



Abu Dhabi EHSMS Regulatory Framework (AD EHSMS RF)

EHS Regulatory Instrument

Code of Practice

**EHS RI - CoP 49.0 – Compressed Gases
and Air**

Version 2.0

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ACKNOWLEDGEMENTS

With gratitude Abu Dhabi EHS Center acknowledges the great support provided by the Executive Council in facilitating the issuance of Abu Dhabi Emirate Environment, Health and Safety Management System (AD EHSMS) and its implementation at Emirate level.

The issuance of the system would not have been possible without the supervision, diligent efforts and productive recommendations of the AD EHS Center Board of Directors.

These documents (Regulatory Instruments) constitute the efforts of the Abu Dhabi EHS Center and the concerned Sector Regulatory Authorities who worked together to integrate all relevant regulatory requirements under *AD EHSMS RF*. The input, contribution and constructive views of all sectors is highly appreciated.

May these documents prove to be beneficial and helpful in system implementation and in expanding the knowledge in the EHS field.



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Preface

This Abu Dhabi EHS Regulatory Instrument was developed by the Industrial Sector Regulatory Authority as the primary Competent Authority for this topic to set the minimum mandatory requirements.

Every effort was made in developing this document so that it does not conflict with existing local or federal laws and regulations. In case of conflict, requirements of the existing local and federal laws and regulations shall prevail, and all concerned are obliged to bring the same to the attention of AD EHS Center for resolution.

This AD EHS Regulatory Instrument has been developed, reviewed and approved, following the process as described in *AD EHSMS Implementation Guideline: The Integration of EHS Requirements in the Emirate of Abu Dhabi*, by the following stakeholders:

- Abu Dhabi EHS Higher Committee;
- Abu Dhabi EHS Center;
- Environment Agency Abu Dhabi;
- Department of Municipal Affairs;
 - Abu Dhabi City Municipality;
 - Al Ain City Municipality;
 - Western Region Municipality;
- Department of Transport – Abu Dhabi;
- Abu Dhabi Water and Electricity Authority;
- Health Authority - Abu Dhabi;
- Higher Corporation for Specialized Economic Zones (ZonesCorp);
- Center for Waste Management – Abu Dhabi;
- Abu Dhabi Tourism Authority;
- Abu Dhabi Food Control Authority;
- Abu Dhabi Education Council;
- Regulation and Supervision Bureau; and
- Other Relevant Federal and Local Competent Authorities.

The AD EHSMS consists of the following hierarchy of documents:

- AD EHSMS RF Elements - Mandatory System Requirements

EHS Regulatory Instruments:

- Standards and Guideline Values - Mandatory EHS threshold and exposure levels
- Codes of Practice - Mandatory EHS technical requirements – subject specific
- Mechanisms - Mandatory system implementation processes and procedures

Guidelines:

- Technical Guidelines - Non-mandatory guidance on how to implement an EHS Regulatory Instrument
- AD EHSMS Guidance Documents - Non-mandatory guidance and interpretation of an *AD EHSMS RF* concept and/or principle

Further, this document is not intended to conflict with any contractual obligations in effect at the time of its issuance. However, all future contracts shall adhere to applicable requirements stated herein, and existing long term contracts shall be brought into compliance with its requirements as soon as reasonably practicable as stipulated by relevant subject authorities.

This document will be reviewed periodically as part of the continual improvement cycle.

1. Introduction

- (a) This Code of Practice (CoP) applies to all employers within the Emirate of Abu Dhabi that uses compressed gasses to include compressed air. This CoP is designed to incorporate requirements set by UAE and Abu Dhabi regulatory authorities. If requirements of this document conflict with requirements set by another regulatory authority, employers are required to follow the more stringent requirement.
- (b) This CoP sets requirements on how to use, store and transport compressed gases. Labelling of containers can be found *in AD EHS RI – CoP 1.0 – Hazardous Materials*.
- (c) Definitions applicable to this CoP:
- Absolute Pressure: Based on a zero pressure reference point, the perfect vacuum. Measured from this point, standard atmospheric pressure at sea level is 14.7 pounds per square inch (psi) or 101.325 kilo Pascal's (kPa). This is usually expressed as psia where the 'a' indicates an absolute measurement or kPa.
 - Air Receiver means an unfired pressure vessel used to store compressed air for various end uses which are constructed and maintained in accordance with the applicable local / national regulations, internationally recognized standards and industrial best practices including ASME Boiler and Pressure Vessel Code Section VIII.
 - Asphyxiant Gas: Any non-toxic gas which displaces atmospheric oxygen below limits required to support life. These gases are usually colorless, odorless and tasteless and include nitrogen, argon and helium.
 - Compressed Gas: A compressed gas is any gas which when enclosed in a container gives:
 - an absolute pressure reading greater than 276 kPa (40 psi) at 21°C (70°F) or
 - an absolute pressure greater than 717 kPa (104 psi) at 54°C (129.2°F) or
 - any flammable liquid having a vapor pressure greater than 276 kPa (40 psi) at 38°C (100.4°F).
 - Compressed Gas Cylinder: A compressed gas cylinder is any metal cylinder of the type approved by the concerned govt. authority for storage and transportation of gases under pressure, including liquefied gases (ADNOC, etc.). Approved metal cylinders shall be used for packaging compressed gases.
 - Corrosive Gas: A gas that in contact with living tissue causes destruction of the tissue by chemical action.
 - Cryogenic Liquid: A liquid with a normal boiling point below -150°C (-238°F).
 - Cryogenic Liquid Cylinder: Pressurized container designed and fabricated to hold cryogenic fluids. There are three common types of liquid cylinders: gas dispensing; liquid dispensing; or gas and liquid dispensing.
 - Cylinder Valve: A mechanical device attached to a compressed gas cylinder that permits flow into or out of the cylinder when the device is in the open position and prevents flow when in the closed position.

- Dewar: Is an open-mouthed, non-pressurized, vacuum-jacketed container used to hold cryogenic fluids.
- Frangible Disk is a thin piece of metal in a pressure system to relieve excessively high pressure.
- Fusible Plugs are fittings with an alloy that melts at a predetermined temperature.
- Flammable Gas: A substance that meets the definition of a compressed gas which:
 - is flammable in a mixture of 13% or less (by volume) with air, or
 - has a flammable range with air wider than 12%, at atmospheric temperature and pressure, regardless of the lower limit.
- Gauge Pressure: The pressure above or below atmospheric pressure. Therefore absolute pressure minus local atmospheric pressure equals gauge pressure and is usually abbreviated as psig or kPa.
- Handling: Moving, connecting or disconnecting a compressed or liquefied gas container under normal conditions of use.
- High-pressure Cylinders, as defined by international standards are those marked with a service pressure of 900 psi or greater." The term "high pressure" can therefore be any level prescribed for the equipment or system in use. For incident prevention purposes, any pressure system shall be regarded as hazardous.
- Highly Toxic Gas: A compressed gas that has a median lethal concentration (LC50) in air of ≤ 200 ppm. A NFPA Health Hazard rating of 4 is given to gases having an LC50 in air ≤ 1000 ppm. An example of a highly toxic gas is fluorine with a LC50 of 185 ppm.
- High Pressure Gas: A gas in a container that has a pressure of 3448 kPa (500 psig) or higher at 21.1°C (70°F).
- Inert Gas: A gas which is chemically inactive.
- Liquefied Gas: A fluid within a pressurized container, other than in solution, which exists both as a liquid and gas at 20°C (68°F). Examples include propane, butane, ammonia, carbon dioxide, and sulfur dioxide.
- Low Pressure Tank: A tank designed to operate at pressure above 0.35 kg/cm² but not to exceed 1.055 kg/cm².
- Manifold: A gas distribution system which transfers product through multiple outlets/inlets to or from compressed gas containers.
- Nonflammable Gas: A gas which, within the packaging, exerts an absolute pressure of 280 kPa (40 psi) or greater at 20°C (68°F) but is not a flammable gas as defined previously.
- Oxidizing Gas: A gas that can support and accelerate combustion of other materials.
- Pressure Vessel: A tank designed to operate at pressure above 1.055 kg/sq cm.
- Pressure Regulator: A mechanical device used to safely control the discharge pressure of a compressed gas from a container.

- Pressure Relief Device: A pressure and/or temperature activated device used to prevent the pressure from rising above a predetermined maximum and thereby prevent rupture of a pressurized container.
- Pyrophoric Gas: A gas that will spontaneously ignite in air at or below 54.4°C (130°F). Examples include silane and phosphine.
- SCF: One standard cubic foot of gas at 21°C (70°F) and 101.325 kPa (14.696 psia).
- Safety Valves means frequently called "pop" valves because they pop full open when a preset pressure is exceeded.
- Relief Valves do not "pop" but open slightly and then open further as pressure increases.
- Storage: Holding of gas, in its packaging, either on a temporary basis or for an extended period in such a manner as to not constitute usage of the gas.
- Toxic Gas: A gas having a Health Hazard of 3 or 4 as defined in NFPA 704, Standard System for the Identification of the Fire Hazards of Materials.

2. Training and Competency

- (a) Employers shall ensure that EHS training complies with the requirements of:
- (i) *AD EHSMS RF – Element 05 – Training and Competency;*
 - (ii) *AD EHS RI – Mechanism 7.0 – AD EHS Professional Entity Registration; and*
 - (iii) *AD EHS RI – Mechanism 8.0 – AD EHS Practitioner Registration.*
- (b) Employers shall ensure all relevant employees and contractors that perform tasks that work with or near compressed gasses receive training that includes at a minimum:
- (i) physical hazards associated with compressed gases;
 - (ii) design specification, capabilities and limitations of compressed gas storage systems and their uses at the work site;
 - (iii) methods and procedures that will prevent exposure to compressed gases or hazards associated with compressed gases;
 - (iv) the importance of control measures;
 - (v) safe work practices;
 - (vi) required use, maintenance and storage of PPE;
 - (vii) emergency response procedures;
 - (viii) safe handling and storage;
 - (ix) health hazards associated with compressed gases used at the work site;
 - (x) signs and symptoms of exposure to compressed gases used at the work site; and
 - (xi) operator maintenance requirements for compressed gas systems.
- (c) Employers shall ensure managers and supervisors of operators of compressed gas systems requiring shall be trained on:

- (i) requirements listed in Section 2(a);
- (ii) maintenance requirements of compressed gas system to ensure they are working appropriately and within specifications;
- (iii) how to recognize unsafe work practices when working with compressed gas; and
- (iv) how to identify when the compressed gas systems are not working appropriately.

3. Requirements

3.1 Roles and Responsibilities

3.1.1 Employers

- (a) Employers shall undertake their roles and responsibilities in accordance with the general requirements of *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation* Section 3.2.5.
- (b) Employers shall be responsible for performing a risk assessment in accordance with *AD EHSMS RF – Element 02 – Risk Management* to determine the risks associated to identify areas compressed gas control measures and safe work practices are required to reduce employee's exposures to compressed gases and hazards materials/chemicals.
- (c) Employers shall implement the Occupational Health and Safety hierarchy of controls, *AD EHSMS RF – Element 02 – Risk Management*, when developing control measures to remove or reduce employee exposure to hazards associated with exposure to compressed gases.
- (d) Employers shall ensure that protective equipment or other control measures shall be used to keep the exposure of employees to compressed gases and hazardous materials/chemicals within limits prescribed by *AD EHSMS RF – Standards and Guideline Values*.
- (e) Employers shall develop and implement an inspection, testing and preventative maintenance plan to ensure compressed gas systems are safe and working efficiently and according to manufacture specifications and applicable legal requirements.
- (f) Employers shall ensure compressed gases systems are tested and inspected regularly (at a minimum annually) to ensure the system work in accordance with manufactures specifications.
- (g) Employers shall monitor the use of compressed gases systems to ensure employees are using compressed gases appropriately.

3.1.2 Employees

- (a) Employees shall undertake their roles and responsibilities in accordance with the general requirements of *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation* Section 3.2.7.

- (b) Employees shall report any activity or defect relating to compressed gases which they believe is reasonably foreseeable to endanger their safety or that of another person.
- (c) Employees shall comply with safe work practices and standard operating procedures.
- (d) Employees shall use appropriate equipment or safety devices provided by the employer in accordance with any training or instruction received in the use of the work equipment or device concerned.
- (e) Employees shall not perform any task requiring training until they have received the required training and it is documented.
- (f) Employees shall not operate any piece of equipment that they are not familiar with, competent to operate and/or appropriately trained on its use.

3.2 Planning and Assessment

- (a) Employers shall ensure the following:
 - (i) an assessment of the various risks is undertaken and systems of work are established which are safe to all parties involved or affected including the public;
 - (ii) that appropriate control measures are implemented in order to manage activities safely and without risk to health;
 - (iii) that for the Building and Construction Sector the management of compressed gases requirements are included in the Pre-Tender Environment, Health and Safety Plan in accordance with *AD EHS RI – CoP 53.0 – EHS Management During “Construction Work”*; and
 - (iv) that associated safe systems of work, and site rules are included in the Environment, Health and Safety Construction Management Plan (EHS-CMP) in the case of the Building and Construction Sector in accordance with *AD EHS RI – CoP 53.0 – EHS Management During “Construction Work”*.

3.3 Safety Requirements

- (a) When performing risk assessments in accordance with *AD EHSMS RF – Element 02 – Risk Management*, the following shall be considered:
 - (i) the condition of the equipment being used (compressors, hoses, couplings etc.) and if they are rated by an appropriate International Standard for their intended use;
 - (ii) the type, frequency and duration of the compressed air work;
 - (iii) the environment in which the compressed air work is to be undertaken (eg. dirty/dusty conditions, uneven work surfaces, cramped conditions);
 - (iv) the pressure at which the compressor is operating at;
 - (v) the level of experience of the personnel involved in the work; and
 - (vi) other identified hazards associated with the work.

- (b) When using compressed gas systems (to include pneumatic tools), the following requirements shall be met:
- (i) pipes, hoses, and fittings shall display the rating of the maximum pressure of the compressor. Compressed air pipelines shall be identified and tested to maximum working pressure;
 - (ii) under no circumstances shall the pressure of the compressed air exceed the maximum working pressure of any of the components in use;
 - (iii) couplings shall have safety clips fitted to them to prevent inadvertent uncoupling when under pressure – makeshift tie-wire shall not be used;
 - (iv) ensure all components comply with the appropriate International Standard for their intended use and are regularly maintained in a fit for purpose condition;
 - (v) the setting of safety valves or reducing valves shall only be adjusted by a competent person;
 - (vi) air supply shutoff valves shall be located, as near as reasonably practicable, at the point-of-operation;
 - (vii) air hoses shall be kept free of grease and oil to reduce the possibility of deterioration;
 - (viii) hoses shall not be located across floors or aisles where they are liable to cause personnel to trip and fall. When reasonably practicable, air supply hoses shall be suspended overhead, or otherwise located to afford efficient access and protection against damage;
 - (ix) hose ends shall be secured to prevent whipping if an accidental cut or break occurs;
 - (x) pneumatic impact tools, such as riveting guns, shall never be pointed at a person;
 - (xi) before pneumatic tools are disconnected (unless it has quick disconnect plugs), the air supply shall be turned off at the control valve and the tool bled;
 - (xii) compressed air shall not be used under any circumstances to clean dirt and dust from clothing or off a person's skin;
 - (xiii) air used for cleaning shall be regulated to 15 psi unless equipped with diffuser nozzles to provide lesser pressure;
 - (xiv) static electricity may be generated through the use of pneumatic tools. This type of equipment shall be grounded or bonded if it is used where fuel, flammable vapours or explosive atmospheres are present;
 - (xv) when used for cleaning, the compressed air equipment (air nozzle) shall reduce the outlet (working) air pressure to less than 30 pounds square inch (psi) at the discharge tip. In-line chip protection shall be used when airlines are connected directly to a compressed air system. This does not mean that the supply air or line pressure be reduced to 30 psi as long as the static (dead head) pressure exiting the nozzle when restricted does not exceed the mandatory maximum 30psi;
 - (xvi) reduction of air pressure for cleaning can be done with nozzles and tips designed for this purpose. Employees shall not remove, damage, cover (eg. tape), replace or in any way alter the equipment provided for this purpose. Nozzles that have been altered or "home-made" and shall not be used;

- (xvii) goggles, face shields or other eye and hearing protection shall be worn by personnel using compressed air for cleaning equipment, in compliance with *AD EHS RI – CoP 2.0 – Personal Protective Equipment*; and
- (xviii) all defects shall be immediately reported to the employer and the use of the defected equipment shall be ceased.
- (c) The handling, storage, utilization, and inspection of all compressed gases in cylinders, portable tanks, rail tank-cars, or motor vehicle cargo tanks shall be in accordance with current requirements of the Emirates Authority for Standardization and Metrology (ESMA).

3.4 Compressors and Compression Units

- (a) When a gas compressor plant or a gas processing plant discharges gas into a line to which other sources of gas supply are connected there shall be a valve installed in the plant's discharge line, or lines, for the purpose of automatically preventing the return flow of gas. The valve shall, where reasonably practicable, be located outside of the plant but within a reasonable distance of the plant.
- (b) Gas compressor discharge lines shall have a pressure-relieving safety device. There shall be no valve located between the pressure relieving safety device and the cylinder or cylinders it is to protect. The pressure-relieving safety device shall be set to open at a pressure not to exceed the maximum allowable working pressure of the cylinder. The relieving capacity of the pressure relieving safety device shall be such as to prevent a rise of pressure in the cylinders of more than 10 percent above their maximum allowable working pressure. The pressure-relieving valve shall be bench tested, calibrated and certified.
- (c) Where a gas compressor pressure-relieving safety device discharges into the atmosphere, the discharge outlet shall be located outside of the compressor building and if it discharges adjacent to the building, it shall have the discharge outlet located above the compressor building eaves.
- (d) Where hazardous quantities of liquid may be present in the incoming gas to compressors, an inlet scrubber shall be provided and a device installed thereon to give either audible warning or shut down the compressors in case the liquid in the scrubber exceeds a predetermined level.
- (e) Gas lines which enter plants, and which are connected to compressor intakes, shall be provided with shut-off valves in a safe location.
- (f) While maintenance work of a nature requiring the opening of lines or equipment containing gas is being performed on a compressor or its suction or discharge piping, employees shall be protected from being endangered by escaping gas by closing and locking of the valves in the intake and discharge lines. If the closing and locking of the lines is inappropriate, the lines shall be blinded or other equally effective means taken to prevent the escape of gas. Lock out/Tag out shall be done in accordance with *AD EHS RI – CoP 24.0 – Lock Out/Tag Out*.
- (g) Air and gas compressor engines of over 30 horsepower shall be provided with means other than manual for starting, providing that manual starting may be used in emergencies.

3.5 Air Receivers (Tanks and Pressure Vessels)

- (a) The normal operating conditions of the tank or vessel shall not exceed the design pressure or temperature.
- (b) Internal bracing will include vent holes to prevent the forming of gas pockets or liquid pools when liquid level rises or falls.
- (c) The smallest diameter dimension on any manhole will not be less than 400 mm circular or 280 x 400 mm oval or 255 x 410 mm oval.
- (d) Air receivers shall be designed, fabricated, tested stamped and installed in accordance with the applicable local / national regulations, internationally recognized standards and industrial best practices including the ASME Boiler and Pressure Vessel Code, Section VII.
- (e) Air receivers shall be installed to ensure accessibility for maintenance and draining.
- (f) To provide for removal of accumulated water and oil, a drain pipe and valve shall be installed at the lowest point of every air receiver. The drain valve shall be opened at a minimum daily in order to drain the air receiver of accumulated water and oil.
- (g) Drain valve, safety valve, examination holes and manholes shall be accessible.
- (h) Every air receiver shall be equipped with a pressure gauge which is readily visible and with spring loaded safety valves which prevents the receiver from exceeding the maximum allowable working pressure by more than 10 percent.
- (i) Valves, indicated devices, and controlling devices shall be constructed, located, and installed so that they cannot be readily rendered inoperable.
- (j) Tank and vessel supports shall be installed on firm foundations. Tank supports shall be of concrete, masonry, or steel.
- (k) Tanks without supports shall rest on the ground or on foundations made of concrete, masonry, piling or steel.
- (l) Atmospheric tanks shall be vented to prevent the development of vacuum pressure appropriate to distort the tank or exceed the design pressure as a result of filling or emptying, and atmospheric temperature changes.
- (m) Normal vents shall be sized in accordance with good engineering practice or shall be at least as large as the filling or withdrawal connection, whichever is larger but in no case less than 30 mm inside diameter.
- (n) Any physical work other than that permitted (eg. drilling, welding, etc.) to tank or vessel after stamping shall be performed by a manufacturer approved by qualified engineer or third party inspection agency to maintain the integrity of the stamp on the tank. Tanks shall be periodically re-inspected at a frequency determined by the risk assessment and applicable legal and international standards.

- (o) Tank/Vessel Record - A permanent and progressive record for each tank and vessel shall be maintained at the plant where the tank and vessel is located. The record shall be available for inspection by concerned authorities and shall include the following:
- (i) serial or identification number of the tank or vessel;
 - (ii) established safe working pressure of the tank or vessel for the working temperature;
 - (iii) relief valve setting;
 - (iv) maximum working temperature; and
 - (v) manufacturer's data reports, when obtainable, and all data pertaining to tests, inspections and calculations used in establishing the safe working pressure.

3.6 Pressure Relieving Safety Devices

- (a) Only qualified personnel shall be allowed to repair or adjust pressure regulating equipment.
- (b) Valves, gauges and other regulating devices shall be installed on compressor equipment in such a way that cannot be made inoperative, normally locked open.
- (c) Air tank safety valves shall be set no less than 15 psi or 10 percent (whichever is greater) above the operating pressure of the compressor but never higher than the maximum allowable working pressure of the air receiver.
- (d) Air lines between the compressor and receiver shall not be equipped with stop valves. Where stop valves are necessary and authorized, standard safety valves shall be installed between the stop valves and the compressor.
- (e) The Safety valves shall be set to blow at pressures slightly above those necessary to pop the receiver safety valves.
- (f) Blow-off valves shall be located on the equipment and shielded so sudden blow-offs will not cause personnel injuries or equipment damage.
- (g) Case iron seat or disk safety valves shall be approved in compliance to applicable standards and stamped for intended service application.
- (h) If the design of a safety or a relief valve is such that liquid can collect on the discharge side of the disk, the valve shall be equipped with a drain at the lowest point where liquid can collect.
- (i) Safety valves exposed to freezing temperatures shall be located so water cannot collect in the valves. Frozen valves shall be thawed and drained before operating the compressor.
- (j) Safety relief valves installed on pressure vessels shall be constructed, installed, and maintained in accordance with relevant international standards.

- (k) No pressure vessel shall be operated in excess of the allowable working pressure of the vessel as established by codes or the maximum allowable working pressure as established for the vessel at its last inspection, whichever is the least. Pressure-relieving devices shall be set to prevent the pressure from rising more than 10% above the maximum allowable working pressure.
- (l) A permanent and progressive record of pressure-relieving safety devices in service, showing the serial or identification number, the location, the pressure setting, the free orifices area in sq cm, the date of installation in service, and the date of testing shall be maintained at the location where the pressure relieving safety device is located or at the supervising office.
- (m) A vessel having a stop valve that shuts off the vessel from its pressure relieving device, shall be protected by an additional safety device, if the vessel may become entirely filled with liquid and if it is reasonably practicable that pressure may be generated by continued input of heat through exchanger tubes or similar devices, or by exposure to sun or adjacent hot equipment. This additional safety device shall be connected to the vessel at all times. The additional safety device may be set higher so that the pressure cannot rise higher than 20% above the safe working pressure.
- (n) The aggregate capacity of the pressure-relieving safety devices applied to any vessel or system of vessels for the release of vapor shall be appropriate to carry off the maximum quantity of vapor that can be generated in, or supplied to, the attached equipment within the variations of normal operation, without permitting a rise in pressure within the vessel of more than 16 percent above the safe working pressure.
- (o) Outlets from pressure-relieving safety devices shall be appropriately secured and shall lead to a safe place of discharge. Pressure-relieving safety device stacks which are open to the atmosphere shall be provided with a drain. The size of outlets or stacks shall be such that any pressure drop shall not reduce the relieving capacity of the relieving devices below that required to protect the vessel. No stop valve shall be placed on a discharge line from a pressure relieving safety device except when such discharge line discharges to a common header, in which case such stop valve shall be locked or sealed open and shall be closed, while the vessel is in operation, only by a person definitely assigned to such duties by the employer, and such person shall not leave the location until the stop valve is opened and relocked or resealed.
- (p) Each pressure-relieving safety device installed on operating equipment shall be maintained so as to ensure the appropriate functioning of the device at the intended pressure. Such maintenance shall include inspection, testing, and the repair of the pressure-relieving safety devices at frequencies as required by the service conditions.
- (q) Each pressure-relieving safety device in service shall have serial or identification number stamped upon it and in addition a metal plate or metal tag shall be attached to each such device and shall show the pressure setting and the date the device was installed in service.
- (r) All safety valves shall be tested on a regular basis to ensure they are in good operating condition. This can be performed by a competent external entity and records shall be maintained at the facility and accessible to inspectors and maintenance staff.

3.7 Compressed Gas Cylinders - Portable Cylinders

- (a) The handling, storage, utilization, and inspection of all compressed cylinders shall be in accordance with current requirements of the ESMA.
- (b) Compressed gas cylinders require special construction, handling, storage, transportation and disposal techniques. This Section describes requirements for safe handling of Compressed Gas Cylinders within the workplace.
- (c) Gases drawn from cylinders are usually characterized as:
 - (i) permanent gases having boiling points of -150°F or lower and cannot be liquefied at room temperature no matter how high the pressure. Such gases include oxygen, nitrogen, and helium;
 - (ii) liquid gas which liquefy at temperatures of -130°F or higher at one atmosphere, but can be liquefied and maintained as liquids at higher pressures. Such gases include propane, chlorine, and butane. Carbon dioxide is in this category, but becomes a solid rather than a liquid; and
 - (iii) dissolved gases in common use such as acetylene dissolved in acetone which holds 35 times its own volume of acetylene.
- (d) Compressed gas cylinder users shall maintain and refer to the specific Safety Data Sheets (SDS) for the substances contained in the cylinder for more details. Specific standards for some compressed gases such as acetylene, hydrogen, oxygen, etc. shall be considered.

3.7.1 Construction and Marking of Cylinders

- (a) All portable cylinders used for the storage and shipment of compressed gases shall be constructed and maintained in accordance with the requirements of the Compressed Gas Association (CGA) and applicable local / national regulations and internationally recognized standards appropriate to the use or intended use of the cylinder.
- (b) Labeling and marking of cylinders shall be in accordance to the requirements of *AD EHS RI – CoP 1.0 – Hazardous Materials*.
- (c) Compressed gas cylinders shall be legibly marked, for the purpose of identifying the gas content, with either the chemical or the trade name of the gas. Such marking shall be by means of stenciling, stamping or labeling, and shall not be readily removable. Whenever reasonably practicable, the marking shall be located on the shaller of the cylinder.
- (d) Labels shall be securely attached to cylinders so that they cannot be inadvertently or accidentally detached during use, transport and storage.
- (e) Numbers and markings stamped into cylinders shall not be tampered with.
- (f) Compressed gas cylinders shall be equipped with connections complying with the applicable local / national regulations, internationally recognized standards including American National Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections, ANSI B57.1-1965.

- (g) Cylinders with a water weight capacity of over 30 pounds (13.6 kg) shall be equipped with a means of connecting a valve protection cap or with a collar or recess to protect valve.

3.7.2 Compressed Gas Cylinder Handling

- (a) Cylinders shall always be considered full and shall be handled carefully.
- (b) Cylinders which are designed to accept valve protection devices shall be equipped with such devices when the cylinders are in transport, storage, not in use between shifts, or otherwise not connected for use.
- (c) Unless cylinder valve is protected by a recess in the head, the metal cap shall be kept in place to protect the valve when the cylinder is not connected for use.
- (d) Threads on a regulator shall be identical to those on the cylinder valve outlet. Connections that do not fit shall not be forced on.
- (e) All parts of a compressed gas cylinder shall be checked before use. All cylinders shall be in good condition with an operable valve or regulator. Cylinders without valves and regulators shall be capped.
- (f) Flashback devices shall be fitted at both the regulator and torch end of oxygen/fuel gas systems. Safety devices in valves or on cylinders shall not be tampered with.
- (g) Cylinder valves shall be opened slowly. Cylinders without hand wheel valves shall be opened with a spindle key, special wrench, or other tool provided or approved by the gas supplier.
- (h) Valves of empty cylinders shall be closed.
- (i) Cylinders shall not be dropped or struck or permitted to strike each other violently.
- (j) Cylinder valves not provided with fixed hand wheels shall have keys or handles on valve spindles or stems while cylinders are in service. In multiple cylinder installations only one key or handle is required for each manifold.
- (k) Cylinder valves shall not be tampered with nor shall any attempt be made to repair them. The supplier shall be contacted immediately if damage occurs.
- (l) Complete removal of the stem from a diaphragm-type cylinder valve shall be avoided.
- (m) Cylinders shall never be used as rollers or supports.
- (n) Cylinders shall never be used without a pressure-reducing regulator attached to the cylinder valve except where cylinders are attached to a manifold – in which case the regulator shall be attached to the manifold header.
- (o) Before making connection to a cylinder valve outlet, the valve shall be slightly opened for an instant to clear the opening of particles of dust or dirt. The valve and opening shall always be pointed away from the body and not toward anyone else.

- (p) Regulators and pressure gauges shall be used only with gases for which they are designed and intended.
- (q) Employers shall not attempt to repair or alter cylinders, valves, or attachments. This shall be done only by the manufacturer / approved service agent.
- (r) Oil or grease shall never be used as a lubricant on valves or attachments of oxygen cylinders. Oxygen cylinders and fittings shall be kept away from oil and grease such cylinders or apparatus shall not be handled with oily hands, gloves, or clothing.
- (s) Oxygen shall not substitute for compressed air in pneumatic tools, in oil pre-heating burners, to start internal combustion engines, or to remove dust from clothing. It shall be used only for the purpose for which it is intended.
- (t) Cylinders shall never be brought into confined spaces or unventilated rooms.
- (u) DO NOT use or compress Acetylene in a free state at pressure higher than 15 pounds per square inch.
- (v) Never completely empty a cylinder; there shall always be a minimum residual gas pressure of 30psi.
- (w) Before a regulator is removed, the cylinder valve shall be closed and the gas released from the regulator.
- (x) Unless the cylinder valve has first been closed tightly, no attempt shall be made to stop a leak between the cylinder and the regulator.
- (y) If a leak occurs in a fuel gas cylinder it shall be taken out of use immediately and handled as follows:
 - (i) the valve shall be closed and the cylinder taken outdoors well away from any ignition source. The cylinder shall be tagged (Do Not Use, No Smoking, No Ignition Source) and the supplier notified; and
 - (ii) a regulator attached to the valve may be used temporarily to stop a leak through the valve seat.
- (z) When flammable gas lines or other parts of equipment are being purged of air or gas, open lights or other sources of ignition shall not be permitted near uncapped openings.

3.7.3 Transportation of Compressed Gas Cylinders

- (a) Unless cylinders are secured on a specifically designed rack / equipment, regulators shall be removed and valve-protection devices put in place prior to movement.
- (b) Compressed gas cylinders in portable service shall be conveyed by appropriate trucks to which they are securely fastened; and all gas cylinders in service shall be securely held in substantial racks or secured to other rigid structures so that they will not fall or be knocked over.

Note: Exception: When it is not reasonably practicable to transport cylinders neither by truck, nor to bring in racks to point of operation, as in some construction work, cylinders may be carried in, and appropriately secured in an appropriate manner. For short distances, cylinders may be moved by tilting and rolling them on their bottom edges.

- (c) Gas cylinders transported by crane, hoist, forklift, or derrick shall be handled in appropriate cradles, nets or skip boxes, and shall never be lifted by magnet or by slings, unless the slings are designed and constructed to prevent accidental release of the cylinders.
- (d) Valve protection devices shall not be used for lifting cylinders. Exception: Valve protection devices may be used for manual lifting if they were designed for that purpose.
- (e) Bars shall not be used under valves or valve protection caps to pry cylinders loose when frozen to the ground or otherwise fixed; the use of warm (not boiling) water is recommended.
- (f) Ensure cylinder valves shall be closed before moving cylinders.

3.7.4 Storage of Compressed Gas Cylinders

- (a) Cylinders shall always be secured to prevent them falling over. Chains or a clamp-plus-strap is an acceptable method of keeping cylinders upright. The chain or strap shall be placed above the midpoint of the cylinder to keep it from falling over.
- (b) Cylinders of compressed gas shall be stored in areas where they are protected from external heat sources such as flame impingement, intense radiant heat, electric arc, or high temperature steam lines.
- (c) Inside of buildings, cylinders shall be stored in a well-protected, well-ventilated, dry location, at least six meters from highly combustible materials such as oil or excelsior. Assigned storage spaces shall be located where cylinders will not be damaged by passing or falling objects, or subject to tampering by unauthorized persons.
- (d) Storage rooms for cylinders containing flammable gases shall be well ventilated to prevent the accumulation of explosive concentrations of gas; no source of ignition shall be permitted; smoking shall be prohibited.
- (e) Storage areas shall contain the appropriate safety signage, in accordance with *AD EHS RI – CoP 17.0 – Safety Signs and Signals*.
- (f) Employers shall ensure that only authorized persons have access to compressed gases storage areas.
- (g) Cylinders shall not be stored in temperatures above 51 degrees Celsius or near sources of heat such as radiators/furnaces, or near highly flammable substance like gasoline, oil, or volatile liquids.

- (h) Do not store incompatible gases together. Oxygen cylinders in storage shall be separated from fuel gas cylinders or combustible materials (especially oil or grease) a minimum distance of 6 meters or by a non-combustible barrier at least 2 meters high, or a minimum of 46 centimeters above the tallest cylinder and having a fire-resistance rating of at least one hour.
- (i) Compressed gas cylinders shall be stored or transported in a manner to prevent them from creating a hazard by tipping, falling or rolling.
- (j) Liquefied fuel-gas cylinders shall be stored or transported in a position so that the safety relief device is in direct contact with the vapor space in the cylinder at all times.
- (k) Acetylene and liquefied fuel gas cylinders shall be stored with the valve end up.
- (l) Cylinders stored in the open shall be protected from contact with the ground and against weather affects.
- (m) Cylinders shall not be placed where they might form part of an electric circuit.

3.8 Gases with Specific Hazard Classes

The following information regarding specific classes of gases is offered as additional requirements to be used in conjunction with the general usage requirements listed in preceding sections.

(a) Corrosive Gases:

Corrosive gases, examples include chlorine, hydrogen chloride, fluorine, hydrogen fluoride, hydrogen sulfide, carbon monoxide and carbon dioxide:

- (i) when using corrosive gases, equipment and lines shall be checked daily for damage and leaks;
- (ii) a diaphragm gauge shall be used with corrosive gases that would destroy a steel or bronze gauge. Check with gas supplier for recommended equipment; and
- (iii) after removing regulators, employers shall inspect them for damage and flush them with dry air or nitrogen.

(b) Cryogenic Liquids and Gases:

Cryogenic liquids and their boil-off vapors rapidly freeze human tissue and cause embrittlement of many common materials which may crack or fracture under stress. All cryogenic liquids produce large volumes of gas when they vaporize (at ratios of 600:1 to 1440:1, gas: liquid) and may create oxygen-deficient conditions. Examples of common cryogenic liquids include liquid oxygen, hydrogen, helium, and liquid neon. The following information applies to the use and handling of cryogenics:

- (i) employees shall use appropriate personal protective equipment (PPE) including insulated gloves and eye protection (goggles and a face shield) during any transfer of cryogenic liquid;

- (ii) emergency procedures shall be developed for accidental exposures to include skin contact with a cryogenic liquid;
- (iii) only equipment, valves and containers designed for the intended product and service pressure and temperature shall be used;
- (iv) employers shall inspect containers for loss of insulating vacuum. Repairs shall be made by the manufacturer or an manufacturer approved entity;
- (v) transfer operations involving open cryogenic containers such as dewars shall be conducted slowly to minimize boiling and splashing of the cryogenic fluid;
- (vi) ice or other foreign matter shall not be allowed to accumulate beneath the vaporizer or the tank;
- (vii) all cryogenic systems including piping shall be equipped with pressure relief devices to prevent excessive pressure build-up;
- (viii) pressure reliefs shall be directed to a safe location;
- (ix) employees shall not tamper with pressure relief valves or the settings for the valves; and
- (x) hot air, steam or hot water shall be used to thaw frozen equipment. Do not use water to thaw liquid helium equipment.

(c) Flammable Gases:

The following information applies to the use and handling of flammable gases. Some common examples of flammable gases include acetylene, hydrogen, methane, propane and iso-butane:

- (i) flammable gases, except for protected fuel gases, shall not be used near ignition sources. Ignition sources include open flames and sparks, sources of heat, oxidizing agents and ungrounded or non-intrinsically safe electrical or electronic equipment;
- (ii) portable fire extinguishers shall be available for fire emergencies. The fire extinguisher shall be compatible with the apparatus and the materials in use;
- (iii) flames shall not be used for detecting leaks. A compatible leak detection solution shall be used for leak detection;
- (iv) spark proof tools shall be used when working with or on a flammable compressed gas cylinder or system;
- (v) access doors to areas which use or store flammable gases shall be posted "No Smoking" and "No Open Flames";
- (vi) manifold systems shall be designed and constructed by competent personnel who are thoroughly familiar with the requirements for piping of flammable gases. Manifolds shall comply with the applicable standards;
- (vii) standard specifications shall be identified before starting design and construction; and
- (viii) consultation with the gas supplier shall be completed before installation of manifolds.

(d) Fuel, High Pressure and Oxidizing Gases:

The following information applies to the use and handling of fuel, high pressure and oxidizing gases:

- (i) use of fuel gases shall comply with applicable national & international standards including NFPA and industrial best practices;
- (ii) employers shall have a qualified engineer or other competent person design and oversee the installation of Oxygen-Fuel Gas Systems for Welding, Cutting and Allied Processes;
- (iii) high pressure gases can be rated up to 3000 pounds per square inch (psi). Typical uses include MIG (Metal Inert Gas) welding gas mixtures, cryogenics, non-toxic gas distribution, medical gas distribution, and emergency oxygen services;
- (iv) in addition to any gas specific hazards, high pressure gases shall carry the following hazard label : “CAUTION: HIGH PRESSURE GAS”; and
- (v) do not use oil in any apparatus where oxygen will be used. Gauges and regulators for oxygen shall bear the warning “OXYGEN - USE NO OIL”.

(e) Toxic and Highly Toxic Gases:

The following information applies to the use of toxic and highly toxic gases;

- (i) unless otherwise indicated, all gases shall be stored in a continuously mechanically ventilated gas cabinet, fume hood or other enclosure;
- (ii) small quantities (eg. lecture cylinders) or dilute concentrations of these gases may be stored outside of a ventilated enclosure;
- (iii) audible alarms shall be utilized in ventilated hoods that are dedicated to toxic gas usage or storage; and
- (iv) Standard Operating Procedures (SOP's) for processes or procedures which use toxic or highly toxic gases shall be developed that include emergency response actions.

3.9 Gas Cylinder Disposal

- (a) When feasible, employers shall purchase compressed gas only from manufacturers that will agree to take back the empty cylinder.
- (b) A cylinder is considered empty when the container pressure is 35psi or less.
- (c) Refillable cylinders shall be returned to the authorized supplier or directly to the vendor.
- (d) If a refillable cylinder is encountered that does not have a manufacturer label, contact approved Registered Service Providers, as per *AD EHS RI – CoP 54.0 – Waste Management*, for advice on disposal and / or identifying the manufacturer through stamp marks on the cylinder.
- (e) Maintain manufacturer labels and label the cylinder as “Empty”.
- (f) Appropriate identification of the contents of all cylinders is required and is the responsibility of the employer and/or cylinder owner.

3.10 Inspection and Maintenance

- (a) Compression Units as per *Ministerial Order 32 of 1982* shall be inspected by a competent person that licensed by the ministry of labor at a minimum annually.
- (b) Gas Cylinders:
 - (i) gas cylinders shall be hydrostatically tested at a minimum every five years which shall be conducted by a qualified testing facility. The test date shall be stamped onto the cylinder each time the cylinder is tested;
 - (ii) cylinders in use are allowed to exceed the five year limit, but shall be tested prior to refilling or before the sixth (6th) year, whichever is sooner; and
 - (iii) inspection of Low-Pressure Cylinders (0.35 kg/cm² to 1.055 kg/cm²) is exempted from the Hydrostatic Test.
- (c) Air Receiver shall be tested by a competent person or a skilled third party agency at a frequency defined by the applicable legal requirements, manufacturer recommendations and/or employer's inspection & maintenance scheme. Inspection shall include, but not be limited to:
 - (i) visual Examination each six month by Employer's competent person;
 - (ii) thorough Internal and External Visual Inspection plus a Gas Leak test at full working pressure OR Internal overpressure test plus a Gas Leak Test at full working pressure; and
 - (iii) thorough internal and external visual examination and gas leak test to maximum working pressure. If the competent person deems it necessary, an overpressure test to 1.1 times the maximum working pressure shall be conducted.
- (d) Pipework shall be tested by a competent person or a skilled third party agency at a frequency defined by the applicable legal requirements, manufacturer recommendations and/or employer's inspection & maintenance scheme. Inspection shall include, but not limited to:
 - (i) visual examination;
 - (ii) gas leak test at maximum working pressure of the system; and
 - (iii) internal pressure test to 1.5 times maximum working pressure of the system plus gas leak test at maximum working pressure of the system.
- (e) Electronics shall be visually examined, function tested (to include protective devices), and continuity and resistance testing of any cables by the employer competent person or a skilled third party agency.

3.11 Emergency Response

- (a) Emergency Response procedures compliant to *AD EHSMS RF – Element 06 – Emergency Response & Management* shall be developed for all compressed gas systems. Requirements for emergencies involving compressed gas cylinders include leaks, fire, explosions etc. as identified through the Risk Assessment as required by Section 3.1(a) of this CoP.

- (b) First aid procedures in accordance with *AD EHS RI – CoP 4.0 – First Aid and Medical Treatment* shall be developed.
- (c) Emergency and first aid procedures shall include:
- (i) the provision of first aid facilities, kits and officers to appropriately deal with compressed air injuries, such as air and foreign particle injection;
 - (ii) provisions to immediately shut down air compressors isolate gas cylinders etc. in the event of an emergency;
 - (iii) contact details for external emergency services and the relevant on site personnel;
 - (iv) evacuation routes and emergency assembly points; and
 - (v) for toxic gases leaks, the cylinder shall be removed to an isolated, well-ventilated area, but only if this is reasonably practicable while maintaining personal safety. A general evacuation of the building may be necessary and have the cylinder approached only by trained emergency response personnel wearing protective apparel and self-contained breathing apparatus (SCBA).

4. References

- *AD EHSMS RF – Element 01 – Roles, Responsibilities and Self-Regulation*
- *AD EHSMS RF – Element 02 – Risk Management*
- *AD EHSMS RF – Element 06 – Emergency Response & Management*
- *AD EHS RI – CoP 1.0 – Hazardous Materials*
- *AD EHS RI – CoP 4.0 – First Aid and Medical Treatment*
- *AD EHS RI – CoP 54.0 – Waste Management*
- *Ministerial Order 32 of 1982*
- *NFPA 704, Standard System for the Identification of the Fire Hazards of Materials*
- *U.A.E Standard 215 E / 1995 (Industrial Safety and Health Regulations - Equipment- Tanks, Pressure Vessels, Boilers and Compressed Gas Equipment)*
- *UK HSE HSG 39: Compressed Air Safety*
- *OSHA Standards for General Industry 29 CFR 1910*
 - *1910.101 Compressed Gases (General Requirements)*
 - *1910.102 Acetylene*
 - *1910.103 Hydrogen*
 - *1910.104 Oxygen*
 - *1910.105 Nitrous Oxide*

- *1910.242(b) Compressed Air, Cleaning*
- *1910.169 Compressed Air, Receiver*
- *1910.253 Oxygen-fuel Gas Welding and Cutting*

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