SECTION 14

Compressed Air and Gas Safety

SECTION 14: COMPRESSED AIR AND GAS SAFETY

Compressed Air

Compressed air is air kept under high pressure that is used on its own and to power mechanical devices. This section provides information about the hazards involved with compressed air and the associated safe work practices. It also contains information about pneumatic impact tools and compressed air systems.

What Hazards Are Associated With Compressed Air?

Compressed air is a focused stream of air driven at a high velocity, which can cause serious injury or death to its operator or persons in the immediate area if used improperly.

Compressed air is extremely forceful

Air pressure of 40 pounds per square inch (psi) can dislodge chips and other particles and drive them into your eyes and face with the force of shrapnel. Flying particles can also cause cuts and bruises to other parts of the body. Damage depends on the size, weight, shape, composition, and speed of the particles.

Compressed air itself can be a serious hazard

Compressed air, even at relatively low pressures (as low as five psi) can cause serious injuries to the eyes, ears, or any other body part. Compressed air can even enter the bloodstream through a break in the skin or through a body opening and cause air bubbles in the blood that lead to serious medical problems.

Compressed air is noisy. Hearing damage can result from the sound of compressed air, which can reach 120-130 decibels (dB) - well above Cal OSHA's 90 dB permissible exposure limit.

Safe Work Practices

Can compressed air be used for cleaning?

No - because compressed air is so powerful, it must NEVER be used for cleaning. Using compressed air to clean debris off clothes is hazardous. Injuries can be caused by the stream of air or by flying dust or debris. Use a brush or vacuum cleaner to clean equipment and remove debris.

Training

You must receive the appropriate training for using compressed air during your site orientation in the shop. This training will help you to understand the limits of the equipment you are using and know how to shut it off when necessary. Know the maximum allowable pressure of the compressor, and make sure that all pipes, hoses, and fittings match the pressure rating. Locate air supply shutoff valves as close as possible to the point of operation.

PPE

Wear the appropriate personal protective equipment (PPE) for the task. Safety glasses are always required when using compressed air or pneumatic tools, and face guards or shields and hearing protection are required with some impact tools. Gloves and steel-toed shoes may also be required. Never wear loose clothing while working with compressed air and tie long hair back or secure under a cap.

Inspections

All components of compressed air systems should be visually inspected regularly. This includes the air receivers or tanks, air distribution lines, pressure regulation devices, and air compressors.

Pneumatic Impact Tools

Pneumatic tools include air compressors and a variety of tool attachments. Wrenches, nail guns, and blow guns are common attachments. Although they require some special handing, they can save a great deal of time and effort and are relatively easy to use.

Always visually inspect the tool, air hose, and fittings for damage, wear and tear, or missing parts before using. Make sure air hoses and fittings are securely tightened. If a tool fails the pre-use inspection, notify your supervisor and tag it out of service by attaching a red tag that states “DO NOT OPERATE – EQUIPMENT TAGGED OUT.”

Never point pneumatic impact tools toward a person. Turn off the air supply at the control valve and tool blade before disconnecting a pneumatic tool (unless it has quick disconnect plugs). Be especially careful when using pneumatic tools around fuel, flammable vapors, or explosive atmospheres. They can generate static electricity and must be grounded or bonded when these chemical hazards are present.

Compressed Air System

A compressed air system is comprised of an air receiver, air distribution lines, and a pressure regulatory device.

Air Receivers

Testing air receivers. Only hydrostatically tested and approved tanks may be used as air receivers. The only time the maximum allowable pressure of an air receiver can be exceeded is when testing it.

Be prepared to inspect air tanks and install them so that the entire outside surface can be easily inspected. Do not bury them or place them in hard to reach locations. The intake and exhaust pipes of small tanks must be removable for interior inspections. Tanks over 36 inches in diameter must have manholes. Inspection openings are sufficient for smaller tanks. Tanks with volumes of 5 cubic feet or less can have pipe lug openings.

Air Distribution Lines

Select air lines made of high quality materials with standard fittings and secure connections. Check hoses before use to make sure they are free of defects and properly connected to pipe outlets. Repair or replace defective equipment immediately.

Identify the maximum allowable pressures (psi) by tagging or marking pipeline outlets.

Air hoses are subject to damage and can become hazards. Avoid bending or kinking air hoses. Hose reels can help with this. Keep air hoses free of grease and oil to prevent deterioration. Secure hose ends to prevent whipping if an accidental cut or break occurs. Whenever possible, suspend hoses overhead for more efficient access and protection against damage, and to reduce tripping hazards.

Pressure Regulation Devices

Use ASME approved cast iron seat or disk safety valves that are stamped for the intended service application.

Air Compressor Safety Guidelines

1. Make sure air intake is from a clean outside source.
2. Use filters or screens to maintain clean air intake.
3. Do not operate gasoline or diesel powered compressors indoors.
4. When using equipment outside buildings, position exhausts so they are directed away from doors, windows, and air intakes.
5. Ground all exposed, non-current carrying, metal parts of a compressor.
6. Operate at manufacturer's recommended speeds.
7. Keep equipment from overheating.
8. Use guards on all moving parts, such as compressor flywheels, pulleys, and belts.
9. LO/TO the switches of electrically operated compressors during maintenance to prevent accidental starting.
10. Disconnect portable electric compressors from the power supply before performing maintenance.
11. Use Cal/OSHA compliant air nozzles with pressure-relieving valve.

Valves, gauges, and other regulating devices should be installed such that they cannot be made inoperative. Never set the valve higher than the maximum allowable working pressure of the receiver. The safety valves should be set to blow at pressures slightly above those necessary to pop the receiver safety valves. Settings must be less than 15 psi or 10% above the standard operating pressure of the compressor. Shield blow-off valves to prevent personal injury and equipment damage from sudden blow-offs.

Do not position stop valves on air lines running between the compressor and the receiver.

If the design of a safety or a relief valve allows liquid to collect on the discharge side of the disk, equip the valve with a drain at the lowest point where liquid can collect.

Maintaining Compressed Air Equipment

Keep equipment appropriately lubricated, while avoiding over lubricating. Do not use flammable lubricants on compressors, because they often operate at high temperatures that could cause a fire or explosion.

Frequent cleaning with soapy water (e.g., lye solutions) is recommended to keep carbon deposits off of compressor parts. Do not use kerosene or other flammable substances to clean compressed air equipment. Be sure to purge air systems after each cleaning.

Compressed Gas Cylinders

Compressed gas cylinders are specifically designed to contain gases under pressure and to safely dispense the gas through a control valve. This section provides information about compressed gas cylinders and their associated hazards and safe handling guidelines.

What Kinds of Compressed Gases Are Stored in Cylinders?

There are three major categories of compressed gases stored in cylinders: liquefied, non-liquefied, and dissolved gases.

Liquefied Gases

Liquefied gases can become liquids at normal temperatures when they are inside cylinders under pressure. They exist inside the cylinder in a liquid-vapor balance or equilibrium. When the cylinder is new, it primarily contains liquid gas with vapors filling the space above the liquid. As the gas is removed from the cylinder, liquid evaporates to replace it, keeping the pressure in the cylinder constant. Anhydrous ammonia, chlorine, propane, nitrous oxide, and carbon dioxide are examples of liquefied gases.

Non-Liquefied Gases

Non-liquefied gases are also known as compressed, pressurized, or permanent gases. These gases do not become liquid when they are compressed, unless they are exposed to extremely high temperatures. Common examples of these are oxygen, nitrogen, helium, and argon.

Dissolved Gases

Dissolved gases are dissolved in a volatile solvent in order to stabilize them. Acetylene is the only common dissolved gas used on campus. It is an unstable chemical and can explode at atmospheric pressure. Nevertheless, acetylene is routinely stored and used safely in cylinders at high pressures (up to 250 psi at 21°C), because the cylinders are filled with an inert, porous filler. The filler is saturated with acetone or another suitable solvent. When acetylene gas is added to the cylinder, the gas dissolves in the filler, resulting in a stable solution.

Hazards

Compressed gases present unique hazards. Depending on the particular gas, there is a potential for simultaneous exposure to both mechanical and chemical hazards.

Mechanical hazards

All compressed gas cylinders are hazardous because of the high pressures inside the cylinders. Gas can be released deliberately by opening the cylinder valve, or it can be released accidentally from a broken valve, leaking valve, or from a broken safety device. Even at relatively low pressure, gas can flow rapidly from an open or leaking cylinder. The large amount of potential energy resulting from the compression of the gas makes the cylinder a potential rocket or fragmentation bomb. Exposing the cylinders to extreme temperatures or physically damaging them in any way can pose serious threats to life and property.

Chemical hazards

Gases stored in cylinders range from inert and harmless, to toxic, and explosive. The range includes the following:

- Flammable or combustible
- Explosive
- Corrosive
- Toxic or poisonous
- Inert
- A combination of hazards

Flammable gases, such as acetylene, butane, ethylene, hydrogen, methylamine, and vinyl chloride, can burn or explode under certain conditions. A gas can ignite at temperatures between its lower flammable limit (LFL) and upper flammable limit (UFL), called the flammable range. The flammability range of any gas is widened in the presence of oxidizing gases such as oxygen or chlorine and by higher temperatures or pressures.

An ignition source must be present for a flammable gas to ignite. There are many possible ignition sources in most workplaces, including open flames, sparks (either resulting from work being done in the shop or from static electricity), and hot surfaces.

Flash-back can occur with flammable gases. If a cylinder leaks in a poorly ventilated area, these gases can settle and collect in sewers, pits, trenches, basements or other low areas. The gas trail can spread far from the cylinder. If the gas trail contacts an ignition source, the fire produced can flash back to the cylinder.

Some pure compressed gases are chemically unstable. If exposed to slight temperature or pressure increases, or mechanical shock, they can readily undergo certain types of chemical reactions such as polymerization or decomposition. These reactions may be violent, resulting in fire or explosion.

Some compressed gases are **corrosive**. They can burn and destroy body tissues on contact. Corrosive gases can also corrode metals. Common corrosive gases include ammonia, hydrogen chloride, chlorine, and methylamine.

Many compressed gases are **toxic**. Health problems can result from exposure depending on the specific gas, its concentration, length of exposure, and the route of exposure (that is, inhalation, eye, or skin contact).

Even though inert gases, such as argon, helium, and nitrogen, are not toxic and do not burn or explode, they can cause injury or death if present in high concentrations. Large quantities can displace enough air to reduce oxygen levels. If oxygen levels are low enough, people entering the area can lose consciousness or die from asphyxiation. Low oxygen levels can particularly be a problem in poorly ventilated areas, such as confined spaces.

Who Can Handle Gas Cylinders?

You must be trained before handling compressed gas cylinders. Training must include how to read and interpret the cylinder label and the Safety Data Sheet (SDS) for the gas in the cylinder. You also need to understand the hazards that cylinders present and how to handle, transport, and dispose of cylinders. If you are required to use PPE, you must be provided with it and trained in its use and wear.

Hard copies of SDSs for all compressed gases that you handle must be kept in your Shop Safety Manual/SDS binder for easy access. SDSs can be found online on the manufacturer's website or at https://ehs.ucop.edu/sds/#/.

How Do I Know What is in a Compressed Gas Cylinder?

The contents of all compressed gas cylinders must be clearly identified. The manufacturer or shipper must label or tag each cylinder with the name of its contents.

Do not accept any compressed gas cylinder without an identifying label or tag. If the labeling on a cylinder becomes unclear or a tag is defaced to the point where the contents cannot be identified, mark the cylinder as

"contents unknown" and return directly to the shipper or manufacturer.

What other identifying information is required?
Rooms with compressed gases must have a National Fire Protection Association (NFPA) fire diamond posted at the entry of the room with the hazard classifications and the types of gases stored.

All gas lines leading from a compressed gas supply should be clearly labeled to identify the gas, the shop or area served, and the relevant emergency telephone numbers.

Safe Handling Guidelines

Careful procedures are necessary for handling compressed gases. This includes the cylinders containing the compressed gases, regulators or valves used to control the gas flow, and the piping used to confine the gases during flow.

Users and installers must know the type of gas contained in cylinders before installation and use. The cylinder must be returned to the supplier if its content is not identified, if the hydrostatic test date is past due, or if it is damaged. An inventory must be kept of all gas cylinders used and stored in your shop. The inventory must be kept in the shop's SDS binder.

Never modify, tamper with, paint, deface, obstruct, remove, or repair any part of the cylinder, including the pressure relief device, the container valve, or the valve protection device. This can turn a cylinder into a potential rocket or fragmentation bomb and result in serious injury. Never strike an electric arc on the cylinder. This can cause an explosion and fire.

What PPE is required?
Steel-toed, slip-resistant shoes and gloves are required when transporting cylinders. Eye-protection, face shields, and protective aprons may be required when working with the gas, depending on the gas in the cylinder.

When are regulators and caps required?
Regulators and caps are always required. Never use a cylinder without attaching the correct pressure regulator. After attaching the regulator, check the adjusting screw of the regulator to see that it is released before opening the cylinder. Never permit the gas to enter the regulator suddenly.

Before using a cylinder, slowly "crack" the valve to clear dust or dirt. Do not stand in front of the regulator gauge glass when opening the valve and make sure that the opening is not pointed toward anyone. Additional precautions must be taken with toxic or flammable gas cylinders.

If there is a leak between the cylinder and regulator, always close the valve before attempting to tighten the union nut. Regulators must be removed from the cylinders when not in use and replaced with caps. Never force the regulator or cap when removing or replacing them. In addition, the cap should only be hand tightened.

How do I handle leaking cylinders?
If you discover a leaking cylinder, first evaluate the size of the leak and hazards of the gas. For minor leaks, immediately evacuate the room or area. If it is safe to do so, wear the appropriate PPE to match the hazard, and

move the cylinder to a safe place such as a fume hood. Immediately contact both Environment Health & Safety and the cylinder vendor to inform them of the leaking cylinder.

If you find a major and uncontrollable leak, immediately evacuate the room or area. Call 911 and initiate the emergency response procedures outlined in your emergency response/action plan or chemical release procedures.

Storage

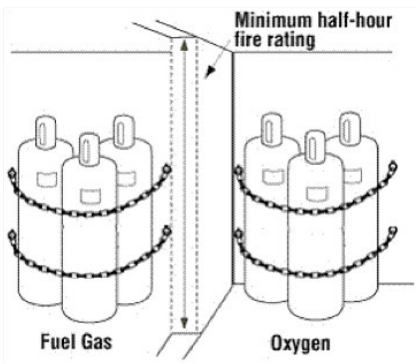
Chaining

Compressed gas cylinders must be double chained to a stable structure, such as a wall. Install one chain one-third from the bottom of the cylinder and a second chain one-third from the top of the cylinder. Do not use straps or bench clamps for securing cylinders. If chains are needed, submit a request to Facilities Management or contact EH&S for guidance on having restraints installed.

A maximum of three cylinders may be clustered together. Secure cylinders of equal sizes together to avoid chaining problems.

Casings

Whenever feasible, use cylindrical "clam shell" casings or frame casings to secure cylinders next to workbenches. Clam shell casings are safer than chains for larger sized cylinders, and frame casings can be used to secure cylinders of various sizes. Both types of casings allow cylinders to be securely bolted to the floor and secured adjacent to the working area, away from walls and without the need for chaining.



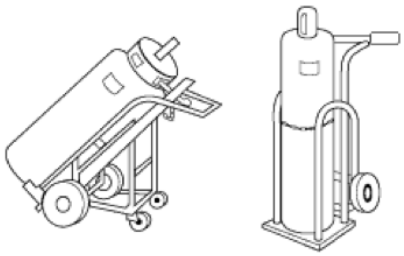
How do I store cylinders that contain different types of gases?

You must store oxygen cylinders at least 20 feet away from fuel-gas cylinders or combustible materials (especially oil or grease). If this is not possible, you can separate them by a noncombustible barrier that is at least five feet high with a fire resistance rating of least one-half hour. The barrier must be at least 18 inches above the tallest cylinder. Some shops have affixed five-foot sheet metal partitions between cylinders to meet regulations.

Additional Storage Requirements

As a general rule, never store cylinders on transportation carts. The only exception to this rule involves the use of welding cylinders (oxygen and fuel cylinders). When used for portable service or for intermittent use, welding cylinders may remain on carts.

Always store cylinders in upright positions on their base unless they are designed for use in a horizontal position. If used horizontally, they must be secured horizontally.



Cylinder Trolleys

Transporting Cylinders

Unless cylinders are secured on a special cart, remove the regulators, close the valves, and replace with the protective valve caps before moving them. Do not lift the cylinder by the protective valve caps. Transport cylinders weighing more than 40 pounds on a cart and secure them with a chain.

Always handle cylinders with care. Cylinders must never be dragged, pushed, or pulled across the floor. Never drop a cylinder, or permit cylinders to strike each other violently when moving. Load cylinders to allow as little movement as possible and secure them to prevent violent contact or upsetting.

Disposal

When cylinders are empty or no longer needed, you must dispose of them. Empty cylinders must be marked "Empty" and stored apart from other cylinders. Whenever possible, return empty cylinders to the supplier. If the supplier is unknown, dispose of the cylinder as hazardous chemical waste through EH&S.

Never discard pressurized cylinders in the trash.