



Chlorine Facts

Significance of Chlorine in the United States

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UN # 1017

Chlorine is often used as a bleaching agent, in treatment of sewage effluent, for water purification, and as a disinfectant. At room temperature it is a yellow-green gas with a sharp, burning odor. It becomes a clear, reddish colored liquid under increased pressure or at temperatures below minus 30 degrees F. Chlorine is usually shipped as a compressed liquid in steel cylinders. The sheer volume of chlorine required to meet the needs of users places it on the list of the top ten chemicals produced in the US.

Chlorine Releases in North Carolina

The information in this report was collected by staff in the North Carolina Hazardous Substances Emergency Events Surveillance (HSEES) Program. Chlorine releases in North Carolina have resulted in injuries, hospitalizations, and workplace evacuations (Table 1). Some examples of chlorine releases in NC include:

- *A hotel employee mixed chlorine bleach with an alkaline chemical for cleaning purposes. The chemicals were stored in the washroom next to the front desk. Two desk clerks were overcome by the toxic gases and complained of nausea and dizziness. The local fire department, HAZMAT, and local emergency management coordinators responded to the emergency.*
- *While changing the regulator on a one-ton cylinder of chlorine, an employee in a wastewater treatment center was exposed to chlorine gas. Plant HAZMAT workers were able to turn the valve off and stop the leak. The affected employee was transported to the hospital with respiratory problems.*
- *A chlorine leak occurred at a wastewater treatment plant due to a leaky cylinder valve. Ten people were evacuated from a campsite downwind of the facility.*
- *A gasket leak in a pipeline occurred at a paper/pulp mill. Over 2,295 pounds of chlorine gas were released into the air. Seventeen employees were exposed and complained of difficulty breathing, eye irritation, and nausea. First aid was given to 14 of the workers and 3 others were transported to the hospital. Everyone was evacuated from the building. Company HAZMAT personnel responded to the emergency.*

Table of Contents

Significance of Chlorine in US	1
Chlorine Releases in NC	1
Common Routes of Chlorine Exposure	3
Acute Health Effects of Chlorine Exposures	4
Chronic Health Effects of Repeated Exposure to Chlorine	4
Proper Handling and Storage Procedures	4
Personal Protective Equipment	5
First Aid Management	5
Decontamination	5
Spill Management	6
NC HSEES Program	6
Resources and Information	7

Of the 61 chlorine releases that occurred between 1993-1997 in North Carolina, 57 (93.4%) occurred in fixed facilities and four (6.6%) took place in transit. Most of the fixed-facility spills resulted from unintended releases from pipelines (N = 16, 28.1%), above-ground storage tanks (N = 17, 29.8%), and process vessels (N = 13, 22.8%). Efforts to identify the factors contributing to chemical releases were initiated in 1995. Of the 16 chlorine events that occurred from mid-1995 to 1997, 7 (43.8%) were caused by equipment failure. Operator error was cited as the major contributing factor in another 5 (31.3%) incidents. Table 2 lists the types of industries involved in chlorine releases. Location of chlorine releases is shown in Map 1.

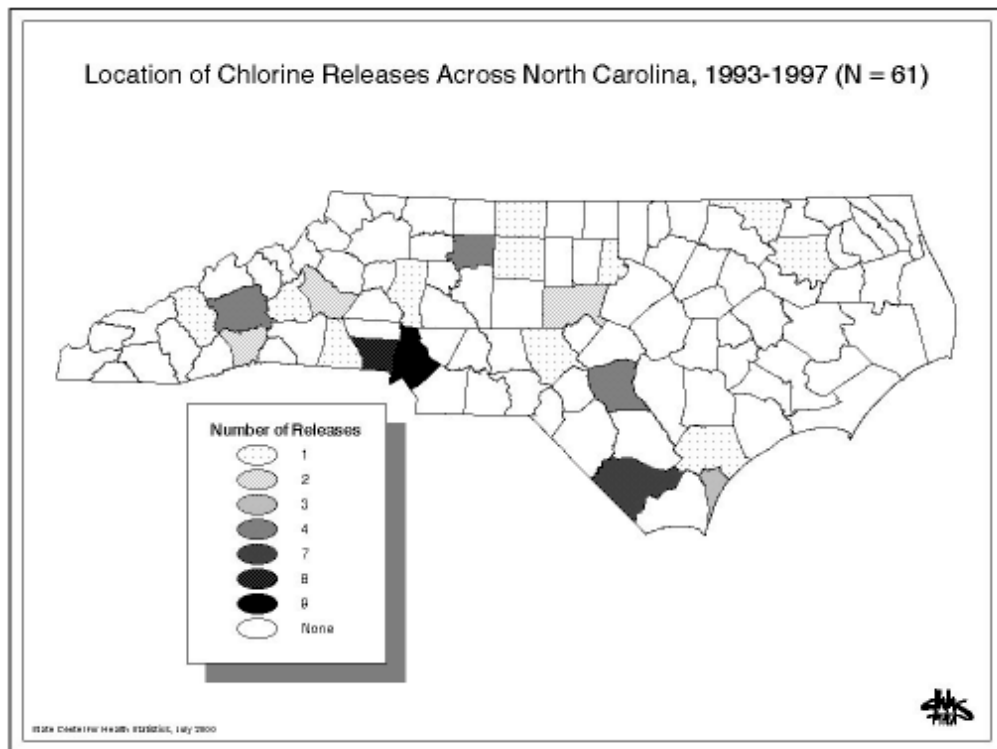
Table 1: Summary of HSEES Data on Chlorine Releases in North Carolina, 1993-1997

Survey Question	No.
Number of chlorine releases	61
Number of events involving victims	21
Number of victims	70
Types of injuries: <ul style="list-style-type: none"> ▪ Respiratory ▪ Eye irritation ▪ Nausea/vomiting ▪ Dizziness ▪ Headache ▪ Other 	 59 33 38 16 16 6
Range of amounts released	1 – 2298 pounds
Type of chlorine release: <ul style="list-style-type: none"> ▪ Spill only ▪ Air release only ▪ Spill and air release ▪ Air release and explosion ▪ Fire ▪ Threatened release 	 9 37 11 1 1 2
Events with decontamination <ul style="list-style-type: none"> ▪ No. of events with responders decontaminated ▪ No. of events with employees decontaminated 	 7 5 2
Events requiring evacuation	26
Type of response: <ul style="list-style-type: none"> ▪ Ad hoc (no pre-existing plan followed) ▪ Company's operating procedures ▪ HAZMAT/response team's SOP ▪ Other ▪ Unknown (respondent did not know type of response) 	 2 8 36 4 10

Table 2: Industries Involved in Chlorine Releases in North Carolina, 1993-1997

Type of NC Industry Releasing Chlorine	No. of Events
Water supply/waste water treatment	16
Chemical manufacturing	15
Swimming pool	7
Paper/pulp mill	5
Fabric manufacturing	3
Ground transportation	3
Optical fiber manufacturing	2
Dairy/poultry	2
Metal scrap/metal plating	2
Other (electric power, uniform rental, hotel youth rehab facility, rest home, rail transit)	6

Map 1: Location of Chlorine Releases across North Carolina, 1993-1997 (N = 61)



Common Routes of Chlorine Exposure

- **Inhalation.** The most common way for chlorine to enter the body is through the respiratory system. Signs and symptoms of chlorine inhalation can include
 - Rapid, difficult breathing
 - Bluish skin color
 - Wheezing and congestion
 - Cough
 - Nausea and dizziness
 - Burning, irritated throat
 - Swelling or narrowing of the airways
 - Chlorine-induced pneumonia
 - Possible lung collapse
- **Absorption through the Skin.** Chlorine can be absorbed through the skin and cause burns ranging from mild to severe depending on the length of contact. The victim may also experience pain, inflammation or swelling, and blisters. Symptoms displayed by skin exposed to liquid chlorine can include frostbite or tissue death.
- **Absorption through the Eyes.** Chlorine can also be absorbed through the eyes and cause burning or discomfort, irregular blinking, involuntary closing of the eyelids, redness, and tearing. Larger amounts of chlorine in the air may lead to severe eye burns, pain, and blurred vision.
- **Ingestion.** Chlorine may cause tissue injury upon swallowing.

Acute Health Effects of Chlorine Exposure

Generally the more severe the chlorine exposure, the more severe the symptoms. However, even minor exposures to chlorine can cause immediate burning of the eyes, nose, and throat. These symptoms can help to warn people of potentially hazardous exposure levels. But continued exposure can lead to tolerance to these irritant effects and victims may no longer be aware of chlorine's presence. The very young, the very old, and people with health problems are at an increased risk from the health effects of chlorine exposure.

Because chlorine is heavier than air, it can push the air in a room up over itself as it moves. This can lead to suffocation in poorly ventilated, enclosed, or low-lying areas.

Chronic Health Effects of Repeated Exposure to Chlorine

Acute (short-term) exposures to chlorine do not often result in long-term or chronic health effects. Long-term effects are usually found with people who have repeated exposures to chlorine. These repeated chlorine exposures can irritate the lungs and lead to cough, mucus production, or shortness of breath which can last for months or, in some cases, years.

Cigarette smoking can worsen the effects of either chronic or acute chlorine exposure. No matter how long you have smoked, quitting now will decrease the risk of developing health problems.

Proper Handling and Storage Procedures for Chlorine

Before working with chlorine, you should be trained in its proper handling and storage and know how to use proper personal protective equipment.

Chlorine should be stored in a cool, dry, well-ventilated area in tightly sealed containers protected from exposure to weather, extreme temperature changes, and physical damage. The containers should be stored separately from flammable gases, vapors, and combustible substances such as gasoline, petroleum products, alcohol-based products, ammonia, sulfur, hydrocarbons, and acetylene. Chlorine itself is not combustible, but contact with these other substances can lead to a fire or explosion. Sources of ignition usually include smoking or open flames. Chlorine is considered a strong oxidizer and steps should be taken to separate chlorine and chlorine products from incompatible material.

If a fire occurs in the immediate vicinity of chlorine cylinders, remove them promptly if it can be done safely. If removal is not possible, cool non-leaking cylinders by spraying with water. Under no circumstances should water be applied if the cylinders are leaking because it is a potent oxidizer and will react violently in the presence of water. Never use chemical or carbon dioxide (CO₂) extinguishers if chlorine is involved in a fire.

Personal Protective Equipment

□ Clothing

Avoid skin contact with chlorine. Wear protective gloves and chemical-resistant clothing. Keep clothing clean and free of oils and grease.

□ Eye Protection

Wear splash-proof chemical goggles and a face shield when working with liquid chlorine, unless full face-piece respiratory protection is worn. Gas-proof goggles with a face shield should be worn when there is chlorine gas exposure or risk for a gas exposure.

□ Respiratory Protection (respirators)

Respiratory protection should be NIOSH (National Institute for Occupational Safety and Health) approved specifically for chlorine and used in accordance with the OSHA Respiratory Protection Standard, 29 CFR (Code of Federal Regulations) 1910.134. Under routine exposures where the ambient concentration of chlorine exceeds 0.5ppm¹, an air purifying, full-face respirator equipped with chemical cartridges appropriate for chlorine should be used. For exposures of unknown concentrations of chlorine, such as uncontrolled releases, only a pressure-demand SCBA (self-contained breathing apparatus) is appropriate. Respirator use must be limited to individuals who have been adequately trained and fitted for the respirator face piece. Companies are also referred 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals Standard. Chlorine presents a potential for a catastrophic event at or above the threshold quantity of 1,500 pounds according to the List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory) in 29 CFR 1926.64 Appendix A.

First Aid Management

Prompt action is essential if there is a chlorine spill or leak. If a chlorine spill or leak occurs, take the following actions:

1. Remove the exposed person(s) to fresh air.
2. Call 911 immediately and notify company safety personnel.
3. If the victim is not breathing, begin artificial respiration.
4. If the victim is breathing, place them in a seated position or lying down with the head and upper body in an upright position. Encourage slow, deep, regular breaths. Have a health professional administer oxygen as soon as possible.
5. Keep the person warm and quiet.
6. Persons with serious symptoms may need to be hospitalized.

¹ American Conference of Governmental Industrial Hygienists, *2000 Threshold Limit Values and Biological Exposure Indices*, p. 24.

Decontamination

Clothing or the victim's skin that is soaked with chlorine solutions may be caustic and expose rescuers, as well as victims, to vapors. To decontaminate:

1. Remove soaked clothing from the victim and double-bag it immediately.
2. Flush exposed skin and hair with water for 2-3 minutes then wash twice with mild soap. Rinse thoroughly with water.
3. Flush exposed or irritated eyes with water or saline for 15-30 minutes. If the person is wearing contact lenses, try to remove them.

Spill Management

Chlorine spills will become increasingly dangerous if they are not contained promptly. If a spill or leak has occurred, take the following actions:

- Notify trained personnel immediately, such as the company HAZMAT team or the local fire department. Untrained persons or those without proper personal protective equipment must not enter areas with high concentrations of chlorine.
- Evacuate people from the hazardous area for at least 50 feet in all directions and have them stay upwind from the chlorine release. They should be sheltered in a building with doors and windows shut and air conditioners turned off.
- Stop or control the source of exposure. If the exposure is from a leaking cylinder, take the cylinder outdoors or to an open area until it has completely drained and the contents have evaporated.
- Ventilate potentially explosive atmospheres by opening windows.
- Keep combustibles such as wood, paper, and oil, away from the leak.
- Remove all sources of heat and ignition.
- Refer to the manufacturer's Material Safety Data Sheet (MSDS) for more information about chlorine hazards.

North Carolina HSEES Program

The North Carolina Department of Health and Human Services, Division of Public Health studies and describes the public health effects associated with releases of hazardous substances, such as chlorine, as part of a federal study called Hazardous Substances Emergency Events Surveillance (HSEES). North Carolina is one of 15 states participating in this study. Data are analyzed to determine trends and areas for prevention. The information is then used to develop ways to protect health and prevent or minimize hazardous substance releases.

The Division of Public Health staff are notified about spills by several sources. The primary sources of information are the NC Division of Emergency Management, the US Coast Guard's National Response Center, and the US Department of Transportation's Hazardous Materials Information System (HMIS). To gather specific information about each spill, staff contact the local emergency management personnel, fire department personnel, emergency medical personnel, and/or industry representatives.

To plan appropriate prevention strategies, we rely on accurate and timely reporting. If you are contacted about a hazardous chemical spill, please answer the questions as precisely and truthfully as possible. The information you provide is critical to preventing future spills, or reducing the risk of injury to employees, responders, and the public. Contact the NC HSEES Program at 919-733-3410 or visit our web site at www.schs.state.nc.us/epi/oii/hsees.html.

Resources and Information

- **The Chlorine Institute, Inc.**
2001 L Street, NW, Suite 506
Washington, DC 20036
202-775-2790
www.CL2.com

This is a non-profit trade association of chlorine manufacturers who are concerned with the safe transport of chlorine, employee health and safety, and control of chlorine emergencies. Trained Chlorine Emergency Plan (CHLOREP) teams can provide immediate advice for those at the scene of an emergency in either the US or Canada and are available 24 hours a day, 7 days a week.

For information or to contact the closest chlorine emergency group, call 1-800-424-9300.

- **Occupational Safety and Health Administration (OSHA)**
OSHA provides specific information about proper handling, storage, and safety and health management of chlorine. Publications can be obtained by written request or through the OSHA web page.

OSHA Publications Office,
200 Constitution Avenue NW
Room N3101
Washington, DC 20210
(202) 219-4667
www.osha.gov

For specific chlorine information: www.osha-slc.gov/SLTC/healthguidelines/chlorine/recognition.html

- **National Institute of Occupational Safety and Health (NIOSH)**
1-800-35-NIOSH (1-800-356-4674)
www.cdc.gov/niosh/homepage.html

- **Environmental Protection Agency (EPA)**
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460
202-260-2090
www.epa.gov

Chlorine information including hazard summary and health effects.
www.epa.gov/ttn/uatw/hlthef/chlorine.html

Region IV EPA (includes North Carolina)
Atlanta Federal Building
61 Forsyth Street, SW
Atlanta, GA 30303-3104
404-562-9900
1-800-241-1754

- **North Carolina Department of Health and Human Services
Occupational and Environmental Epidemiology Branch**
HSEES Program
1912 Mail Service Center
Raleigh, NC 27699-1912
(919) 733-3410
www.schs.state.nc.us/epi/oii/hsees.html



North Carolina
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www.dhhs.state.nc.us

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