

# Environmental Health Information

## Accidental Chlorine Releases

October 2005

*Chlorine is a naturally occurring and highly reactive greenish-yellow gas with a strong odor. Eighteen companies in the U.S. made more than 26 billion pounds of chlorine in 1992 alone. Chlorine is often used as a bleaching agent by paper companies, in the treatment of sewage, and as a disinfectant for drinking water and swimming pools. The largest users of chlorine are companies that manufacture ethylene dichloride and other chlorinated products.*

### Accidental chlorine releases in Minnesota

Staff with the Minnesota Hazardous Substances Emergency Events Surveillance (HSEES) program gather information on accidental chlorine releases in Minnesota. From 1995-2004:

- Chlorine was accidentally released 93 times (about 2.5% of all HSEES events for that time period (Table 1)).
- Over 8200 lbs. were accidentally released.
- Over half (53%) of these events resulted in evacuations, injuries, or both.
- 2797 people had to be evacuated during 45 of these accidental chlorine releases.
- 64 people were injured during 24 of the accidental chlorine releases (8.5% of all HSEES event victims (Table 1)).
- All but one of the accidental chlorine release events in Minnesota occurred at fixed facilities.

### Some examples of accidental chlorine releases in Minnesota include:

- A release of 4000 pounds of chlorine occurred in an aluminum smelter. Six employees were injured and admitted to the hospital with respiratory and eye irritation, and nausea. Eight employees were decontaminated at the scene. The building was evacuated for four hours. The local fire department and a HAZMAT team (trained and equipped first responders to hazardous material releases) responded to this emergency.
- A custodian in a school mixed chlorine with water and generated hydrochloric acid. Fumes moved through the school. Two employees were treated at a hospital for respiratory and eye irritation, and then released. The school was evacuated for five hours.
- A leak in a chlorine tank at a recreational pool released 15 pounds of chlorine. Fourteen children were treated at a local hospital. One child was held overnight for observation. Twelve employees and thirteen members of the general public were decontaminated at the scene.
- A leak in a chlorine container at an oil refinery caused a release of 22 pounds of chlorine. An employee on the company's response team experienced damaged personal protective equipment, and respiratory irritation and chemical burns.
- An unknown amount of chlorine was released when contractors were checking on a chlorine feeding system for a city water supply and a chlorine regulator was bumped, separating it from a chlorine cylinder. Two contractors sustained respiratory irritation that required treatment at a hospital. About 30 people were evacuated from their homes for 1.5 hours.

### Chlorine exposure and what it does to your body

People can be exposed to chlorine through inhalation (breathing in), eye and skin contact, and ingestion (eating/drinking). Chlorine effects on health depend on the concentration of chlorine gas, the length of time of exposure, and the number of times a person is exposed to chlorine.

Acute (short-term) exposure to low levels of chlorine (1 to 10 ppm) may cause eye, throat and nose irritation, sneezing, excessive salivation, general excitement, and restlessness. Higher levels (30 to 60 ppm) can cause difficulty in breathing, violent coughing, nausea, vomiting, dizziness, headache, and chemical pneumonia. The very young, the very old, and people with health problems are more likely to experience adverse health effects from contact with chlorine.

Chronic (long-term) effects are a concern for people who have had many exposures to chlorine. These repeated exposures could result in severe chest pain, sore throat, tooth enamel corrosion, inflammation inside the nose, and greater risk of developing tuberculosis.

1. *Inhalation.* Most exposures to chlorine occur by inhalation. Signs and symptoms of chlorine inhalation include:

- Rapid, difficult breathing
- Blue coloring of the skin
- Wheezing and congestion
- Cough
- Nausea and dizziness
- Burning, irritated throat
- Swelling or narrowing of the airways
- Chlorine-induced pneumonia
- Possible lung collapse

2. *Contact with skin.* Chlorine can cause mild to severe burns depending on the length of contact. The victim may also experience pain, inflammation or swelling, and blisters. Exposure to liquid chlorine can result in frostbite.

3. *Contact with eye.* Chlorine can cause burning or discomfort, irregular blinking, uncontrolled closing of the eyelids, redness, and tearing. Large amounts of chlorine in the air may lead to severe eye burns, pain, and blurred vision.

4. *Ingestion.* Ingestion is unlikely to occur because chlorine is a gas at room temperature. Products with chlorine in them (e.g., sodium hypochlorite solutions) may cause injury if eaten.

### **Personal protective equipment (PPE)**

PPE is specialized equipment designed for an individual to wear to prevent excessive contact with a hazardous chemical.

*Clothing:* Protective gloves and chemical-protective clothing prevent skin contact. Chlorine gas can collect on the skin and cause irritation and burns. Protective clothing should be kept free of oil and grease, and should be inspected and maintained regularly to preserve its effectiveness.

*Eye protection:* Splash-proof chemical safety goggles and a face shield prevent eye, respiratory system and face injury for workers who handle liquid chlorine. Gas-proof goggles with a face shield should be worn when there is chlorine gas exposure or risk of gas exposure.

Alternatively, a full-face respirator may be used.

*Respiratory protection:* Respirator use must be limited to people who have been trained and fitted for the respirator face piece.

1. Respiratory protection should be NIOSH (National Institute for Occupational Safety and Health) approved specifically for chlorine.
2. Respirators must be used in accordance with the OSHA Respiratory Protection Standard, [29 CFR (Code of Federal Regulations) 1910.134].
3. Under routine exposures where the level of chlorine exceeds 0.5 parts per million (ppm)\*, a full-face respirator equipped with a chemical cartridge for protection against chlorine gas and a dust/mist type pre-filter should be used.
4. For exposures to unknown concentrations of chlorine, such as uncontrolled releases, only a pressure-demand SCBA (self-contained breathing apparatus) is appropriate.

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

### **Proper handling and storage procedures for chlorine**

- Chlorine reacts violently with water, moisture, & steam. Steps should be taken to separate chlorine and chlorine products from incompatible materials.

- People using chlorine should be trained in 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 extreme temperature changes, and physical damage.
- It should be stored away from flammable gases and vapors, flammable substances such as gasoline, petroleum products, alcohols, ammonia, sulfur, hydrocarbons, acetylene, and finely divided metals. Chlorine itself is not flammable, but contact with flammable substances may lead to fire or explosions.
- Containers of chlorine may explode in high temperatures. If a fire occurs near the chlorine containers, remove them right away if it can be done safely. If the containers cannot be moved, cool non-leaking containers by spraying with water.
- Never use chemical or carbon dioxide extinguishers if chlorine is involved in a fire.

## Spill management

In the event of a spill or a leak, take the following actions:

- Persons not wearing protective equipment, and not totally dressed in vapor-protective clothing should NOT go near the accident area until cleanup is finished.
- Notify safety personnel immediately, such as a HAZMAT team or the local fire department.
- Remove all sources of heat, sparks, & flames.
- Keep flammable material (wood, paper, oil) away from the leak.
- Ventilate the room or building.
- Move people at least 100 feet away in all directions and have them stay upwind from the accidental chlorine release.
- Find and stop the leak if it can be done without risk; otherwise, move the leaking container away from people to a well-ventilated area until the container is empty.
- Do not put water directly on the leak or spill area because chlorine will react violently with water.

## Minnesota HSEES Program

The Minnesota Department of Health, Division of Environmental Health studies and describes health effects associated with releases of hazardous substances, such as chlorine, as part of a federal project called HSEES. Minnesota is one of 15 states participating in this study. The goal of this program is to develop ways to protect health and prevent or minimize hazardous substance releases. HSEES staff is notified about spills and air releases by the Minnesota State Duty Officer and the National Response Center.

We rely on accurate and timely data 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. If you have any questions or comments, please contact the MN HSEES staff at (651) 201-4923 or visit our website at <http://www.health.state.mn.us/divs/eh/hazardous/surv/index.html>

## Resources

Chlorine Facts. Occupational Illnesses & Injuries. 1991. NC Department of Health and Human Services, Division of Public Health, Occupational & Environmental Epidemiology Branch, Hazardous Substances Emergency Events Surveillance, Raleigh, North Carolina. <http://www.schs.state.nc.us/epi/oii/chlorine/>. April 30, 2002.

Managing Hazardous Materials Incidents. Volume III. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry.

Occupational Safety and Health Guideline for Chlorine. U.S. Department of Labor, Occupational Safety and Health Administration. <http://www.osha.gov/SLTC/healthguideline/chlorine/recognition.html>. May 1, 2002.

**For help with a chlorine release call the Minnesota Duty Officer at:  
Twin Cities metro area (651) 649-5451 or  
Statewide (800) 422-0798.**

For health and exposure information call MDH at:  
Twin Cities metro area (651) 201-4897 or  
Statewide (800) 657-3908, press #4 and leave a message.



**Table 1: Summary of HSEES Data on chlorine releases in Minnesota, 1995-2004**

HSEES Survey Category	Count
Number of chlorine releases	93
Number of events involving injury	24
Number of injured	64
Factors <ul style="list-style-type: none"> <li>• Equipment failure</li> <li>• Human error</li> <li>• Other</li> </ul>	35 53 5
Types of injuries <sup>a</sup> <ul style="list-style-type: none"> <li>• Respiratory system irritation</li> <li>• Eye irritation</li> <li>• Gastrointestinal problems</li> <li>• Skin Irritation</li> <li>• Dizziness</li> <li>• Chemical burns</li> <li>• Headache</li> </ul>	62 12 11 2 2 1 1
Range of amount released in pounds	0.0001 - 4000
Path of chlorine release: <ul style="list-style-type: none"> <li>• Air emission</li> <li>• Spill</li> <li>• Fire</li> <li>• Spill/Air release</li> <li>• Threatened release</li> <li>• Spill/Fire</li> <li>• Explosion</li> </ul>	69 12 5 3 2 1 1
Type of industry releasing chlorine <ul style="list-style-type: none"> <li>• Manufacturing/processing industries</li> <li>• Water supply/wastewater treatment plants</li> <li>• Recreational public pools</li> <li>• Private pools</li> </ul>	35 35 15 8
Location within fixed facility <ul style="list-style-type: none"> <li>• Above ground storage</li> <li>• Ancillary process equipment</li> <li>• Below ground storage</li> <li>• Dump/waste area</li> <li>• Material handling (loading/unloading)</li> <li>• Piping</li> <li>• Process vessel</li> <li>• Outdoor non-farming or non-industrial area</li> <li>• Unknown</li> </ul>	25 4 1 6 9 40 5 1 2

<sup>a</sup> Number of injuries is greater than the total number of victims because some victims sustained multiple injuries.