UAH

The University of Alabama in Huntsville

COMPRESSED GAS POLICY

Office of Environmental Health and Safety
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1. PURPOSE

1.1 This procedure establishes minimum rules to protect the health and safety of employees required to handle gas cylinders, and to minimize the potential for personal injury and environmental risk.

1.2 Although this practice describes specific safety measures to be taken for handling gas cylinders, it is not intended to prevent the use of any additional measures that may be deemed necessary for a particular situation.

2. HAZARDS

2.1 POTENTIAL HAZARDS which may be encountered when handling gas cylinders are as follows:

2.1.1 PRESSURE - When the cylinder valve is opened the released gas will expand rapidly. It is known that cylinders with sheared valves can penetrate masonry walls under the force of the escaping gas.

2.1.2 TOXICITY - Some compressed gases can cause physiological harm to personnel exposed to them. The toxicity of the effects is dependent on the gas, its concentration, and the duration of exposure.

2.1.3 FLAMMABILITY - Leaking or otherwise mishandled cylinders of some gases may present fire and explosion hazard.

2.1.4 REACTIVITY - Under certain conditions, heat, etc., the leaking gases may combine with incompatible materials to form toxicants.

3. REQUIREMENTS - EMPLOYEES HANDLING GAS CYLINDERS

3.1 Training - Personnel who are required to receive and transport gas cylinders shall minimally receive the following safety training. It is the responsibility of the employee's supervisor to ensure that they receive this training and are updated at least annually.

3.1.1 Chemical safety training

3.1.2 Gas cylinder handling training

3.2 Personal Protective Equipment - Personnel who are required to receive and transport gas cylinders must wear the appropriate personal protective equipment (PPE). The type of equipment required depends upon the classification of the gas as listed. See Table 1 for Gas Classification and Table 2 for required PPE.

3.3 Leak Testing - All gas cylinders will be tested for leaks prior to removing cylinders from the delivery vehicle, if possible. Leaking gases can cause a number of hazards, such as oxygen deficient atmosphere, fire, explosion, toxic effects. Therefore no leaking gas cylinders shall be accepted for delivery in a UAH facility.

3.3.1 Leak Detection Methods: The preferred and primary method for leak detection is a direct reading instrument with a sensor that uses thermal conductivity different from that of the ambient air for detection, such as the Matheson Leak Hunter Plus Model 8066 or its equivalent. This type of detector is highly sensitive and can locate leaks too small to bubble quickly with a liquid solution leak detector. An **alternate method** is liquid solution leak detection.

A. Delivery Leak Test Procedure:

1. With the cylinder on the delivery vehicle, visually inspect the cylinder for cap, proper labels, dents, excessive rust, pitting, or other physical damage. Check to ensure the cylinder has been pressure tested within the prescribed time.
2. Following the calibration and operation procedures for your detector, insert the probe of an operational detector through the cap slots and sample for at least 2 seconds or 2 times the response time, whichever is longer.
3. If the cylinder cap does not have slots (remove the cap) or the cylinder does not have a cap, slowly move the probe around the neck of the cylinder or apply the leak detection solution to likely leak locations, following the directions on the container.
4. If a leak is detected, leave the cylinder on the delivery vehicle for immediate return to the vendor.
5. If the leak prevents the delivery vehicle from leaving, immediately call 9-911 and evacuate to a safe proximity location to wait on the arrival of emergency responders.

B. Alternate Method

1. Apply a leak checking fluid around cylinder outlet connection and/or use a leak-checking device (**Leak checking method is selected based on the content of the gas inside the cylinder).**
2. If bubbles are observed or a reading is detected on the leak-checking device, STOP and leave the cylinder on the vehicle and follow directions 4 and 5 above.

   NOTE: Use the same procedures as during delivery (as in 2 – 5 above) for cylinders suspected to be leaking, except place the cylinder in an appropriate exhausted enclosure such as a gas cabinet or fume hood, visually inspect the cylinder for cap, proper labels, dents, excessive rust, pitting, or other physical damage.

4. RECEIVING GAS CYLINDERS

4.1 All personnel receiving compressed gas cylinders must wear the appropriate PPE (see Section 3).

4.2 A compressed gas cylinder shall be accepted only if its contents are legibly identified by name. Cylinders are identified in several ways:

4.2.1 Stenciling, labels, or decals on the cylinder body/shoulder.

4.2.2 Tags attached to the cylinder valve and/or valve protection cap.

4.3 The receiver shall confirm that all of these forms of identification agree and correspond to what was ordered. If they do not, the cylinder shall not be accepted.

4.4 Under no circumstances shall identification markings or tags be obliterated or removed from any compressed gas cylinder.

4.5 All compressed gas cylinders must be inspected prior to acceptance. Below is a list to be used when receiving cylinders. If the answer to any of the questions is no, then the cylinder shall not be accepted.

4.5.1 Is the valve cap in place?

4.5.2 Upon removal of the cylinder cap, are the tamper seals (shrink wrap) and / or valve cap securely in place?

4.5.3 Is the cylinder leak tight, giving off no odors, issuing no visible vapors or hissing sounds?

4.5.4 Is the product identified by name?

4.5.5 Do all forms of identification on the cylinder agree?

4.5.6 Is the cylinder and valve free from damage in the form of dents, gouges, burn marks or corrosion?

4.6 Once accepted, a cylinder status tag (Figure 4) shall be affixed to the cylinder(s) and the cylinder(s) shall then be transported with care to prevent damage to the cylinder or the cylinder valve. The cylinder status tag will go on the valve. Cylinders should be segregated for empty and full.

4.6.1 The cylinder cap must be kept tightly in place at all times except when in use.

4.6.2 Transport the cylinder only with the supplier's truck .The cylinder must be adequately secured within the truck.

4.6.3 Do not smoke while handling or transporting gas cylinders.

4.6.4 Cylinders shall be moved by means of an approved hand truck or cart. Cylinders shall never be dragged, rolled, or slid even for short distances. (Hand movement is allowed between the cart and cabinet)

4.7 Once the cylinders is at its designated delivery area, the cylinder(s) must be secured by a restraint system (i.e. strap, rack and chain) restraint system (i.e. strap, rack, chain).

4.7.1 At the discretion of the OEHS, cylinders with height: diameter aspect ratio equal to or less than 2.1:1 may be exempted from complying with paragraph 5.7.

4.7.2 Dollied cylinders (DOT 4L and similar) that are used to contain and transport liquid nitrogen are exempted from complying with paragraph 5.7.

4.7.3 Gas cylinders which are less than 25" in height (i.e. acetylene, MAP gas, oxygen, SCBA) are exempted from 4.7 provided that they are stored upright and in such a manner to prevent tipping over.

4.8 SCBA cylinders may be stored on their sides provided that they are restrained from rolling.

4.9 The cylinder valve cover must remain in place at all times during storage.

4.10 If at any time a cylinder is found to be or suspected of leaking, refer to Section 9.

5. TRANSPORTING GAS CYLINDERS

5.1 Cylinder valve covers must remain in place at all times during transportation.

5.2 Personnel transporting the cylinders are required to wear all of the appropriate protective equipment for the task and type of gas (see Table 2.0).

5.3 Gas cylinder carts (specialized hand trucks) must be used for transport. Individuals may only handle one cart at a time and the carts shall be pushed ahead rather than pulled by the employee.

5.4 The gas cylinder is not to be removed from its cart until the cylinder that it is replacing is leak checked and disconnected.

5.5 If the disconnected cylinder is found to be leaking, STOP, refer to Section 9.

5.6 When removing Dichlorosilane cylinders from a shipping crate, the crate must be moved to the chemical dock for storage until the next Dichlorosilane cylinder is returned to that crate for shipping.

5.7 Gas cylinders which are less than 25" in height are exempted from Section 5.3 above, provided that all the following conditions are met:

5.7.1 The person transporting the cylinder is wearing the appropriate PPE, as described in Table 2,

5.7.2 The cylinder is not handled in a rough manner.

5.7.3 The cylinder is not too heavy for the transporter to easily lift, and

5.7.4 Only one cylinder is carried at a time, small welding gas cylinders, MAP gas cylinders, propane cylinders and refrigerant cylinders. If a cart is used to transport these cylinders, care needs to be taken to ensure that the cylinder is properly restrained in/on the cart. In the case of SCBA cylinders, a maximum of 2 SCBA cylinders may be carried at one time.

5.8 Due to the possibility of slow leaks, do not transport compressed gas cylinders in passenger elevators where freight elevators are available.

5.8.1 If there are no freight elevators in the building, you and/or the person transporting the cylinder shall prohibit entry of passengers in the elevator with the cylinder.

5.8.2 The person accompanying the cylinder must block the elevator doors at each floor between the start and final floors with a "Temporarily Out of Service" sign before placing the cylinder inside the elevator.

5.8.3 Toxic, corrosive, oxygen displacing and depleting gases are forbidden to be transported in an elevator with personnel. Two people are required for transporting toxic or corrosive gases. One person is designated as the loader and the second person is designated as the unloader. The loader secures the cylinder in the elevator and pushes the button for the delivery floor. He then steps out of the elevator and takes the stairs to the unloading floor. Prior to loading, the unloader is required to block the doors of the elevator between the start and final floors of the trip with "Temporarily Out of Service" signs and required to be in place wearing appropriate PPEs to receive the cylinder at its destination floor.

5.9 If at any time a cylinder begins to tip over to fall, DO NOT ATTEMPT TO CATCH IT AS IT WILL RESULT IN SERIOUS INJURY. Let it fall.

6. DELIVERING CYLINDERS TO THE PURCHASER

6.1 Upon arrival at the delivery destination, the purchaser must receive the cylinder and sign the receipt. In the absence of the purchaser or a designated agent of the purchaser, the cylinder must be returned to the vendor's storage facility and the purchaser will incur any associated delivery cost. A second attempt of delivery will be made upon request.

6.2 The purchaser must ensure that the cylinder is safely secured and is appropriately labeled as full, in use, or empty.

6.3 Never leave compressed gas cylinders outside the lab or in the corridor unattended.

7. INSTALLING OR REMOVING GAS CYLINDERS

7.1 Whenever installing or removing a gas cylinder containing toxic, corrosive, flammable, pyrophoric, or irritants the "Buddy System" must be used. Two people wearing PPE must be working together and one person must be located outside of the hazard area ready to respond in an emergency.

7.2 Personnel installing or removing compressed gas cylinders (and the Buddy) are required to wear the appropriate PPE (see Table 2.0)

7.3 Only personnel who have been trained on cylinder changes are qualified to do so.

7.4 Supervisors must provide correct installation instructions and training for installation.

7.4.1 Precautions must be taken when installing a gas cylinder containing toxic, corrosive, flammable, pyrophoric or irritants, to restrict unauthorized access in the immediate area. Only employees performing the cylinder change are allowed in the restricted area.

7.4.2 When performing a cylinder change in a laboratory that can be restricted by closing a door(s), the door(s) shall be closed and a sign posted on the door(s) that states that there is a “Danger Gas Cylinder Change in Progress Entrance is Not Permitted”.

7.4.3 When performing a cylinder change in an area which cannot be restricted by use of a door, the area must be roped off with caution tape and a sign indicating “ Danger Gas Cylinder Change in Progress Entrance is Not Permitted”.. The size of the restricted area shall be based upon the judgment of the persons performing the cylinder change. Factors which are to be considered include: physical layout of the area, associated hazards of the gas, space needed to perform the cylinder change, and general room ventilation.

8. RETURNING THE USED CYLINDER

8.1 The user must leak test and replace its valve outlet cover and keep the used cylinder secured.

8.2 The "IN SERVICE" section of the cylinder status tag shall be removed, so only the "EMPTY" section remains. The cylinder status tag shall be attached to the outside of the cylinder cap so that the tag is visible.

8.3 Contact CRS to arrange the vendor pick up.

8.4 While removing the EMPTY cylinder follow the same procedures as specified in Section 5.0 (TRANSPORTING COMPRESSED GAS CYLINDERS)

9. LEAKING GAS CYLINDERS

9.1 There should be no reason to transport a leaking cylinder into a UAH building. All cylinders shall be leak tested prior to removal from the delivery vehicle.

9.2 If a cylinder is found to be leaking, attempt to relocate it into an exhausted gas cabinet or hood within the nearest room, if it is safe to do so.

9.3 Wear the appropriate PPE as specified in Table 2.0.

9.4 Leaking Gas Cylinders

9.4.1 If a leaking cylinder is detected during receipt. DO NOT ACCEPT. If it is safe to do so, locate the cylinder within an exhausted cabinet. If it is on a delivery vehicle, leave it on the vehicle. Only handle the cylinder if you have been trained in emergency response.

1. If the gas is hazardous evaluate the threat posed by the risk and move and/or isolate the delivery truck to a safe distance. If this is not possible or the threat is immediately dangerous to health and safety evacuate to a safe distance away from the cylinder. Call 911, state your name, problem, gas type, location, and telephone number that you can be reached.

2. Police will contact the appropriate emergency responders. Emergency responders will stabilize the cylinder.

3. Remain in the nearest safe or assembly area until the all-clear is provided by the Building Emergency Coordinator.

4. Handling and Disposal of Leaking Gas Cylinders

9.4.2 Upon discovery of a non-hazardous leaking gas cylinder the cylinder should be relocated near a fume hood or to a well-ventilated area, tagged as “Defective Cylinder” and the vendor contacted immediately for pick-up.

9.4.3 In all cases the following departments must be notified upon discovery of a leaking cylinder:

1. **Office of Environmental Health & Safety**

2. **Department chair, PI or supervisor**

TABLE 1 – GAS CLASSIFICATION

GAS NAME	SYMBOL	TOXIC	CORROSIVE	OXIDIZER	PYROPHORIC	FLAMMABLE	CRYOGNIC	INERT
Acetylene	C2H6					X		
Ammonia	NH3		X			X		
Argon	Ar							X
Arsine	AsH3	X				X		
Boron Trichloride	BCI3		X					
Boron Trifluoride	BF3		X					
Carbon Dioxide	CO2							X
Carbon Monoxide	CO	X				X		
Carbon Tetrafluoride	CF4							X
Chlorine	CI2	X	X	X				
Chloroform	CHCI3	X						
Diborane	B2H6	X			X	X		
Dichlorosilane	H2SiCI2	X	X			X		
Difluoromethane	CH2F2					X	X	
Disilane	Si2H6				X	X		
Decacarbonyldirhenium	Re-2(CO)10	X						
Dodecacarbonyltriruthenium	Ru3(CO)12	X						
Ethylene	C2H4					X	X	
Fluorine (5% in Helium)	F2	X	X					
Forming Gas (Hydrogen/Nitrogen mixture)	H2N2							X
Freon 11 (Trichlorofluoromethane)	CCl3F							X
Freon 12 (Dichlorodifluoromethane)	CC12F2							X
Freon 14 (Tetrafluoromethane)	CF4							X
Freon 22 (Chlorodifluoromethane)	CHCIF2							X
Freon 23 (Trifluoromethane)	CHF3							X
Freon 113 (Trichlorotrifluoromethane)	CCI2FCCIF2							X
Freon 115 (Chloropentafluoroethane)	C2CIF5							X

GAS NAME	SYMBOL	TOXIC	CORROSIVE	OXIDIZER	PYROPHORIC	FLAMMABLE	CRYOGNIC	INERT
Freon 116 (Hexafluoroethane)	C2F6							X
Germane	GeH4	X			X	X		
Helium	He							X
Hexafluoro-1,3-butadiene	C4F6	X				X		
Hydrogen	H2					X		
Hydrogen Bromide	HBr	X	X					
Hydrogen Chloride	HCI		X					
Hydrogen Fluoride	HF		X					
Hydrogen Sulfide	H2S	X				X		
Liquid Nitrogen	LN2						X	X
Liquid Oxygen	LO2			X			X	
Methane	CH4					X		
Methyl Chloride	CH3CI					X		
Methylene Fluoride	CH2F2					X		
Methyl Fluoride	CH3F					X		
Methylsilane	CH3SiH3				X	X		
Neon	Ne							X
Nitrogen	N2							X
Nitrogen Trifluoride	NF3		X	X				
Nitrous Oxide	(NO)			X				X
Octafluorocyclobutane	C4F8	X						
Octafluorocyclopentene	C5F8	X						
Octane	C8H16					X		
Oxygen	O2			X				X
Ozone	O3	X	X	X				
PDE-100	CF4 & O2							X
Phosphine	PH3	X			X	X		
Propane	C3H8					X		
Silane	SiH4				X	X		
Silicon Tetrafluoride	SiF4		X					
Silicon Tetrachloride	SiCI4		X					
Sulfur Hexafluoride	SF6							X
Tetramethylcyclotetrasiloxane	C4H16O4Si4					X		

GAS NAME	SYMBOL	TOXIC	CORROSIVE	OXIDIZER	PYROPHORIC	FLAMMABLE	CRYOGNIC	INERT
Trimethylsilane	C3H10Si					X		
Tungsten Hexafluoride	WF6	X	X					
Xenon	Xe							X

TABLE 2 – REQUIRED PPE

REQUIRED PPE	SHIPPING/RECEIVING	TRANSPORTING	INSTALLING
Toxics (OSHA permissible Exposure Limit (PEL) <500 ppb)	Safety glasses / steel-toes shoes / gloves, leather	Safety glasses / steel-toes shoes	SCBA or airline respirator w/SKA-PAK / steel-toes shoes / gloves, chemical-resistant / arm-guards / apron or chemical resistant smock.
Corrosives	Safety glasses / steel-toes shoes / gloves, leather	Safety glasses / steel-toes shoes	SCBA or airline respirator w/SKA-PAK / steel-toes shoes / gloves, chemical-resistant / arm-guards / apron or chemical resistant smock.
Pyrophorics	Safety glasses / steel-toes shoes / gloves, leather	Safety glasses / steel-toes shoes	SCBA or airline respirator w/SKA-PAK / steel-toes shoes /flame retardant gloves / Nomex flame resistant hood/ flame resistant coat
Flammables	Safety glasses / steel-toes shoes / gloves, leather	Safety glasses / steel-toes shoes	SCBA or airline respirator w/SKA-PAK / steel-toes shoes /flame retardant gloves / Nomex flame resistant hood/ flame resistant coat
Cryogenics	Safety glasses / steel-toes shoes / gloves, leather	Safety glasses / steel-toes shoes / gloves, cold-retardant	Safety glasses / steel-toes shoes / gloves, cold-retardant gloves, cold-retardant / apron, cold retardant / face-shield
Inerts	Safety glasses / steel-toes shoes / gloves, leather	Safety glasses / steel-toes shoes	Safety glasses / steel-toes shoes

APPENIX 1 – CYLINDER TAGS

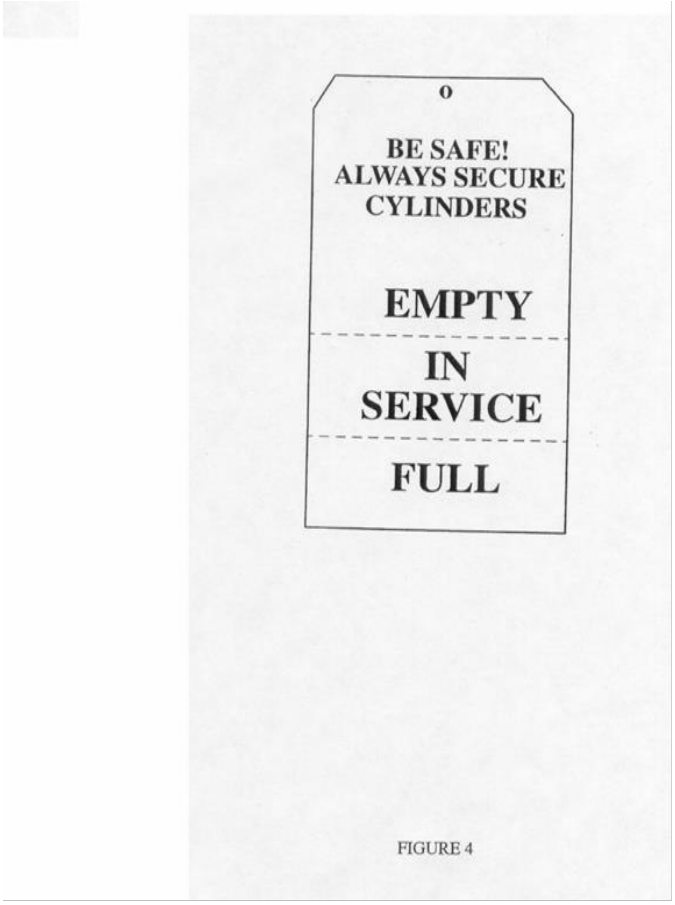
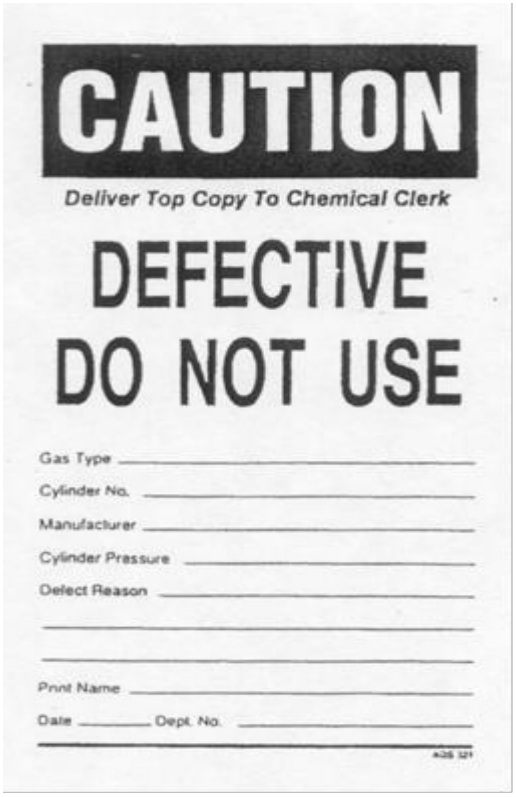


FIGURE 4

APPENDIX 2 - DEFECTIVE CYLINDER TAGS



CAUTION

Deliver Top Copy To Chemical Clerk

DEFECTIVE
DO NOT USE

Gas Type _____

Cylinder No. _____

Manufacturer _____

Cylinder Pressure _____

Defect Reason _____

_____

_____

Print Name _____

Date _____ Dept. No. _____

REFERENCES

1. http://esh-docdb.fnal.gov/cgi-bin/RetrieveFile?docid=878&ver
2. http://www.ehs.iastate.edu/publications/manuals/gascylinder.pdf