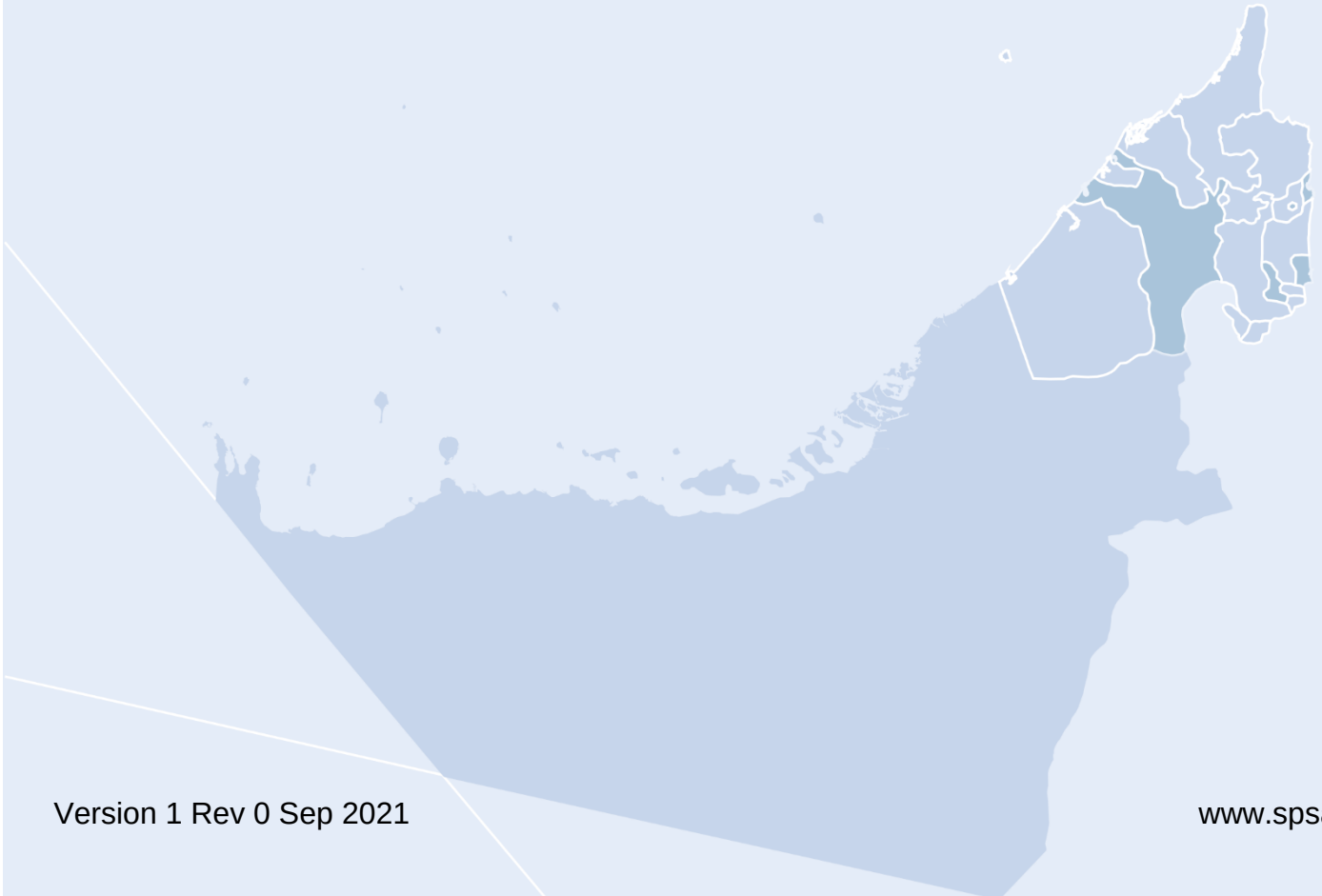
نظام الشارقة للسلامة والصحة المهنية
Occupational Safety & Health Sharjah

حكومة الشارقة
هيئة الوقاية والسلامة
Government of Sharjah
Prevention And Safety Authority

Guideline

Compressed Gases and Air

OSHJ-GL-13



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1 Introduction

Compressed gases and air are commonly used in workplaces for a variety of different activities, including but not limited to:

- Spray painting;
- Refrigeration;
- Heating, Ventilation and Air Conditioning (HVAC);
- Pneumatics;
- Diving operations;
- Welding, cutting and brazing.

2 Purpose and Scope

This Guideline document has been developed to provide information to entities to assist them in complying with the requirements of the Occupational Safety and Health System in Sharjah.

To achieve compliance in the Emirate of Sharjah, all entities are required to demonstrate a standard of compliance which is equal to or higher than the minimum acceptable requirements outlined in this Guideline document.

3 Definitions and Abbreviations

Entities:	Government Entities: Government departments, authorities or establishments and the like in the Emirate. Private Entities: Establishments, companies, enterprises and economic activities operating in the Emirate in general.
Risk:	Is the combination of likelihood of the hazard causing the loss and the severity of that loss (consequences).
Risk Assessment:	The systematic identification of workplace hazards and evaluation of the risks associated. This process takes existing control measures into account and identifies and recommends further control measures where required.
Hazard:	Anything that has the potential to cause harm or loss (injury, disease, ill-health, property damage etc).
Competence:	The combination of training, skills, experience and knowledge that a person has and their ability to apply all of them to perform their work.
Compressed Air:	Compressed air is air kept under a pressure that is greater than atmospheric pressure
Compressed Gases:	Are gases that are stored under pressure in cylinders. The three major types of compressed gases are liquefied gases, non-liquefied gases and dissolved gases.

Liquified Gases:	Are liquid at normal temperatures when they are inside cylinders under pressure. Common liquefied gases include ammonia, chloride, propane and nitrous oxide.
Non-liquified Gases:	Are also known as compressed, pressurised or permanent gases. Common non-liquified gases are oxygen, nitrogen, helium and argon.
Compressor:	A compressor is a mechanical device that increases the pressure of a gas by reducing its volume.
SDS:	Safety Data Sheet.
Dissolved Gases:	Gas that has been dissolved into another material. This creates a solution, a mixture, where the gas is the solute, the minor component, and the other material, generally a liquid, is the solvent, the main component.
Manufacturer's Manual:	The instructions, procedures and recommendations provided by the manufacturer to ensure the safe operation, maintenance and repair of the equipment.

4 Responsibilities

4.1 Entity Responsibilities

- Identify all foreseeable risks for employees using, storing, transporting and handling compressed gases and air are identified;
- Resources are available to implement the identified control measures;
- Compressed gases and air and the equipment is suitable for use, and for the purpose and conditions in which it is to be used;
- The provision of adequate information, instruction, supervision and training to the employee on the transportation, storage, use and handling of compressed gases and air and the equipment associated with it;
- Compressed gases and air are only used by competent employees;
- Compressed gases and air equipment is maintained in a safe condition for use and as per the manufacturer's manual and any other relevant authority.

4.2 Employee Responsibilities

- Not endanger themselves or others;
- Follow precautionary control measures to ensure work activities associated with the use of compressed gases and air are performed safely and without risk to health;
- Cooperate with the entity and receive safety information, instruction, supervision and training;
- Report any activity or defect which they know are likely to introduce risks to the safety and health of themselves or that of any other person.

5 Guidelines

Compressed gases and air are widely used during work activities and can be extremely hazardous. The entity needs to manage the risks from transporting, handling, using, storage, maintenance and inspection of compressed gases and air equipment and ensure that employees are competent through the provision of instruction, information, supervision and training.

5.1 Risk Assessment

The entity risk assessment shall take into consideration the following factors, including but not limited to:

- All work activities involving compressed gases and air are adequately assessed;
- The selection and use of compressed gases and air;
- The maintenance, inspection and storage of compressed gases, and installation of equipment;
- The segregation and restriction of access to compressed gas/air equipment and installation;
- The protection of employees from moving parts, ejected materials or substances;
- Information, instruction, supervision and training;
- Provision of personal protective equipment (PPE);
- Emergency procedures and response.

Further information on risk assessment can be found in OSHJ-CoP-01: Risk Management and Control.

5.2 Compressors

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor.

The major hazard associated with compressors is over-pressurisation, which may arise from:

- A blocked outlet or some other restriction to flow;
- Failure of automatic controls combined with low air consumption;
- Compressor malfunction, for example overspeeding;
- An external fire/heat source near the pressure system;
- Overheating and the build-up of carbonaceous deposits, both of which can lead to fires or explosions.

Compressed air is a means for the transfer of energy in work activities and can be used for power tools such as; air hammers, drills, wrenches and others, as well as to atomise paint in spray finishing.

There are many ways in which compressed air can be hazardous, including but not limited to:

- It can enter body orifices such as the mouth, ears and anus, causing severe and often fatal injuries;
- At high pressure it can penetrate the skin;
- Particles or oil carried in an air jet can cause severe injury and/or damage the eyes;
- Oil-coke deposits in a system can spontaneously ignite and cause an explosion;
- Vessels containing compressed air, even at comparatively low pressure, can explode violently once their integrity is lost;
- Dirty or 'wet' air can lead to corrosion and blocked valves which may make the system unsafe.

5.2.1 Installation

The installation of the compressor compromises of an air receiver, where applicable, and the associated pipework.

Compressor installations should:

- Only be undertaken by a competent person;
- Be located in a well-ventilated, cool, dry and clean air environment;
- Ensure that intercoolers and aftercoolers are cooled by air should be located so that the air flow over their surfaces is not obstructed;
- Ensure that the inlet air is drawn from an area which is free from potentially flammable or corrosive concentrations of fumes or vapours;
- Ensure that the safety equipment is installed correctly and functioning as intended;
- Installed as per the design and manufacturer’s manual;
- Ensure the use of retractable air hoses, where possible;
- Ensure that the inlet air is not excessively laden with moisture or dust.

5.2.2 Safety Devices

Safety devices, include but not limited to:

- Guarding - transmission machinery, including ‘V’ belts, pulleys and other hazardous parts, should be guarded to prevent access;
- Safety valves:
    - On all medium or large multi-stage positive displacement compressors a suitable safety valve should be fitted between each stage and, where appropriate, in the inter or after cooler circuit;
    - Where an isolating valve is installed in the discharge pipework between the compressor and receiver, the pipework on the compressor side of the valve should be protected by a suitable safety valve;

- On compressor units, where the outlet of the compressor is directly connected without shut-off or non-return valves to an air receiver to which no other source of pressure is attached, a safety valve on the air receiver is required.

5.2.3 Maintenance and Inspection

The entity should maintain and inspect the compressors in accordance with the manufacturer's manual and periodically after a set number of operating hours. Maintenance should be conducted by competent employees or third parties, including but not limited to:

- Checking oil levels;
- Checking for leaks in control lines and fittings, clamps and connectors, valves, safety relief valves, piping, pressure gauge connections, and flexible joint packing;
- Frequently removing moisture and contaminants from filters, dryers, oil separators, and the air tanks which can collect water, oil, and other contaminants from the air;
- Checking and cleaning belts, air intake vents, heat exchangers, air filters, and change them, where required;
- Inspecting and calibrating pressure gauges and safety relief valves.

The entity shall record and retain compressor maintenance and inspection records.

5.3 Air Receivers

An air receiver is a part of a compressed air system, the air receiver is the component that stores air produced by the compressor. The air receiver also acts as a buffer to help regulate demand for the air versus the amount of air that is being used downstream from the receiver.

5.3.1 Installation

Air receivers are pressure vessels and must be installed in accordance with the manufacturer's manual and any other relevant authority.

The entity should consider the following points for the installation of air receivers, including but not limited to:

- Ensure that safety valves are available and installed;
- Vessels are constructed in accordance with the specification;
- Air receivers shall be installed such that all drains, examination holes, and manholes are easily accessible;
- Under no circumstances shall an air receiver be buried underground or located in an inaccessible place;
- No valve of any type is placed between the air receiver and its safety valve or valves;
- A drainpipe and valve shall be installed at the lowest point of every air receiver to provide for the removal of accumulated oil and water. Adequate automatic traps may be installed in addition to drain valves.

5.3.2 Safety Devices

The entity shall equip air receivers with:

- Pressure gauge - Indicating pressure gauge, located as to be easily visible and with one or more spring-loaded safety valves should be fitted to an air receiver. The scale of any gauges needs to be clearly visible;
- Safety valves - Safety valves shall be fitted to prevent pressure in the receiver and allow air to escape as soon as the safe working pressure has been exceeded. The safety valve must be capable of discharging more air than the system can supply to the receiver;
- Safety appliances - Indicating devices and controlling devices, shall be constructed, located, and installed so that they cannot be readily rendered inoperative by any means, including the elements.

5.3.3 Maintenance and Inspection

The entity shall test air receivers frequently and at regular intervals to determine whether they are in good operating condition. The drain valve, safety valve, examination holes and manholes need to be accessible. The entity shall ensure that:

- Only competent employees or third parties undertake maintenance of work equipment;
- Where possible, maintenance is conducted with the power to the equipment off and ideally disconnected or with the fuses or keys removed, particularly where access to hazardous parts will be needed;
- The part of the system being maintained should be isolated and de-energised;
- All moving equipment/parts have stopped before maintenance commences;
- All components which operate at high temperatures are allowed to cool.
- The drain valve on the air receiver shall be opened and the receiver completely drained frequently and at intervals as to prevent the accumulation of excessive amounts of liquid in the receiver.

The entity shall record and retain air receivers maintenance and inspection records.

5.4 Pipework and Distribution Lines

Pipework and distribution lines are the system of pipes, valves and fittings from the source of the supply to the point of application or control. The main hazards associated with pipework and distribution lines, include but are not limited to:

- Compressed air systems invariably grow over time, any foreseeable expansion of the system should be planned and adequate allowance should be made on the size of piping provided;
- Inadequately sized and designed systems can lead to the operating units being starved of air, causing machine malfunction;
- Repeated malfunctions may tempt operators to adopt unsafe practices to overcome any problems;

- Badly designed pipe runs and lack of isolation valves may expose maintenance staff to unnecessary risks;
- Some grades of plastic pipework are not recommended for use in compressed air installations and designers are advised to consult manufacturers when selecting materials.

There are two main types of compressed air system; single line and ring main. The entity should keep a schematic drawing of the air system showing pipe runs, intended direction of air flow, and the positions of fittings, valves and drains. The entity should amend drawings when modifications or additions are made to the system.

5.4.1 Pipework and Distribution Line Installation

The entity should ensure the following requirements for pipework and distribution lines installation, including but are not limited to:

- The route of the pipe run and the position of valves and operating points should be safe and convenient for those who will use and maintain the system;
- The pipe route itself should not present a hazard or obstruct access and should be routed away from any areas where it may be vulnerable to mechanical damage;
- There should be adequate and sufficient access ways, working platforms and clearance space provided to enable the compressed air system to be operated and maintained without exposing anyone to unnecessary risk;
- Pipe runs should have a slight fall in the direction of air flow, and drainage valves should be fitted at the lowest point, in such a way that moisture and air can be discharged safely;
- A drain valve should be fitted at the bottom of vertical pipe runs;
- Pipe runs should be secured by brackets or other supports installed at appropriate intervals to support the pipe system such that each removable section is self-supporting and the remaining pipe is stable after removal. To allow for expansion, particularly at the compressor/receiver discharge or on straight runs exposed to sunlight or heat from the process, suitable and adequate expansion devices should be fitted;
- Piping and associated fittings connected between the compressor and air receiver should be easy to clean;
- All outlet points should, where practicable, be taken from the top of the pipe run and a stop valve or self-venting ball valve, where necessary complete with handle should be provided adjacent to the connection point;
- The connection point at any outlet should be arranged horizontally or face downwards; upward facing connection points invariably fill with dirt and prompt the bad practice of blowing out before use. Outlet points should be provided at convenient places for all routine activities which require compressed air. They should be positioned so that hoses attached to them will not cross or obstruct the normal access to the workplace, and can be connected without the need for climbing;
- Where air cannot be vented from the system or any part of the system through the normal outlets, valves should be fitted for this purpose. The valves specified should

be suitable for the application. In most cases threeport valves or self-venting ball valves are the most suitable type for isolating and venting; these valves should be arranged so that when the supply is shut off, the downstream part of the air system is vented through the exhaust port of the valve and provision made to lock the valve in this position.

5.4.2 Safety Devices

The entity should equip pipework and distribution lines with:

- Pressure regulators - Where it is necessary to protect equipment from over pressurisation, pressure regulators should be provided and set to maintain a constant safe downstream pressure. An air pressure gauge should be provided on the outlet side;

- Pressure relief valve - Safety valve or other suitable overpressure protective device should be fitted and set to relieve if the safe working pressure of the equipment or vessel is exceeded. The relief valve should be positioned so that if the valve discharges, the risk to personnel is minimised;

- Stop valves - Provided and positioned so that the complete pipework system can be isolated from the compressed air supply. All branch lines of subsections of the system should also have stop valves fitted to allow separate isolation. Where appropriate each valve should have a facility to be locked in the closed position or the lever handle should be removed;

- Signage - Where valves are grouped, or where the purpose or location of the valve is not obvious, signage should be provided indicating the position and/or purpose of the valve.

5.4.3 Maintenance and Inspection

The entity should maintain filters, traps, separators and lubricators frequently and at regular intervals to determine whether they are in good operating condition. Filters, traps, separators and lubricators need to be accessible and maintained to a standard of cleanliness appropriate to end usage are necessary, including but not limited to:

- Air line lubricators provided for operations which involve air tools, air cylinders or air control valves; be positioned after the stop valve and after any filter or separator. In both cases it is essential that filters and lubricators are positioned after and adjacent to a stop valve to allow safe service and maintenance. They should not be fitted into ring mains where the direction of air flow is not controlled but into the branch lines leading from them;

- High standards of filtration will be required for instrument control or in the electronics industry. Ultra-high efficiency filtration will be required in hospitals and the pharmaceutical, foodstuffs preparation and brewing industries and appropriate filters, traps or separators should be fitted and adequately maintained;

- The use and maintenance of exhaust port filters to protect against the ingress of dirt and other contaminants from the surrounding area into the compressor;

- In most cases these components will have either metallic or transparent plastic bowls. The properties of the materials may however be adversely affected by solvents, alcohols, cleaning solutions or synthetic lubricants, and maintenance in accordance with the manufacturer’s manual is essential.

It is good practice to shield all non-metallic bowls and manufacturers should ensure that such bowls can be shielded.

The entity shall record and retain pipeline and distribution line maintenance and inspection records.

5.5 Compressed Gas Cylinders

Types of gases commonly stored in cylinders includes:

Liquified Gases **-** Are liquid at atmospheric temperatures when they are inside cylinders under pressure. Common liquefied gases include ammonia, chloride, propane and nitrous oxide.

Non-liquified Gases **-** Are also known as compressed, pressurised or permanent gases. Common non-liquified gases are oxygen, nitrogen, helium and argon.

Dissolved Gases **-** Acetylene is a commonly dissolved gas and is very unstable chemically.

The entity shall ensure; the handling, transportation, storage, use, maintenance and inspection of all compressed gas cylinders is conducted as recommended by the manufacturer's manual and any other relevant authority.

5.5.1 Transporting Gas Cylinder

The transporting of gas cylinders requires the entity to have adequate safety control measures in place, including but not limited to:

- The cylinder valve is in the fully closed position and the regulator has been removed;
- All cylinders are fitted with protective guards or caps in place over the valve assemblies;
- Cylinders are transported on a cradle or similar equipment designed for the purpose;
- Cylinders are transported in a secure upright position and chained to prevent the cylinder falling over and hitting other cylinders or obstructions;
- Different gas cylinders are not mixed together when being transported, except within specifically designed vehicles, for example oxygen or oxidising gases should never be transported with flammable gases;
- Employees transporting gas cylinders shall be competent and receive adequate information, instruction, training and supervision and are trained in emergency procedures.

5.5.2 Gas Cylinder Use

Prior to starting work activities using gas cylinders, the entity should ensure the following, including but not limited to:

- The gas equipment connected to the gas cylinder is checked to ensure the correct equipment is available for the gases being used, all safety devices are fitted and the equipment is not damaged;
- Check all connections for leakage using gas testing equipment or a surfactant, for example a detergent solution;

- Where leaks are identified, the gas supply should be isolated and the leaking components taken out of service, replaced or repaired. A leak identified at a cylinder valve or pressure regulator connection, requires the cylinder to be removed to a safe place in the open air. A leaking fuel gas cylinder shall be moved away from any source of ignition.

The entity should ensure equipment that has been or appears to have been modified may not be suitable and may be hazardous and examined before use by a competent person. Damaged or defective hose or hose assemblies shall not be repaired and only be replaced by a competent person.

5.5.3 Gas Cylinder Handling and Storage

Gas cylinders are heavy and filled with gas held under high pressure, when handling and storing gas cylinders, the entity should ensure the following, including but not limited to:

- Gas cylinders are properly secured at all times to prevent tipping, falling or rolling. They can be secured with straps or chains connected to a wall bracket or other fixed surface, or by use of a cylinder stand;
- That gas cylinders are stored in a cool, dry, well-ventilated, fire-resistant area designed to store gas cylinders;
- Incompatible gases are not stored together;
- When a gas cylinder is empty or not being used, the valve is closed, the regulator removed and the valve protector cap is secured in place;
- Gas cylinders are transported using hand trolleys designed for that purpose and the cylinders should be secured so that they do not tip, fall or roll;
- Appropriate lifting devices are provided, such as cradles or nets, when a crane, hoist or derrick is used to transport gas cylinders. It is **never** advised to use magnets, slings or the valve protection cap for lifting a gas cylinder;
- Precautions are taken to prevent gas cylinders from being dropped or allowed to strike each other or other objects. Dropping or striking may damage the gas cylinder valve, which could turn the gas cylinder into a torpedo with the potential to cause injury and damage property;
- Refer to the appropriate safety data sheet (SDS) for detailed information on the chemical contained in the gas cylinder. Specific chemical handling and storage precautions will be outlined in the SDS.
- The SDS will also provide specifications for appropriate PPE.

5.5.4 Gas Cylinder Disposal

A gas cylinder is normally considered to be empty when the container pressure is 35psi, otherwise known as pounds per square inch, or less. Gas cylinders, once empty, will normally be exchanged by the gas supplier taking the empty cylinder and replacing it with a full cylinder.

Where the contents of a refillable gas cylinder cannot be identified and the original supplier cannot be recognised or contacted. The entity should contact a waste processor for advice on how to dispose of the cylinder safely.

5.6 Maintenance and Inspection

The entity should adequately maintain all compressed gas and air systems in a suitable condition, to ensure the safety and health of employees during operation.

The entity should include compressed gases and air systems in a preventative maintenance schedule to ensure that regular checks and servicing is conducted. The schedule should include both routine and non-routine maintenance and is required to be comprehensive to minimise risk, including but not limited to:

- Systems are depressurised before any maintenance work is carried out;
- A safe system of work is in place so that maintenance work is carried out safely and under proper supervision;
- Depending on the nature, location and operational requirements, maintenance work may be subject to a Permit to Work;
- A maintenance log is updated and maintained.

The frequency of inspection should be determined by the following, but is not limited to:

- Age of the equipment;
- Nature of the equipment;
- How the equipment is used;
- Location of the equipment;
- History of the equipment;
- Any other criteria that may affect the use and operability of the equipment.

A written scheme of examination may be required for pressure systems. The criteria of this scheme is:

- The written scheme should be drawn up by a competent person;
- The written scheme of examination must cover all protective safety devices including all components of the pressure vessel and those parts of pipe work and pipelines that may increase the risk;
- The written scheme of examination must specify the nature and frequency of examination and include any special measures that may be needed to prepare the system for examination.

A written scheme of examination is designed to ensure that the pressure system is working correctly and should not be a substitute for any planned preventative maintenance that may also be in place.

The entity shall record and retain gas cylinder maintenance and inspection records.

5.7 Personal Protective Equipment

The entity should ensure that employees are provided with suitable PPE where other methods are not available or effective in controlling exposure to compressed gases.

The correct selection of PPE for a particular work activity is essential, the SDS should provide some general guidance, however a competent person should evaluate the hazards of the work activity and select the most appropriate PPE, including but not limited to:

- When using gases that are harmful by skin contact, wear protective gloves, aprons or other clothing depending on the risk of skin contact. Choose clothing made of materials that resist penetration or damage by the chemical;
- Wearing eye protection when working with compressed gases, chemical safety goggles provide the best eye protection. In some cases, a face shield with safety goggles may be required to protect the face;
- Suitable footwear to protect feet and provide a good grip;
- Any other PPE identified as being required in the risk assessment.

Further information on PPE can be found in OSHJ-GL-07: Personal Protective Equipment.

6 Training

The entity should provide training for all employees who conduct and supervise work activities with compressed gases and air, in languages and in a format that employees understand. The employees need to have adequate knowledge on how to transport, use, store, maintain and inspect compressed gases and air equipment safely, including but not limited to:

- Specific information, instruction on how to operate compressed gases and air equipment safely;
- Using manufacturer's SDS instructions and check they understand these instructions;
- The use, handling, storage, transportation, inspection and maintenance of compressed gas and air cylinders;
- How to avoid risks, for example, using methods and procedures to prevent exposure to compressed gases and/or associated hazards;
- The safe selection, use, maintenance and storage of suitable PPE;
- Emergency preparedness and response.

Periodic refresher training should be conducted to ensure employees competency is maintained, including but not limited to:

- Where training certification has expired;
- Where identified as part of a training needs analysis;
- Where risk assessment findings identify training as a measure to control risks;
- Where there is a change in legal requirements;
- Where incident investigation findings recommend refresher training.

The entity must record and maintain accurate training records of OSH training provided to employees.

Further information on training can be found in OSHJ-GL-26: Training and Competence.

7 Emergency Preparedness and Response

The entity should be prepared for emergencies that may occur during the transportation, use, handling, storage, maintenance and inspection of compressed gases and air and associated equipment.

SDS for the gases used are a good starting point for drawing up an emergency response plan. SDS have specific sections on spill and leak procedures, first aid instructions, fire and explosion hazards.

The entity shall ensure that the emergency plan contains the following, including but not limited to:

- Emergency response personnel are available, who can take charge and make decisions on behalf of the entity during an emergency and liaise with emergency services;
- Emergency response personnel are available, who are familiar with the work area ensuring the prompt evacuation of the workplace in the event of a gas cylinder leak or a fire;
- Adequate firefighting and first aid equipment is available for the type of work activities and the compressed gases and air present in the workplace;
- Employees are trained in emergency response, including information of first aid arrangements and where first-aiders, first aid equipment and facilities are located;
- Employees are appointed as first-aiders and available at each location and during each working shift when work is being conducted.

Further information on first aid can be found in OSHJ-CoP-16: First Aid at Work.

Further information on developing an emergency plan can be found in OSHJ-CoP-18: Emergency Preparedness and Response.

8 References

OSHJ-CoP-01: Risk Management and Control

OSHJ-CoP-18: Emergency Preparedness and Response

OSHJ-GL-07: Personal Protective Equipment

OSHJ-GL-26: Training and Competence

9 Document Amendment Record

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