

# The City of Troy



# Chlorine Standard Operating Procedure

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## **What is Chlorine?**

Pure chlorine comes in two forms: gas and liquid. Chlorine gas is easily liquefied under pressure. Typically, a commercial cylinder contains liquefied gas under pressure.

Chlorine gas has a disagreeable, sharp, pungent, penetrating odor. In airborne concentrations above 1000 parts per million (ppm) it has a greenish-yellow color. In smaller concentrations it is colorless. Chlorine gas is 2.5 times heavier than air and tends to flow downhill and pool in lower areas. Wind and weather, however, will cause a chlorine gas cloud to disperse, spreading it in all directions, even uphill.

Liquid chlorine is a transparent, amber-colored, oily fluid that is 11 times heavier than water. Liquid chlorine has a high compression ratio. The ratio of liquid to gas is 1 to 460, which means that 1 L of liquid chlorine expands to form 460 L of pure chlorine gas.

## Hazards of Chlorine

### Health -

Chlorine is corrosive. It can burn moist body surfaces such as the eyes, nose, throat, lungs, and wet skin because it forms harmful acids when it reacts with moisture.

Repeated exposure to chlorine does not produce an immunity or tolerance. Long-term exposure to low concentrations of chlorine may cause a gradual decrease in lung efficiency. A single exposure to a high concentration can cause the same effect.

Long-term complications may occur after breathing in high concentrations of chlorine. Complications are more likely to be seen in people who develop severe health problems such as fluid in the lungs (pulmonary edema) following the initial exposure.

### Fire -

Chlorine will not burn by itself, but will support combustion.

### Chemical Action -

Chlorine, in both gas and liquid forms, reacts with almost all chemicals, usually with a release of heat. At high temperatures, chlorine reacts vigorously with most metals. For instance, a chlorine reaction can cause stainless steel to catch fire or melt.

Some water treatment facilities use chlorination, a process in which chlorine and ammonia are mixed in a water solution. Chlorination is safe because chlorine and ammonia mixed in a water solution do not present a serious risk. The process may form chloramines, which are toxic, but only at concentrations higher than for chlorine gas. Pure chlorine gas, however, may react vigorously with ammonia gas. An excessive mix of the two gases in air can produce hazardous compounds such as the explosive nitrogen trichloride. In facilities that use chlorination, the pure chlorine and ammonia must be stored in separate, sealed rooms or buildings.

Chlorine leaks are usually confirmed using a standard ammonia test. This test is safe because it uses ammonium hydroxide (ammonia dissolved in water or moist air) rather than pure ammonia. Chlorine reacts readily with ammonium hydroxide to form ammonium chloride, a relatively harmless compound. This reaction forms a white cloud, indicating a chlorine leak. The continuous monitors now required indicate chlorine leaks automatically, but the ammonia test is still useful for pinpointing the exact location of a leak.

### Corrosive Action -

Chlorine reacts with water or moisture in the air to form highly corrosive acids. Every precaution must be taken to keep chlorine and chlorine equipment moisture-free. Never use water on a chlorine leak.

## **Responsibilities**

According to the City of Troy Safety Policy, supervisors and or department heads must develop and implement an effective health and safety program specific to their department, which includes training workers and supervisors in relevant safety procedures to their day to day jobs or responsibilities.

## **Materials Safety Data Sheet (MSDS)**

Material safety data sheets are included with or attached to each hazardous materials container, implement, etc. These MSDS's assure the employee(s) who work with or near chlorine or other hazardous materials, are instructed in its safe use, storage, handling, and disposal. MSDS's may be in the form of labels, stickers, print outs, or other forms of identifying chlorine containers, etc. or any other hazardous chemical systems.

Supervisors and or department heads shall make these documents, stickers, or other forms of information available to the employees and or exposed public at all times. It is highly recommended that employees make themselves familiar with all information pertinent to their individual job safety as it relates to chlorine and the use or maintenance of hazardous chemicals.

## Exposure Control

Chlorine is a severe irritant. As noted above, when mixed with water (including moisture in mucous membranes, eyes and skin), it forms an acid. The primary route of exposure is through the eyes and respiratory system.

Exposure to chlorine has effects ranging from irritation to death, depending on the concentration and time of exposure.

A level of 10 ppm is considered *Immediately Dangerous to Life and Health* under the National Institute for Public Safety and Health (NIOSH).

At low levels for a short time, chlorine can cause eye irritation, coughing, sneezing, and throat irritation. At higher levels, labored breathing and vomiting may occur. Death can result from suffocation.

Department heads, supervisors, and employees should take all necessary precautions to assure that exposure levels are kept at such minimum levels to not cause harm to exposed individuals and or the public.

Chlorine tanks, containers, etc. should be maintained, carried, handled, etc. in a manner that will reduce the likelihood of employee contact.

Chlorine may be stored indoors or outdoors, though shading from sunlight is recommended for outdoor storage. Storage areas should be away from HVAC intakes, as chlorine gas could be distributed throughout a building in case of a leak.

Indoor storage areas should have a ventilation fan located near the floor with a fresh air intake near the ceiling. The ventilation fan must be operated a switch that is weather proof and located outside the chlorine room entrance door. The fan should be turned on and allowed to run prior to entering the chlorine room.

Separate the chlorine storage area from incompatible materials, especially ammonia, sulfur dioxide, and hydrocarbons like fuels and oils.

Employees should never handle chlorine or any other hazardous chemical without proper authority and training. Employees should also never handle chlorine or other hazardous chemicals when other means or methods of contact are feasible.

## Safe Work Practices

### Changing Chlorine Cylinders -

This work procedure requires that only competent employees change cylinders. A Filtered Half Face Respirator shall be worn when chlorine cylinders are being changed, during general maintenance, etc.

The following safe work procedure for changing cylinders is for a non-emergency situation, when the alarm has not been activated. (If the alarm has been activated, workers would follow the emergency procedures seen on page 8.)

1. Turn on the exhaust ventilation before entering the room.
  2. Put on appropriate personal protective equipment if a leak is known or suspected.
  3. Turn on the light and visually ensure that the room is safe to enter (there may be visible signs of damage).
  4. Close the main chlorine container valve.
  5. Allow the system to purge itself of chlorine. Ensure that the float drops to the bottom of the feed-rate indicator (rotameter). Verify that there is a high vacuum and that the weigh scale reads zero.
  6. Loosen the chlorinator (auxiliary valve or vacuum regulator) and remove it from the empty cylinder.
  7. Replace the cylinder cap on the empty chlorine cylinder and remove the cylinder to secured storage.
  8. Secure the new cylinder into place.
  9. Remove the protective hood from the new cylinder.
  10. Ensure that there is no chlorine leaking from the packing gland. Use ammonia vapor from the ammonia test bottle, which contains a strong ammonia solution (25% or 26° Baumé).
  11. Ensure that the cylinder valve is closed. Do not open the valve yet.
  12. Remove the cylinder outlet cap and check that the cylinder outlet face is clean and smooth.
  13. Using a new washer, connect the vacuum regulator or the yoke assembly to the valve outlet using the supplied wrench only.
- Note: Never use oil-based material or water to clean the mating surfaces.
14. Crack open the chlorine cylinder valve and then quickly close it again. This will let enough chlorine into the lines to charge them. The valve should open with no more than a sharp rap from the heel of your hand. Never use a "helper" wrench or a larger wrench than the one supplied. If the valve will not open, carefully loosen the packing gland slightly.
  15. Check all the connections you have made to ensure there are no leaks. Use the vapor from the ammonia test bottle (see step 10). If a leak is indicated, activate the leak control procedure.
  16. When no leaks are indicated, open the chlorine cylinder valve no more than half a turn and leave the cylinder wrench on the valve.
  17. Open any additional system valves and test for leaks as each stage is charged with chlorine.
  18. Check for leaks again with the ammonia test bottle to be sure that everything is in order.
  19. Ensure that the alarm system is functioning.
  20. Turn off the exhaust ventilation and lights and close the door when you leave.
  21. Remove your respirator or other personal protective equipment.

## Leak Detection and Control –

More than one employee must be present while leak repair or alarm repair/response is occurring.

This section covers two components: What to do if a leak is indicated after a cylinder change and what to do if the chlorine alarm is activated during routine operation of the system. If the ammonia test indicates a leak after a cylinder change, follow these steps.

Note: Employees shall wear a Self-Contained Breathing Apparatus when performing the following:

1. Immediately close the main cylinder valve.
2. Open (and close) the main cylinder valve and repeat the ammonia test.
3. If a leak is still indicated, make a third and final attempt to get a good seal using a new lead washer.
4. If the leak cannot be corrected after three attempts, remove the cylinder from service and contact the supplier. Ensure that there is no leak from this cylinder with the main valve closed. A different cylinder must be connected to the chlorination system.
5. Leave the chlorine room and remain nearby to restrict access to the room or provide other assistance, as directed, until the chlorine alarm has automatically shut off.

If the chlorine alarm has been activated during routine operation of the system, at least two people must respond. Follow these steps:

1. Approach the location cautiously.
2. If chlorine gas can be smelled in the open, immediately leave the area and activate full emergency procedures. Do not attempt to turn on the exhaust ventilation.
3. If the chlorine concentration is less than 10 ppm:
  - Put on the appropriate personal protective equipment.
  - Enter the room and close the main cylinder valve.
  - Turn on the ventilation system and leave the area until the alarm stops.
  - While still wearing the SCBA, enter the room after the alarm has stopped, isolate the leak, and perform necessary repairs. Remember that all chlorine lines must be free of oil, grease, and moisture before re-opening the chlorine cylinder.

Note: Never apply water to a chlorine leak. Moist chlorine is more corrosive than dry chlorine and the leak will worsen rapidly if water is applied to it. Remember also that a chlorine leak never gets better — it always gets worse.

## **Responding to Emergencies**

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.

Maintain a secure area around the leak within a reasonably safe distance. Call 911 and make emergency responders fully aware of the situation. Notify the department head as soon as possible.

Emergency Phone Numbers:

911

Troy Police Department 334-566-0500

Haynes Ambulance 334-566-0518

General Manager, Brian Chandler 334-372-0234

Assistant General Manager, Mike Davis 334-697-0062

To speed response and recovery, each department should have the appropriate Chlorine Institute Emergency Kit at the site or available within a timely manner:

- Kit A: for 100 or 150-pound cylinders

Whether a chlorine leak is handled in-house or requires the use of emergency response, your Standard Operating Procedure should be followed. These procedures should be practiced and reviewed on an annual basis. Finding the Emergency Response Plan and reading it is not a good option in the middle of a chlorine gas leak.

Refer to the Materials Safety Data Sheet for more specific information about chlorine and other chemicals emergency handling.

## **Working Safely Around Chlorine**

### Storing Chlorine -

This section describes what you must and must not do when storing chlorine.

- Use signs to clearly identify all areas where chlorine is used or stored. Only qualified personnel are permitted to enter these areas.
- Store chlorine cylinders and containers in a cool, dry, and relatively isolated area, protected from weather and extreme temperatures. If storing cylinders and containers outside, shield them from direct sunlight, unless they are specifically designed for unshaded, outdoor storage.

Note: Never apply heat to pipes, containers, or container valves unless they have been thoroughly purged of chlorine.

- When storing chlorine containers inside, store the containers in a well-ventilated building, away from any heat sources, such as steam pipes.
- Store chlorine containers on the lowest working level but not below grade.
- Store cylinders upright and secure them against falling. Cylinders will discharge vapor when upright and discharge liquid when upside-down.

## **Repair and Maintenance**

Workers should be familiar with these procedures before carrying out repairs or maintenance on the chlorine system. Qualified workers must supervise the cleaning and repairing of chlorine systems. Workers must be familiar with all the hazards and the safeguards necessary to perform the work safely.

The chlorine system must be shut off before cleaning or repairing it, and all piping and other equipment must be thoroughly purged with dry air or nitrogen. Vacuum systems can be purged by drawing the remaining chlorine into the process. Do not weld any part of a chlorine system until it has been purged with dry air or nitrogen.

## **Personal Protective Equipment**

Controlling exposure requires strict attention to chlorine exposure limits. Appropriate eye, skin, and respiratory protection are essential. Workers must be familiar with and understand the requirements of their employers written exposure control program.

### **Respiratory Protection -**

This section outlines the types of respirators available to protect workers from exposure to chlorine and the limitations of each respirator. Respirator choices must be based on the needs of each individual worksite.

#### **Filtered Half Face Respirator -**

Half face respirators shall be used in general daily maintenance and/or use of chlorine, chlorine equipment, changing tanks or cylinders, general maintenance, etc. The mask are not to be used in an oxygen deficient environment, but will assist an employee in leaving a hazardous areas where chlorine has leaked. Safety glasses shall be worn when a half face respirator is in use. These mask should be maintained as per manufactures recommendations and cleaned after each use.

#### **Self-Contained Breathing Apparatus (SCBA) -**

A worker must use an SCBA when a chlorine leak is suspected and the airborne chlorine concentration is unknown or is measured at more than 10 ppm or when responding to an alarm. A worker wearing an SCBA must not enter a contaminated atmosphere until a second, qualified person is present, also equipped with an SCBA, and ready to perform a rescue. SCBA air cylinders should be refilled annually or after each use, whichever comes first. Cylinders must have a hydrostatic test at least every five years. Since workers rely on this equipment in immediately dangerous to life or health conditions, it is essential that maintenance and inspections be carried out according to the manufacturer's instructions. These instructions are located in the carry box that the unit was delivered in.

## First Aid

All employees must keep and maintain basic first aid kits in their issued City of Troy vehicles at all times. These kits are available through the utility warehouse manager or the Risk Management Coordinator. These kits should be at minimum OSHA/ANSI compliant and marked as such on the front cover/lid.

When someone is injured in a chlorine-related incident, first aid can help reduce the impact of their injuries and prevent further injuries from occurring. The following steps apply to any situation in which someone is injured:

### DIAL 911

1. Do not panic.
2. Ensure that there is no more danger to yourself or the victim.
3. Using appropriate safety gear, remove the victim from the contaminated area.
4. Send for medical help or administer first aid (if you have been properly trained).

### Chlorine Inhalation -

Someone who has inhaled chlorine may be unconscious, and may have difficulty breathing or may have stopped breathing completely. Follow these steps when treating a victim of chlorine inhalation:

### DIAL 911

1. Assess the victims breathing:
  - If breathing has stopped, begin artificial respiration (if you have been properly trained) and continue until the victim resumes breathing. Pocket masks are recommended for artificial respiration, although the mouth-to-mouth method may also be used.
  - If the victim is having difficulty breathing (for example, gasping or coughing), place the victim in the most comfortable position, usually semi-sitting.
2. If an oxygen therapy unit and trained personnel are available, administer oxygen at a 10-litre flow.
3. Ensure that the victim is transported to hospital in case the victim suffers a delayed reaction in the form of pulmonary edema. Any physical exertion, excitement, or apprehension increases the chance and severity of a delayed reaction. Keep the victim warm and completely at rest. Reassure the victim while waiting for assistance and transportation to hospital.

## Skin Contact -

Skin contact with chlorine can result in severe burns. Before attempting to flush a victim's contaminated skin, make sure the victim is breathing properly. Follow these steps:

### DIAL 911

#### 1. Assess the victims breathing:

- If breathing has stopped, begin artificial respiration (if you have been properly trained) and continue until the victim resumes breathing. Pocket masks are recommended for artificial respiration, although the mouth-to-mouth method may also be used.
- If the victim is having difficulty breathing (for example, gasping or coughing), place the victim in the most comfortable position, usually semi-sitting.

2. As soon as the victim resumes breathing, flush the victims contaminated skin and clothing with large amounts of water for 30 minutes.
3. Remove all contaminated clothing while flushing.
4. Continue flushing until all traces of chlorine have been removed.
5. Dress obvious burns with sterile gauze and bandage them loosely. Apply insulated cold packs to help reduce pain.
6. Get the victim to hospital.

### Note:

1. Do not attempt to neutralize the chlorine with other chemicals.
2. Do not apply salves, ointments, or medications unless prescribed by a doctor.
3. Skin contact with liquid chlorine coming straight out of a cylinder can result in frostbite.

## Eye Contact -

### DIAL 911

Eye contact with chlorine (liquid or gas) for even a short period can cause permanent disability. Flushing must begin within 10 seconds. Follow these steps:

1. Flush the eyes immediately with large amounts of running water (preferably lukewarm) for 30 minutes. Hold the eyelids forcibly apart to ensure full flushing of the eyes and eyelids.
2. After flushing has removed all traces of chlorine, cover both eyes with moistened sterile gauze pads and bandage, enough to keep light out.
3. Apply insulated cold packs to help reduce pain.
4. Get the victim to hospital.

### Note:

1. Do not attempt to neutralize the chlorine with other chemicals.
2. Do not apply oils, ointments, or medications to the eyes.