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1. OBJECTIVE

This SOP is to provide guidance to all staff and students on safe use and operation of the compressed gas cylinders in the Department of Medicine research laboratories.

2. SCOPE

This SOP is applicable to all staff and students in Department of Medicine research laboratories at MD1, MD6 and NUH where compressed gas cylinders will be/are used and/or stored.

3. RESPONSIBILITY

3.1 Principal Investigator shall designate and train staff and students who are required to handle and use compressed gases and ensure that compressed gases are handled in accordance with good work practices.

3.2 All staff and students working with compressed gases must be able to handle and use compressed gases, ensure that compressed gases are handled in accordance with good work practices and must obtain necessary training to work safely.

4. TYPES OF COMPRESSED GASES

A gas cylinder is a pressure vessel used to store gases at high pressure. The three main types of compressed gases that are stored in gas cylinders are liquefied gas, non-liquefied gas and dissolved gas.

a. Liquefied gases are gases that become liquids at room temperature when compressed at high pressure in a cylinder. Examples are carbon dioxide, ammonia, chlorine, etc.
b. Non-liquefied gases are gases that remain gases at room temperature even at high pressure. Examples are nitrogen, argon, carbon monoxide, helium, hydrogen, methane, oxygen, etc.
c. Dissolved gases are gases that are dissolved in a volatile solvent in order to stabilize them. Acetylene is a good example of a dissolved gas. It is usually dissolved in acetone.

5. CLASSIFICATIONS OF COMPRESSED GASES

a. Flammable or combustible - Gases are flammable if their flashpoints (temperature above which there is not sufficient vapors given off to ignite) are lower than room temperature. In these situations there is an ever present danger of fire or explosion. Examples are acetylene, butane, ethane, ethylene, hydrogen, isobutene, methane, propane, etc.

b. Corrosive - A gas that causes visible destruction or permanent changes in skin tissue at the site of contact. Exposure to corrosive gas affects can be compounded due to the nature of the material. Examples are ammonia, boron trifluoride, chlorine, hydrogen chloride, methylamine and etc.

c. Poisonous – Exposure to poisonous gases and vapors can go unnoticed for long periods of time. Common poison or highly toxic gases include: arsine, ethylene oxide, hydrogen cyanide, nitric oxide, phosphine, etc.

d. Inert - An inert gas is a non-reactive gas and is usually a member of the noble gas family. Examples include helium, neon, argon, nitrogen, xenon, krypton, and radon.

6. HAZARDS ASSOCIATED WITH GAS CYLINDERS

- Asphyxiation caused by gas leaks.
- Impact from the blast of a gas cylinder explosion or rapid release of compressed gas.
- Impact from parts of gas cylinders that fail, or any flying debris.
- Contact with the released gas or fluid (such as chlorine).
- Fire resulting from the escape of flammable gases or fluids.
- Impact from falling cylinders.
- Injuries from improper lifting or move of cylinders.

7. PERSONAL PROTECTIVE EQUIPMENT

Wear proper Personal Protective Equipment (PPE) when performing lab operations/tasks involving compressed gases: long sleeved lab coat, long pants, covered toe shoes, safety glasses and gloves.

8. SAFE PRACTICES WHEN WORKING WITH COMPRESSED GASES

8.1 Identification of Contents

- Contents of the gas cylinder should be clearly identified.
- Color coding is not a reliable means of identification. Cylinder colors vary from supplier to supplier.
- Do not deface or remove any markings, tags or stencil marks used for identification of contents attached by the gas vendor.
- Cylinders which do not bear a legibly written, stamped, or stenciled identification of the contents should not be used and the gas vendor should be contacted for removal.
- Read the SDS and labels for all of the materials you work with.

8.2 Operational Safety Checks

- Cylinders MUST always be secured.
- Never open the cylinder valve unless the cylinder is connected to a regulator or to equipment.

- Regularly check for leaks using soapy water. Leakage will be revealed by either hissing or, in the case of fuel gases, by an odour. DO NOT TEST FOR LEAKS WITH A NAKED FLAME.
- Never use force when opening or closing valves. Only use reasonable force. OPEN by turning the hand wheel or cylinder valve key anticlockwise. CLOSE by turning the hand wheel or cylinder valve key clockwise.
- The storage area should be secure, kept well ventilated and clean at all times. The ground surface should be reasonably level and firm (preferably concrete), that allows for easy trolley access.

8.3 Handling and Use

- Gas cylinders should always be used in a vertical position, unless specifically designed to be used otherwise.
- Gas cylinders should always be securely restrained to prevent them falling over.
- Cylinders must always be secured to a trolley when being transported
- Ensure that the cylinder/gas is the right one for the intended use.
- Segregate and clearly mark full and empty cylinders.
- Wear appropriate personal protective equipment, such as long sleeved lab coat, long pants, covered toe shoes, safety glasses and gloves.
- Never roll, drag, or drop cylinders or permit them to strike each other.
- Close all valves when cylinders are not in use.

8.4 Lifting and Transport

- Use cylinder trolley when handling gas cylinders.
- Fit suitable protective valve caps and covers to cylinders before transporting.
- Transport cylinders with valve caps. Do not lift cylinders by the cap.
- Do not transport with the regulator attached.
- Cylinders must be fastened securely in upright position.
- Recommend to work with another lab personnel (buddy system) when transporting cylinder.

8.5 Storage

- Gas cylinders should not be stored for excessive periods of time. Only purchase sufficient quantities of gas to cover short-term needs.
- Properly secure the cylinder at all times: straps, belts, or chains.
- Store gas cylinders in cool, dry, well-ventilated areas, away from incompatible materials and ignition sources.
- Gas cylinders should be stored away from sources of ignition, other flammable materials or oxygen cylinders.
- Store gas cylinders securely when they are not in use and should be properly restrained.

9. SAFE USES OF REGULATORS

- A regulator is a device that receives gas at a high pressure and reduces it to a much lower working pressure.
- Regulators are gas specific. Be sure to use the proper regulator for the gas tank in the cylinder.
- Always check the regulator before attaching it to a cylinder. If the connections do not fit together readily, the wrong regulator is being used.
- Before a regulator is removed from a cylinder, close the cylinder valve and release all pressure from the regulator.
- Regulators shall be removed from the cylinder during transport.
- Two stage regulators are commonly used in most labs. The gauge closest to the tank itself is the main gauge. It provides the total pressure reading of the gas in the tank. The primary stage should be kept closed whenever the gas tank is not actually in use. The second stage allows careful control and release of a lower constant pressure of gas. The reading on the second gauge provides an indication of the actual pressure of the gas being released from the tank.

10. INCIDENTS OR ACCIDENTS REPORTING

Accidents resulting in injuries must be reported to the PI and/or laboratory safety lead immediately after first aid is applied.

Seek medical attention when necessary at the University Health Centre or proceed to the Accident & Emergency units of National University Hospital after office hours.

All incidents or accidents have to be notified to OSHE within 24 hours via the online NUS Accident and Incident Management System (AIMS) @https://inetapps.nus.edu.sg/osh/portal/eServices/ehs360_aims.html. The AIMS report can be submitted by the injured staff/student, safety leads, his or her supervisor/representative if the staff or student is unfit/unable to do the initial report.

11. REVISION HISTORY

Date Revised	Version No.	Author	Summary of Revisions
21-03-2016	001	Yeo Soh Bee	
01-10-2016	002	Yeo Soh Bee	Section 10: Revised Accident and Incident Reporting System (AIRS) to Accident and Incident Management System (AIMS)
15-04-2019	003	Yeo Soh Bee	
29-10-2021	004	Adeline Chow	Update of HOD Section 6: Update of Hazards Section 8.3: Update of Handling and Use Section 8.4: Update of Lifting and transport