

Handling Chlorine Safely



What Water Technicians need to know to understand the hazards and precautions for handling gaseous and/or Liquid Chlorine

Why is this class needed?

1. The **NJ DEP** requires annual operator training for employees who could be exposed to a toxic gas. At the minimum, the training must include:
 - Hazards of Chlorine.
 - Effects of exposure.
 - Safety systems.
 - PPE.
 - Storage and Handling.
 - Emergency procedures.
2. **Federal EPA** regulates chlorine quantities of 2,500 pounds or more.
3. The **Chlorine Institute** is pushing its members to require training programs for all customers of their member companies.

Sources of Information

- Shipping papers
- SDS
- HSFS
- SOP's

The Properties of Chlorine

- At normal pressure it is gas but under pressure it is liquid.
- Gaseous chlorine is yellow but liquid chlorine is amber color.
- It is pungent and suffocating.
- It is slightly soluble in water.
- Wet chlorine is very corrosive.
- Chlorine has a vapor density 2.5 so it is heavier than air. Always remain at ground level in case of leakage.
- The CAS registry number is 7782-50-5.

Hazards of Chlorine

- PEL is 1 PPM Ceiling (Never to be Exceeded)
- Short term exposure limit is 1ppm
- Under this limit one can work safely up to 15 minutes with out any irritation, chronic tissue change and any other problem.
- Fatal dose is 1000ppm
- Chlorine has not been identified as a Human carcinogen

Health Hazard of Chlorine Liquid or Gas

- Chlorine is very corrosive & reacts with body moisture to form corrosive acid.
- Cause respiratory injury ranging from irritation to death.
- 0.2 – 0.4 Odor threshold (decrease in odor perception occurs over time)
- Up to 0.5ppm no long term affect.
- 1-3 ppm can be recognized by nose & preventive can be taken immediately
- 5-15 ppm Moderate Irritation, gas is very irritating
- 40-60 Toxic Pneumonitis and pulmonary edema
- 100 ppm can cause lethal damage
- 1000 ppm Fatal within a few minutes

Other Hazards of Chlorine

Fire

- Chlorine is neither explosive nor flammable. Chlorine will support combustion under certain conditions. Many materials that burn in Chlorine Atmospheres

Corrosive Action on Steel

- At ambient temperatures, dry chlorine, either liquid or gas, does not corrode steel.
- Wet chlorine is highly corrosive because it forms hydrochloric and hypochlorous acids. If water is used on a chlorine leak, the resulting corrosive conditions will make the leak worse

Volumetric Expansion

- The volume of liquid chlorine increases with temperature. Precautions should be taken to avoid hydrostatic rupture of piping, vessels, containers, or other equipment filled with liquid chlorine

Reactivity of Chlorine

- Chlorine has great affinity for Hydrogen
- Reacts with water to produce toxic and corrosive solution of HCl & HOCl
- Reacts with NH_3 in the cold to produce extremely explosive Nitrogen Tri Chloride
- Reacts with many metals & nonmetals to form the salt.
- Chlorine can react, at times explosively, with a number of organic materials such as
 - Oil & grease from sources such as air compressors, valves, pumps, oil-diaphragm instrumentation, pipe thread lubricants, as well as wood & rags from maintenance work.

Equipment Maintenance

- All chlorine piping and equipment should be carefully visually inspected on a regular basis.
 - Suggest using our checklist
- Inspections can also be done using ultrasonic thickness testing, eddy current testing, magnetic flux testing, and other non destructive testing

Required Training

- Description of hazards and properties of Chlorine - SDS & HSFS 0367
- Review of your Authority's SOP on Cylinder Change out
- How to inspect the Chlorine Gas Cylinder room - JIF checklist
- Consider using a MEL Media video to supplement your briefing
- Describe the operating characteristics of your gas monitoring system
- Review the spill/release procedures.
- Describe the mandatory PPE
- Discuss your respiratory protection program/equipment.



Precautions for Using Gaseous Chlorine in 150 Pound Cylinders

Incompatibilities'

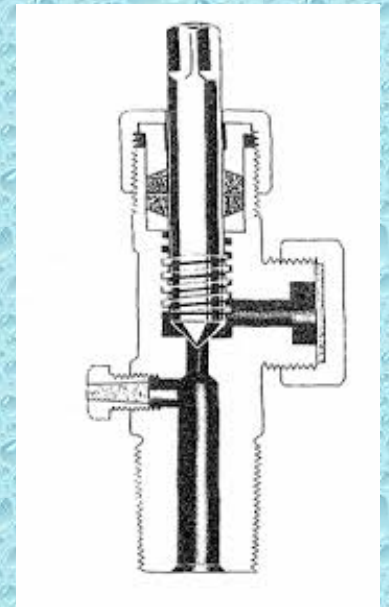
Incompatible Material		Mixing May Result In
Alum (Aluminum Sulfate) Aluminum Chloride Ferrous or Ferric Chloride Ferrous or Ferric Sulfate Nitric Acid Hydrochloric Acid (HCl) Sulfuric Acid	Hydrofluoric Acid Fluorosilicic Acid Phosphoric Acid Brick & Concrete Cleaners Chlorinated Solutions of Ferrous Sulfate	<p>Release of chlorine gas, may occur violently.</p>
Ammonium Hydroxide - Ammonium Chloride - Ammonium Silicofluoride - Ammonium Sulfate	Quaternary Ammonium Salts (Quats) Urea	<ul style="list-style-type: none"> • Formation of explosive compounds. • Release of chlorine or other noxious gases.
Fuels & Fuel Oils Amines Methanol Organic Polymers	Propane Ethylene Glycol Insecticides, Solvents, & Solvent Based Cleaning Compounds Cotton cellulose	Formation of chlorinated organic compounds. - Formation of explosive compounds - Release of chlorine gas, may occur Violently
Copper Nickel Vanadium	Cobalt Iron Molybdenum	Release of oxygen gas,

Handling & Storage of Cylinders

- Compressed gases shall be handled only by properly trained persons. Training must include the contents of this guide as well as specific information relevant to Chlorine.
- Safety shoes are required when moving cylinders.
- Cylinders should not be dragged or physically carried.
- Transport cylinders with a hand truck designed for the transport of cylinders. Cylinder caps shall be secured during transport.
- Prevent damage to cylinders. Locate cylinders where they will be protected from physical damage

Chlorine Cylinder Safety Devices

- Cylinder valves are equipped with a pressure relief device consisting of a **fusible metal plug in the valve body**, located below the valve seat.
- The fusible metal is designed to melt between 158°F and 165°F to relieve pressure and prevent rupture of the cylinder in case of exposure to high temperatures.
- Cylinders should always be stored upright. They are stamped near the neck ring area with the tare weight and the date of the last hydrostatic test. According to U.S. Department of Transportation [DOT]
- Cylinders must be hydrostatically tested every five years. DOT regulations prohibit the marring or defacing of these markings



Minimum PPE

Wear the appropriate personal protective equipment during the procedure.

- Full-face respirator with fresh Cl₂ cartridges (Orange)
- Gloves
- Hard hat
- Safety shoes
- Long sleeved shirts
- Long Pants
- Clothing and gloves should be free of oil or grease.
- Self contained breathing apparatus with full face mask nearby for emergencies



Cylinder Change Guidelines

- Changing cylinders or containers is one of the most likely opportunities for exposure to chlorine. It is extremely important to make sure all operators are thoroughly trained before attempting the task.
- **100 and 150-Pound Cylinders:**
 - Make sure the cylinder is upright and properly secured.
 - The yoke and adapter connects the cylinder valve outlet to the feed system.
 - A gasket must be used on the valve face and **MUST** be replaced with every new connection.
 - Failure to replace the gasket will often lead to a chlorine leak. **Do NOT** reuse the old gasket.

Disconnecting Containers

- As soon as a container is empty, the valve should be closed
- Prior to disconnecting, reconfirm that the valve is closed and provide a means of removing the chlorine trapped in the flexible connecting line.
- Personal Protective Equipment should be used as appropriate for the task
- The container should be cautiously disconnected in case residual chlorine remains in the lines.
- The outlet cap should be applied promptly and the valve protective housing should be replaced. The open end of the disconnected flexible line should be capped promptly to keep atmospheric moisture from entering the system.

Valve Opening Procedure

1. Remove outlet cap and check outlet face
2. Verify valve is closed
3. Connect the Pigtail using the proper yoke and a NEW lead washer
4. Tighten the connection
5. Open the valve momentarily and close
6. Check for leaks using aqua Ammonia vapors
7. Open the valve one complete turn
8. Leave the wrench on the valve

Closing Valves

- Apply 25-30 foot-pounds to the valve stem. Check for leaks. If any leaks still exist,
- the torque may be increased up to 40 foot-pounds.
- If the leak has not stopped at 40 foot-pounds, increase the torque on the valve stem to 50 foot-pounds. If this fails to work, contact your supplier.

Leakage Detection

- Exact leakage point of chlorine can be detected by ammonia vapor squeeze bottle.
 - If a leak exists, it will form a white cloud.
- Liquid chlorine leakage should be converted to gaseous leakage by turning the cylinder.
- One volume of liquid chlorine gives **460** volume of gaseous chlorine.
- Leakage should always be attended by using PPE

Response to Chlorine Leaks

- **NEVER** respond to a chlorine leak unless you have been properly trained and have the necessary safety equipment—including a self-contained breathing apparatus and protective suit.
- If you have an existing ***Emergency Action Plan*** for evacuating the area and/or notification plan review that information with your crew..
- Call 9-1-1
- Make a list of all relevant contact numbers and keep it posted at several locations in the plant
- Inform local police and fire departments about the chemicals used in your plant, especially
- chlorine, so they can be prepared if an emergency occurs
- Whether a chlorine leak is handled in-house or not, your Emergency Response Plan should detail the exact procedure.
- Most importantly, practice, practice and practice the procedure.

Additional Precautions

For Users of One Ton Chlorine Cylinders

Changing Ton Cylinders

1. Turn the valve stem clockwise to close ton container valve.
2. Allow float in flow meter to drop to zero. Indicator on front of gas feeder should show red indicating no gas. All liquid must be vaporized from the trap.
3. Wait about one minute. Float should remain at zero. If float flutters or does not drop to zero, valve may not be closed tightly. Make certain valve is closed before proceeding.
4. Turn off ejector and make certain the gas supply indicator stays in the “No Gas” position by turning the “Reset” knob. If the indicator resets, either gas pressure is still present or there is an air leak in the system. Refer to instruction manual if an air leak is evident.
5. Loosen gas feeder yoke screw. Remove gas feeder from valve.
6. Replace ton container. Make sure the full container is oriented with the valves in the vertical position, one valve above the other. The top valve will always supply gas chlorine and the bottom valve will give liquid chlorine.

Changing Ton Cylinders - Continued

7. Remove old lead gasket. Inspect and clean mating surfaces of gas feeder and valve. Install new unused lead gasket.
8. Position gas feeder on new gas cylinder and tighten yoke screw. Do not tighten excessively
9. Be sure heater is plugged in and operating. An operating heater provides heat to vaporize any trapped liquid.
10. Crack open gas cylinder valve and reclose quickly. Check for leaks. If leaks exist, turn on ejector and *repeat steps 2, 3, 4, and correct leaks.*
11. Leak test solutions: Chlorinator/Sulfonator- Ammonia: Ammoniator-Bleach.
12. Open ton container valve slowly about ¼-turn only and leave cylinder wrench on valve.
13. Turn on ejector.

Using Liquid Chlorine Solutions



Additional precautions from the use of
gaseous Chlorine

CP-34 Tablets

Hypochlorite solution

Effects of Exposure

- The degree of reaction to exposure to any chemical depends on three main factors: the amount one is exposed to, the route of exposure (breathing, touching, etc.), and the length of time of the exposure.
- The lowest level at which humans can smell chlorine and notice its irritant properties generally provides sufficient warning of exposure; however, chronic exposure to chlorine causes adaptation of the sense of smell (olfactory fatigue) and tolerance to its irritant effects.
- Long-term exposure to low levels of chlorine gas is potentially linked to diseases of the lung (bronchitis, shortness of breath, possible permanent damage) and tooth corrosion.
- Hazardous concentrations may develop quickly in enclosed, poorly-ventilated, or low-lying areas. Keep out of these areas. Stay upwind.

Precautions for Safe Handling

- Ensure good ventilation of the work station.
- Remove contaminated clothing immediately. Clean contaminated clothing.
- Keep the substance free from contamination.
- Do not discharge the waste into the drain.
- Keep away from naked flames/heat.
- Observe strict hygiene.
- Keep container tightly closed.
- Measure the concentration in the air regularly.
- Carry operations in the open/under local exhaust/ventilation or with respiratory protection.
- Avoid contact with skin and eyes. Do not breathe, vapors.
- Wear personal protective equipment.