



Guidelines For Chlorine Gas Use in Water and Wastewater Treatment

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Saskatchewan**

Purpose

The purpose of this document is to:

- a) help ensure public safety around chlorine gas facilities;
- b) address operator and personnel safety in and around chlorine gas facilities; and
- c) standardize the siting, design and equipment criteria for chlorine gas facilities in Saskatchewan.

This document presents guidelines for the design, construction and operation of gas chlorination facilities in water and wastewater treatment facilities in Saskatchewan. The guidelines specifically apply to installations using 68 kilogram (kg) cylinders and tonne containers. The guidelines are designed to assist designers, owners, and operators of municipal and industrial chlorination facilities.

The **Hazardous Substances and Waste Dangerous Goods Regulations** (April/89, amended 25/92, 107/92, 28/94, 3/95 and 63/2000), under the *Environmental Management and Protection Act*, apply to the storage of chlorine gas where the weight of the substance stored at the facility exceeds 100 kilograms. Existing facilities require registration and new facilities require Ministerial approval under the regulations. Section 13 in this document discusses the requirements of the *Hazardous Substances and Waste Dangerous Goods Regulations*.

Pertinent **Occupational Health & Safety Regulations** (1996), based on the *Occupational Health and Safety Act* (1993) are included in this publication. Contact Occupational Health and Safety at 1-800-567-7233 (Regina) or 1-800-667-5023 (Saskatoon) for any questions that arise.

Acknowledgment

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Definitions

A **chlorine gas feed room**, for the purposes of this document, is a room that contains the chlorinator(s) and active cylinder(s) used to apply chlorine gas at a water or wastewater facility.

A **chlorine gas storage room**, for the purposes of this document, is a room other than a chlorine gas feed room, in which full, partial, or empty chlorine gas cylinders or tonne containers are stored at a water or wastewater facility.

A **gas chlorinator** is a device used to meter and control the application rate of chlorine gas into a liquid.
chlorine gas at a water or wastewater treatment facility. It is isolated from a water or wastewater treatment plant.

A **chlorine cabinet** is a pre-assembled or factory built unit that contains the equipment used to apply chlorine gas at a water or wastewater treatment facility. It is isolated from a water or wastewater treatment plant.

Table of Contents

	<u>Page</u>
1. Chlorine Gas Feed and Storage Room Requirements.....	2
1.1 Chlorinator Facility (68 kg cylinders)	2
1.2 Tonne Container Facilities.....	2
1.3 General Considerations	2
2. Ventilation.....	3
3. Heating	4
4. Gas Chlorinator Pressure Relief Vent	4
5. Doors and Windows	5
6. Chlorine Gas Feed Equipment Location.....	5
7. Water Supply Line to Chlorinator.....	5
8. Chlorine Gas Piping.....	5
9. Weigh Scales.....	6
10. Safety Considerations	6
11. Identification Signs	7
12. The <i>Hazardous Substances and Waste Dangerous Goods Regulations (HSWDG)</i> Requirements ...	7
12.1 Chlorine Gas Feed and Storage Rooms	7
12.2 Duties of Owners/Operators of Chlorine Gas Facilities	8
12.3 Decommissioning of Chlorine Gas Facilities	9
Appendix A: Start-up and Shutdown Procedures.....	9
A. Pre-Entry Procedure	9
B. Start-Up Procedure	9
C. Shut-Down Procedure.....	10
D. Minor Leak	10
E. Major Leak	11
Appendix B: Emergency Response Contingency Plans.....	12
Appendix C: Emergency Phone Contacts	14
Appendix D: Pertinent Regulations	15

1. Chlorine Gas Feed and Storage Room Requirements

1.1 Chlorinator Facility (68 kilograms cylinders)

(cylinder or wall mounted gas chlorinator)

- 1.1.1 A minimum floor space of five square metres should be provided for gas chlorinator facilities. The basic configuration should be two metres by 2.5 metres. The width should not be less than two metres.
- 1.1.2 The minimum height of the chlorine gas feed and storage room should be 2.5 metres.
- 1.1.3 If full, partially-full and empty cylinders are to be in the chlorine gas feed or storage room, sufficient space and appropriate layout should be provided to allow safe manipulation of the cylinders. (*) A chlorine gas cabinet installation acceptable to the approving authority may be allowed instead of a chlorine gas feed room. These types of cabinet installations should not be installed inside buildings or below ground level.

1.2 Tonne Container Facilities

- 1.2.1 Single tonne container on a scale platform assembly should:
 - allow minimum clearance of one metre between scale face and container valves;
 - allow minimum clearance of 0.75 metres between end of container (opposite end away from scale face) and wall;
 - allow minimum clearance of 0.85 metres between side of tonne container on scale and adjacent wall;
 - allow minimum clearance of 1.25 metres between tonne containers on separate scales;
 - allow minimum clearance of 0.85 metres between side of tonne container on scale and adjacent tonne container in reserve; and
 - allow minimum room height of 3.7 metres above scales to facilitate moving of containers.
- 1.2.2 Two tonne containers on a scale platform assembly should:
 - allow minimum clearance of one metre between scale face and container valves (allows room for chlorine gas header);
 - allow minimum clearance of 0.75 metres between end of container (opposite end away from scale face) and wall, or minimum clearance of one metre between container and wall if chlorine gas header located at this end;
 - allow minimum clearance of 0.85 metres between side of tonne container on scale and adjacent wall;
 - allow minimum clearance of 0.85 metres between side of tonne container on scale and adjacent tonne container in reserve; and
 - allow minimum room height of 3.7 metres above scales to facilitate moving of containers.
- 1.2.3. For installations using scales with up to five tonnes capacity, allow minimum clearances as outlined in Section 1.2.2.
- 1.2.4 Chlorine gas feed and storage rooms should be equipped with overhead track or monorail, hoist or crane, and lifting beam to move tonne containers. The capacity of the crane and supporting structure must be adequate to carry the anticipated loads. The rated capacity of the assembly (including slings and rigging) shall be clearly indicated on the equipment. The design, construction, installation, operation and maintenance of lifting devices shall comply with pertinent Sections of Part XIII and Part XIV, *Occupational Health and Safety (OH&S) Regulations*.

1.3 General Considerations

- 1.3.1. Testing equipment shall be available at the water treatment plant for measuring of chlorine residuals in the drinking water.
- 1.3.2. Chlorination equipment should be regularly inspected, cleaned and maintained.
- 1.3.3. A chlorine gas feed or storage room should not be located below ground level.
- 1.3.4. Sixty-eight kilogram chlorine gas cylinders or tonne containers should not be stored below ground level. These cylinders should be stored in an upright position.
- 1.3.5. A wheeled cart should be provided for movement of single 68 kilogram cylinders. Full or empty chlorine gas cylinders not in service shall be properly secured (*OH&S Regulations* Section 314 (c) {iv}). The safety chains used for this purpose should be wall anchored with a capacity of 2,225 newtons (500 pounds) or greater. Chains should be set at two-thirds of cylinder height.

- 1.3.6. All safety chains should be equipped with safety hooks.
- 1.3.7. Chlorine gas cylinders or tonne containers should not be stored within one metre of any heating device, in a moist area or in direct sunlight.
- 1.3.8. Stored tonne containers should not be stacked more than one high and should be separated by a minimum of 75 centimetres for easy access.
- 1.3.9. Tonne containers should be stored on trunnions equipped with rollers. Rollers should be designed not to allow cylinders to rotate too easily.
- 1.3.10. The chlorine gas feed or storage room shall be located and constructed in such a manner as to prevent leakage of chlorine gas to any other areas of the treatment facility (*OH&S Regulations Sections 302(1)(a) and 314 (1)*).
- 1.3.11. The chlorine gas feed or storage room should be located and constructed such that the chlorine facility is isolated from rooms containing unrelated equipment, or where personnel work. The only access to a chlorine gas room should be from directly outside the building.
- 1.3.12. The chlorine gas feed and storage rooms should be constructed of fire resistant materials having a fire resistance rating of at least two hours.
- 1.3.13. The chlorine gas feed or storage room and appurtenances shall not be located or designed such that any mechanically exhausted gas could enter a ventilating system, air conditioning unit, building or other work area (*OH&S Regulations Section 66(4)*).
- 1.3.14. The chlorine gas feed or storage room floor should be sloped towards the doorway for washing and cleaning purposes (maximum one per cent slope).
- 1.3.15. Floor drains are not permitted in chlorine gas feed and/or storage rooms (*HSWDG Regulations Section 16(1)*), except in installations using evaporators. Where approved, floor drains must be constructed of corrosion-resistant materials and must discharge to a drainage system separate from the rest of the treatment facility (*Saskatchewan Plumbing and Drainage Regulations*).
- 1.3.16. Separate fan and light switches should be located outside the chlorine gas feed or storage room. A signal device shall be incorporated to indicate when the ventilation fan is not operating properly (*OH&S Regulations Section 66 (3) {b}*).
- 1.3.17. Fan and light switches should be weather proof.
- 1.3.18. No provisions should be made for storage or use of any chemical or materials, other than chlorine gas and related components (i.e. ammonia solution for leak detection), in a chlorine gas feed room.
- 1.3.19. To provide continuous operation, spare chlorinator parts and equipment should be kept. It is recommended that solution feed chlorination equipment be available in the event of breakdown or other loss of use of the chlorine gas equipment. Spare parts and equipment should be stored separate from the chlorine gas feed or storage room.
- 1.3.20. If there may be a risk to the eyes of a worker from corrosive or other injurious substances, the employer shall provide suitable and adequate means of flushing the eyes of that worker with lukewarm water or another appropriate liquid at readily accessible locations (*OH&S Regulations Section 313*).
- 1.3.21. A device should be available to indicate the wind direction at or near the chlorine gas room.

2. Ventilation^()**

Requirements on ventilation can be found in the Occupational Health and Safety (OH&S) Regulations - Sections 65 to 67.

Note: Chlorine gas feed and storage rooms are not designed to be occupied by workers on a continuous basis. Therefore, continuous workspace ventilation is not required. Emergency ventilation is, however, required; the emergency ventilation system should be used prior to each time workers enter the chlorine gas feed or storage room and during the time workers are in the room.

- 2.1 Chlorine gas feed and storage rooms require emergency ventilation. Provision should be made for ventilation of emergency exhaust fan operation of at least 30 air changes per hour.
- 2.2 All chlorine gas feed rooms and storage rooms shall have entirely separate mechanical ventilation systems that exhaust directly to the exterior atmosphere. **There should be no continuous ventilation.** During gas leaks, chlorine gas leakage should be contained within the chlorine room itself in order to facilitate safe clean up (i.e. ventilation to atmosphere when conditions are

- suitable, use of granular activated carbon adsorption, etc.).
- 2.3 Exhaust fan motors should be totally enclosed, corrosion-protected motors.
 - 2.4 Exhaust fan intakes and discharges should be located at suitable levels, taking into account the safety of workers and the general public. Factors to consider include:
 - intakes to the exhaust fan should be approximately 15 centimetres (cm) above the floor of the chlorine gas feed or storage room;
 - proximity of the discharge to windows, doors, other buildings and areas accessible to the general public; and
 - proximity of the discharge to other ventilation/air intakes.
 - 2.5 Fresh air inlets should be arranged so that the entire chlorine gas feed and storage rooms are ventilated.
 - 2.6 Fresh air inlets should be installed at the top of a door or within 15 to 30 cm of the ceiling.
 - 2.7 Fresh air inlets should consist of a gravity or motorized louvre fitted with an insect screen and outside storm louvre. Louvres should open when the emergency fan is running.
 - 2.8 Separate fan and light switches should be located outside the chlorine gas feed or storage room. A signal device shall be incorporated to indicate when the ventilation fan is not operating properly (*OH&S Regulations* Section 66 (3) {b}).

(**) **Note to designers:** In the event of a chlorine leak, ventilated air containing chlorine may be a hazard to people and animals in the vicinity of the chlorine gas facility. In such a situation, ventilated air should be routed to a treatment system designed to reduce the concentration of chlorine discharged to the atmosphere. The treatment system should be capable of reducing the concentration of chlorine to one-half of the IDLH (Immediately Dangerous to Life or Health) level at the point of discharge. The IDLH for chlorine is 10 parts per million (source: NIOSH Documentation for Immediately Dangerous To Life or Health Concentrations (IDLHs) - U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health May 1994).

3. Heating

- 3.1 All chlorine gas feed rooms should be provided with independent heat and a thermostat that is capable of maintaining a room temperature of at least 15 degrees Celsius.
- 3.2 Heating devices used in the chlorine gas feed or storage room shall not use hydrocarbons as the fuel (reference: Section 3.9 of Can/CGA B.149.1-M-86, natural gas installation code.)
- 3.3 Permanent chlorine gas feed room heating units should not be adjacent to chlorine containers.
- 3.4 Fan forced or portable electric heating devices should be positioned so that they do not blow hot air directly onto full chlorine containers.

4. Gas Chlorinator Pressure Relief Vent

- 4.1 Each gas chlorinator should be provided with a separate pressure relief vent.
- 4.2 Pressure relief vents from gas chlorinators should discharge to the outer atmosphere, above ground level.
- 4.3 Pressure relief vent lines should run vertically from the gas chlorinators to the exit points. The length of line should not exceed 6.5 metres (m).
- 4.4 The pressure relief vent should exit vertically and have a 180 degree bend at the exit to the atmosphere.
- 4.5 The end of the pressure relief vent piping should be covered with chlorine resistant insect screen.

5. Doors and Windows

- 5.1 There should be no interior entrances from attached or integrated buildings into a chlorine gas feed or storage room
- 5.2 The chlorine gas feed room should have a shatter resistant inspection window installed in an interior wall. The window should be at least 0.20 square metres in area and allow maximum view of chlorine weighing and feeding equipment.
- 5.3.1 All doors of the chlorine gas feed and storage rooms should exit to the open atmosphere and shall comply with requirements for exits in the latest revision of the National Building Code. The door shall swing in the direction of exit.
- 5.3.2 Doors should be equipped with panic hardware of the type with integral locks on the inside of the

- chlorine gas feed or storage room door for emergency exit.
- 5.5 Where no other inspection window is provided, an entry door should be equipped with a wire reinforced shatter-proof inspection window no less than 0.20 square metres in area.
- 6. Chlorine Gas Feed Equipment Location**
- 6.1 Wall mounted chlorinators should be set at a minimum of 1.5 m above floor level.
- 6.2 Where floor mount chlorinators are installed, there should be a minimum distance of 1.5 m in front of the chlorinator. There should be a minimum distance of one metre from the rear of the chlorinator to the wall. Side clearance between each chlorinator and/or a wall should be no less than 0.5 m.
- 7. Water Supply Line to Gas Chlorinator**
- 7.1 The water supply line to the chlorine gas injector should contain the following features:
- shut off valve(s);
 - water pressure gauge set on a tee approximately 30 cm upstream of the injector with a shut-off valve;
 - a strainer that removes particles down to 0.3 millimetres in diameter; and
 - bypass capability of the strainer.
- 7.2 One chlorine resistant water pressure gauge set on a tee should be installed at the solution discharge side approximately 30 cm downstream of the injector.
- 8. Chlorine Gas Piping**
- 8.1 Chlorine gas feed lines under pressure should not carry chlorine gas beyond the chlorine gas feed room.
- 8.2 All valves, fittings, and piping used for the transport, storage and use of liquid or chlorine gas should be of a type that is Chlorine Institute Inc. approved.
- 8.3 Flexible tubing should be replaced at least annually.
- 8.4 All chlorine gas pressure lines should be located on interior walls only. Outside walls can be very cool in winter months. Cold chlorine gas feed lines could allow chlorine gas to condense into liquid chlorine.
- 8.5 When connecting the piping from the cylinders to the chlorinator or re-joining a connection, use a new lead washer.
- 8.6 Auxiliary valves of a type approved by the Chlorine Institute Inc. should be installed where there is the possibility of air entering a chlorine gas pressure feed line, including times when cylinders or tonne containers are being changed.
- 8.7 Chlorine gas pressure feed lines (small diameter) should be of sufficient length to provide for a loop of not less than 25 cm in diameter.
- 8.8 Chlorine manifolds should be made of carbon steel, seamless Schedule 80 of no less than 20 millimetres interior diameter.
- 8.9 Heaters should not be used on chlorine manifolds or chlorine gas pressure feed lines.
- 8.10 Chlorine solution discharge lines should be of materials resistant to the attack of chlorine.
- 8.11 Chlorine injection assemblies should be inserted horizontally into pipes 15 cm in diameter or larger.
- 8.12 Chlorine piping systems should be provided with acceptable supports to prevent pipe sagging. Recommended supports are discussed in the Chlorine Manual, published by The Chlorine Institute.
- 8.13 The employer shall ensure that controlled products in a place of employment that are contained or transferred in piping systems are identified through worker training and the use of colour coding, labels, placards or any other mode of identification (*OH&S Regulations* Section 322 {a and b}). Colour coding of liquid chlorine, chlorine gas and water lines should be:
- liquid chlorine lines - amber;
 - water lines - blue; and
 - chlorine gas lines - yellow with black stenciling on the piping or attachment of durable tags indicating DANGER - CHLORINE GAS.

9. Weigh Scales

- 9.1 Scales used in the chlorine gas feed room should be made of corrosion-resistant material.
- 9.2 68 kilogram chlorine gas equipment requirements:
- All chlorine gas feed rooms using 68 kilogram cylinders should be equipped with acceptable cylinder weigh scales set at grade level with integral safety chains for each cylinder. The chains should have a tensile strength of not less than 2,225 newtons (500 pounds) and be set at two-thirds of cylinder height for each cylinder. Preferred scales are of the low profile type.
- 9.3 Tonne container equipment requirements:
- Use platform-type scales, equipped with roller-trunnions, in order to allow withdrawal valves to be positioned one above the other. A locking device should be used to prevent tonne containers from rolling while connected.

10. Safety Considerations

- 10.1 An Emergency Response Plan is required within the water assurance and quality control policy (*Water Regulations, 2002* Section 43(1)). Written Emergency plans must be prepared in consultation with the Occupational Health Committee, if one exists (*OH&S Regulations* Section 310). They should be kept on-site and at the administration office. A copy must be made readily available for reference by workers. Workers must be trained in any of the procedures that require their involvement. All necessary equipment, supplies and competent personnel must be provided or made available. There are also considerations for those working alone or in isolated places of employment regarding communication and regular contact with an administrative office be maintained and that personal protective equipment be available (*OH&S Regulations* Section 35).
- 10.2.1 Chlorine gas facilities should have posted in a conspicuous place, outside the chlorine gas feed room, safety procedures for handling chlorine leaks.
- 10.2.2 A supply of 10 percent ammonium hydroxide solution (for chlorine leak detection) should be available.
- 10.2.3 When connecting the piping from the cylinders to the chlorinator or re-joining a connection, ALWAYS use a new lead washer.
- 10.5 If there may be a risk to the eyes of a worker from corrosive or other injurious substances, the employer shall provide an approved means of flushing the eyes of that worker with lukewarm water or another appropriate liquid at readily accessible locations (*OH&S Regulations* Section 313). Approved means that the equipment meets the ANSI Z358.1 standard or equivalent (determined by the OH&S director).
- 10.6 Where provided, an appropriate emergency repair kit of a type approved by the "Chlorine Institute Inc." is recommended. Personnel should be periodically trained in repair kit use. Use of chlorine repair kits by untrained personnel is not recommended. Where a repair kit is not supplied, the nearest location of such a kit should be determined and phone numbers should be posted (see Appendix C).
- 10.7 Use proper working safety equipment when changing cylinder(s). This equipment consists of rubber gloves, apron and face shield or properly-fitting goggles.
- 10.8 Proper Start-Up and Shut-Down Procedures should be followed (see Appendix A).
- 10.9 There should be no continuous ventilation.
- 10.10 A chlorine alarm system with sounding alarms and warning lights should be installed and maintained where chlorine gas is used. A chlorine gas concentration of 0.5 ppm (1.5 mg/m³) should activate the warning lights; a concentration of 1.0 ppm (3.0 mg/m³) should activate both the sounding alarm and warning lights. This alarm should not automatically activate the chlorine gas feed room or storage room ventilation system. During an emergency, the chlorine gas leakage may need to be contained within the chlorine room itself in order to facilitate effective, safe clean-up. Alarm systems should be checked frequently to ensure they are in working order.
- 10.11 A positive pressure demand type Self-Contained Breathing Apparatus (SCBA) with a full face piece, and containing a minimum 30 minute air supply, shall be located in close proximity at all installations using 68 kilogram cylinders and tonne containers. The SCBA shall be fitted with either a low pressure warning alarm or an escape bottle (*OH&S Regulations* Sections 88 to 90). The SCBA face piece should incorporate an anti-fog device. The SCBA equipment must be approved by NIOSH or by another agency acceptable to the Occupational Health and Safety Division of Saskatchewan Labour. The equipment must be maintained according to CSA

- standard Z94.4-02 or other manner acceptable the Occupational Health and Safety Division.
- 10.12 The SCBA should not be stored in the chlorine gas feed or storage room. SCBAs should be conveniently mounted in a cabinet clearly marked **AIR PACK INSIDE** in close proximity to; but outside the chlorine gas feed or storage room. It must be far enough away from the chlorine gas feed or storage room to ensure workers can put the equipment on safely.
 - 10.13 The operator(s) must be adequately trained by a competent person in the use of the SCBA and how to maintain the equipment, with a periodic refresher course (*OH&S Regulations* Section 88). The Occupational Health Committee should be consulted regarding training.
 - 10.14 The employer of any worker who is required to enter an atmosphere immediately dangerous to life shall ensure that a second worker, suitably equipped, is present and in communication at all times, and that provision is made for rescuing the endangered worker immediately if his respiratory protective device fails or he becomes incapacitated for any other reason (*OH&S Regulations* Section 90 (2)). For the purposes of these guidelines, the second worker will be referred to as a safety partner. The safety partner will be someone trained in handling chemical emergencies and in the use of respiratory protective equipment. For one-man operations, a member of the local fire department would be a good safety partner.
 - 10.15 Any time the concentration of chlorine gas or the level of oxygen is unknown, wear a SCBA. DO NOT rely on a canister type respirator.
 - 10.16 Always do a Pre-Entry Check before entering a chlorine gas feed or storage room; always use the recommended Start-Up and Shut-Down procedures.
 - 10.17 Do not tighten any pipe or hose connection in the chlorination system without first shutting off all cylinder valves and purging the system until the chlorine pressure gauge registers zero or maximum vacuum.
 - 10.18 Never lift a 68 kilogram cylinder onto the scales -- use a ramp.
 - 10.19 Notify the Occupational Health and Safety Division of any serious injuries or dangerous occurrences (*OH&S Regulations* Sections 8 and 9).

11. Identification Signs

- 11.1 A sign indicating **DANGER CHLORINE GAS** shall be installed on the exterior side of a chlorine gas feed room door. The sign shall contain a telephone number to be used in the event of an emergency at the facility (*HSWDG Regulations* Section 16(1)(b)).
- 11.2 A chlorine gas storage room shall be clearly marked **DANGER CHLORINE GAS STORAGE ROOM**. The sign shall contain storage precautions (*OH&S Regulations* Section 314 (1)(b)) and a telephone number to be used in the event of an emergency at the facility (*HSWDG Regulations* Section 16(1)(b)).
- 11.3 A sign should be installed above the light/exhaust fan switch(es) indicating **TURN ON VENTILATION FAN BEFORE ENTERING**. Proper Entry and Exit Procedures should be followed (see Appendix A).
- 11.4 A **NO SMOKING** sign and a compressed gas symbol should be positioned on the exterior of chlorine gas feed and storage room doors.

12. The Hazardous Substances and Waste Dangerous Goods Regulations Requirements

12.1 Chlorine Gas Feed and Storage Rooms

- 12.1.1 The *HSWDG Regulations* Section 8(1)(c) apply to chlorine gas feed and storage rooms where in excess of 100 kg (net) of chlorine gas is stored at any one time. These Regulations require that all existing and new facilities (see Section 12.1.2 below) be approved (see Section 12.1.3 below) by the nearest EcoRegion Office of Saskatchewan Environment (SE).
- 12.1.2 Existing chlorine gas feed and storage room facilities must be registered with the nearest EcoRegion Office of SE. Also refer to the duties of the operator/owner (see Section 12.2). Existing chlorine gas feed and storage rooms were to be upgraded to meet the full scope of the construction requirements of the Regulations by no later than March 31, 1995.
- 12.1.3 Newly constructed chlorine gas feed and storage room facilities require the issuance of an Approval to Construct from the Environmental Protection Branch of SE under the *Water Regulations, 2002*.

12.2 Duties of Owners/Operators of Chlorine Gas Facilities

12.2.1 The HSWDG Regulations Section 13 (1), Sub-section (a to f) require that owner/operators:

- maintain Material Safety Data Sheet (MSDS) information on chlorine gas;
- keep inventory records;
- keep inspection and maintenance records of leak detection equipment;
- maintain emergency response contingency plans (see Appendix B);
- record and report leakage or unaccountable discrepancies in inventory in accordance with the *Spill Control Regulations* ; and
- retain records for a period of at least two years from the time of their creation.

Section 325 of the *OH&S Regulations* also apply since chlorine is WHMIS controlled. A copy of the MSDS must be readily available to workers. Workers must be trained on chlorine hazards, WHMIS and safe work procedures. Training is to developed in consultation with the Occupational Health Committee and reviewed annually (*OH&S Regulations* Section 318).

Section 371 of the *OH&S Regulations* indicates additional requirements for compressed and liquefied gas systems.

The owner or operator of the storage facility must also provide inventories of chlorine on hand (maximum amounts) to the local fire department on a semi-annual basis. A copy of the emergency response contingency plan must be provided to the local fire department and Emergency Measures Organization on an annual basis or whenever it is revised (*HSWDG Regulations* Section 13 {1}).

12.3 Decommissioning of Chlorine Gas Facilities

12.3.1 At least thirty days prior notification of the decommissioning of chlorine gas feed and storage room facilities and submission of a formal decommissioning plan is required by the nearest EcoRegion Office of SE (*HSWDG Regulations* -- Section 17).

Appendix A Start-up and Shut-Down Procedures

The following Pre-Entry, Start-Up and Shut-Down Procedures, together with observing standard safety practices, are intended as a guide for operators working in municipal gas chlorination facilities.

A. Pre-Entry Procedure

Before entering the chlorine gas feed or storage room for any reason you should perform a Pre-Entry Procedure. This is for your own **safety**.

NOTE: If the Chlorine alarm system is activated, refer to Sections D and E.

Never try to repair a chlorine leak alone. If you are alone, report the leak and stay clear. At least two trained and authorized workers wearing SCBA with a positive pressure-demand feature are needed to respond to a leak. One repairs the leak and the other acts as a safety partner.

The Pre-Entry Procedure is as follows:

1. Ensure that the SCBA is fully charged and ready for immediate use.
2. Put on working safety equipment (gloves, apron and face shield or goggles).
3. Inspect exterior of chlorine gas feed or storage room for any hazards (pressure relief line venting chlorine, blocked exhaust fan louvers...etc.). Inspect interior of chlorine gas feed or storage room through the window for any hazards (chlorine leaks). If any hazard is found, stop to plan your next action. Get help NOW if you need it. If no hazard exists, proceed to the next step.
4. Turn on the ventilation fan. This fan must be running whenever anybody is in the chlorine gas room.
5. Ensure that the chlorine gas feed or storage room air is being blown out without any restrictions.
6. Open the door a crack and sniff the air for chlorine gas before opening it fully.

The following Start-Up and Shut-Down Procedures are to be used during equipment maintenance and repair in the chlorine gas feed room. ***This DOES include instances such as*** equipment maintenance or repair; operating manifold valves; making or breaking piping connections; and changing active cylinders.

This does not include routine activities such as feed rate adjustments; taking rotameter or scale readings; general checks or observations; and moving cylinders not connected to the active chlorine feed system.

B. Start-Up Procedure

1. Perform the Pre-Entry Procedure and leave the exhaust fan ON. Have your safety partner watching you from outside the chlorine gas room, with a SCBA on.
2. Inspect the following equipment outside and inside the chlorine room for proper connections, any obstructions or any breaks:
 - ensure that the fresh air inlet, exhaust vent/louvers are not obstructed and that the suction side of exhaust fan is unobstructed;
 - vent lines (not plugged, vented to outside, and insect screen is on the outlet end);
 - water line (piping, elbows, valves, and tees);
 - chlorinator lines (piping, elbows, valves, and tees); and
 - electric lines (plugged into sockets).
3. Start flow of water or ensure system is in "ON" mode.
4. Check Chlorinator Vacuum:
 - listen for the sound of water "whistling" through the injector;
 - if no water "whistling" sound is heard, check the water supply upstream of the injector; and
 - check the vacuum gauge (if supplied) for a vacuum reading, or disconnect vacuum line at the injector and check manually.
5. Open Valves and Cylinder:
 - open all chlorine gas valves starting at the chlorinator (chlorine feed control, manifold valve, auxiliary valve, etc.) and working toward the cylinder valve. **DO NOT OPEN THE CYLINDER VALVE YET.**

Note: For chlorinators using two or more cylinders, open chlorine gas valves starting with chlorinator feed control and working toward the furthest chlorine cylinder.

- this has now ensured purging of the system in case of leaks.

Note: When opening the cylinder valve, use only the manufacturer-supplied wrench on the valve stem, hit with a sharp blow in a counter-clockwise direction. Never pull or tug on the wrench. One and a half (1.5) turns is fully open. The cylinder valve only needs to be open one quarter (1/4) turn for normal operation.

- crack open the cylinder valve and close again (if there is a bad leak, the cylinder valve is now shut off) and check for leaks (see step #6);
 - if NO LEAKS found, open cylinder valve; and
 - check chlorine pressure gauge for a reading between 275.8 - 517.1 kilopascals (kPa) or 40 to 75 pounds per square inch (psi) pressure, depending on temperature.
6. Check for Leaks
- check all joints and piping on chlorine lines with a plastic squeeze bottle containing 10 percent ammonium hydroxide solution; and
 - white smoke indicates a chlorine gas leak.

Note: If a leak is found, refer to Sections D and E.

Never try to repair a chlorine leak alone. If you are alone, report the leak and stay clear. At least two trained and authorized workers wearing SCBA are needed to repair a leak. One repairs the leak and the other acts as a safety partner.

C. Shut-Down Procedure

1. Perform the Pre-Entry Procedure and leave exhaust fan ON. Have your safety partner watching you from outside the chlorine room, with a SCBA on. Check that the suction side of the exhaust fan is unobstructed.
2. Shut off cylinder valve(s) on cylinder(s)
3. Check chlorine pressure
 - ensure that the pressure gauge drops to zero and vacuum goes to maximum; and
 - ensure rotameter ball goes to zero.
4. Shut chlorine line valves
 - shut off all valves as you move towards the chlorinator; and
 - do not shut off chlorinator yet. Allow chlorinator to operate for approximately 15 minutes, without chlorine entering it, to purge the system.
5. Shut water valves
6. If system is shut down longer than 10 minutes, all chlorine lines must be sealed from the atmosphere; (chlorine and moisture from air cause corrosion of the pipes).

D. Minor Leak

Note: A minor leak is a small leak which can be discharged to the environment without danger or when the source of the leak can be readily controlled.

If you determine from outside the chlorine feed room that there is a minor leak, do the following:

1. Notify your supervisor.
2. Have your safety partner don SCBA and be watching you from outside the chlorine room.
3. Equip yourself with a SCBA.
4. Enter chlorine gas room.

***** Once Inside *****

5. Turn chlorine cylinder(s) OFF, leave water on.
6. Adjust feed rate to maximum to purge system.
7. Vacate room and remove air pack. Wait for 15 minutes, until chlorine pressure drops to zero or vacuum goes to maximum.
8. Do the Pre-Entry Check, put SCBA back on.
9. Crack open cylinder(s) and shut off right away.
10. Use ammonium hydroxide solution to find the leak.
11. Mark the leak.
12. Purge the system of gas as indicated on page 18, Section C (3), with the water still on.
13. Repair gently, using correct tools.

14. Start-up and re-check for leaks.
15. If no more leaks, place system back into service.
NOTE: If unable to repair the source of the leak, call it a Major Leak, and follow the appropriate emergency steps.
16. Clean up:
 - remove air pack and recharge;
 - air or launder clothes; and
 - take a shower.
17. Document the event completely. Report the events which may have serious health or safety implications to the Occupational Health and Safety Division as soon as possible (*OH&S Regulations* Sections 8 and 9).

E. Major Leak

If you determine from outside the chlorine gas feed or storage room that there is a major leak, you could have a real problem not only for your fellow workers but also for nearby residents and for the plant equipment! Workers can protect themselves with SCBA. Residents may have to be evacuated.

We recommend the following steps, if you discover a Major Leak at your facility.

1. **Protect yourself** at all times during the emergency, and make sure you will not be overcome by the leaking gas. Stay out of the chlorine gas room. Keep the SCBA ready. Chlorine gas escaping through the ventilation outlet may be collecting outside the chlorine gas room, so be careful outside as well.
2. Isolate the area.
3. Notify your supervisor.
4. Implement the Emergency Response Contingency Plan that has been established for your facility, in consultation with the Occupational Health Committee.

NOTE: The following steps should be customized as necessary.
5. Notify your Chlorep/Supplier, fire department, police, Spill Report Centre, according to your facility's policy.
6. Follow directions given by Chlorep/Supplier.
7. Document the events.
8. Notify the Occupational Health and Safety Division as soon as possible (*OH&S Regulations* Sections 8 and 9).

Appendix B

Emergency Response Contingency Plans

General Planning Considerations

1. The plan should be clear, concise and easy to use.
2. Include diagrams of the surrounding land use and occupancy (eg. schools, residences, hospitals, businesses,...etc.), with the approximate distances.
3. Include a diagram of the chlorine room layout. It should show equipment location, floor drainage direction, and show the north direction with an arrow. If a floor drain is installed, include drainage system details.
4. Prepare a complete telephone list of the current employees, persons, organizations or other necessary contacts, including 24-hour emergency contact telephone numbers. The list should be revised, updated and distributed periodically by an assigned person.
5. List the personal protective equipment available on-site and from the local fire department. Include phone number(s).
6. List the emergency equipment and supplies available 24 hours a day on-site and from local suppliers. Include phone number(s).
7. Refer to the Environmental Protection Branch booklets: Guidelines for Waterworks Emergency Response Planning EPB 240; Water Quality Contingency Planning Guide EPB 240B, Water Quality Emergency Planning-An Overview EPB 241A and Waterworks Emergency Response Planning Template EPB 241B.
8. Routinely set up an emergency chlorine leak safety exercise. Practice makes perfect.

When developing your detailed Emergency Response Contingency Plan, consider the following questions:

- Who may be affected by a potential incident? This is governed by site location, adjacent population, terrain, the amount of chemical stored at your facility and its potential for release.
- Is an emergency phone list of trained personnel available and updated periodically?
- When should outside emergency response agencies (chlorine supplier, CHLOREP team, government agency, etc.) be called? By whom?
- When should the news media be notified? By whom? What information should statement include?
- Who should be contacted first, second, etc.? An emergency notification list should be developed and periodically updated. It should prioritize who is called, including your own utility personnel.
- Is there an evacuation procedure for employees at the facility? Was this reviewed in the last year?
- How do you notify the public in close proximity to the facility of when to evacuate?
- Should barricades be set up to keep unauthorized personnel from the scene?
- Are proper chlorine leak detectors installed and functioning? Are the alarm systems routinely checked? Are audible and/or visual alarms observable from any approach to the contaminated area?
- Is the local fire department familiar with the facility and your chlorine emergency procedure?
- Does the treatment facility heating and air-conditioning system have to be shut down in a chlorine emergency at the facility?
- Should doors and windows in close proximity to the affected area be closed?
- Are the duty operator(s) familiar with emergency procedures?
- Are proper warning signs in place?
- Is a manual with chlorine emergency guidelines readily available?
- Is there proper documentation of training, equipment inspection, and incidents?
- Is emergency training adequate? Is the training instructor knowledgeable?
- Are personnel trained in the use of self-contained air packs and leak-repair kits? Is this equipment routinely inspected?
- Are medical examinations given to personnel who are trained in the use of self-contained air packs?
- Are chlorine material safety data sheet (MSDS) and first-aid procedures readily available?
- Stopping a leak-who, when and how? Personnel must be trained to determine when it is best to stop the leak or when to spend their efforts in other areas such as evacuation, you often cannot do both. Who is going to help you stop the leak? Are they nearby or must they travel a great distance?
- Who determines when it is safe to return to evacuated neighbourhoods?
- How can your facility be put back into operation? What are the most likely sources of help to put your facility back into operation? How does the emergency plan fit into your operational plan for equipment breakdowns?
- Should the facility designer be notified?
- What else should I plan for?

Appendix C Emergency Phone Contacts

(To Be Posted Next To Chlorine Room Switches and Phone)

	Name	Telephone
1. Supervisor:		
Supervisor:		
Operator:		
Operator:		
Operator:		
2. Emergency Measures Organization (EMO)		
EMO Coordinator:		
3. Fire Department:		
4. Local Ambulance:		
5. Local Hospital:		
6. R.C.M.P. Detachment:		
7. CHLORINE EMERGENCY RESPONSE: 24 hour collect call		
Chlorine Supplier:		
Chlorine Supplier:		
CHLOREP TEAM:	ERCO WORLDWIDE	(306) 652 - 9771
CHLORINE INFORMATION:	CANUTEC	(613) 996-6666
8. SPILL REPORT CENTRE:	Saskatchewan Environment	1-800-667-7525
9. Medical Health Officer:		
10. Occupational Health and Safety Division:		
OH & S Officer:		
11. Environmental Project Officer:		

NOTE: CHLOREP: CHLORine Emergency Plan, sponsored by the Chlorine Institute.
CANUTEC: CANadian Transport Emergency Centre.

Appendix D Pertinent Regulations

The following table summarizes several pertinent Regulations

Agency	Regulations	Part/Section	Content
EcoRegions, Saskatchewan Environment	<i>Hazardous Substances and Waste Dangerous Goods</i>	Section 8(1)	Storage in small containers
		Section 9	Approval to store
		Section 10	Approval to construct
		Section 13	Duties of operator, owner
		Section 16(1)	Prohibition re: storage in certain containers or stockpiles
		Section 17	Decommissioning
Environmental Protection Branch, Saskatchewan Environment	<i>Water Regulation, 2002</i>		
Occupational Health and Safety Division, Saskatchewan Labour	<i>Occupational Health and Safety</i>	Part IV	Occupational Health Committees
		Part VI	General Health Requirements
		Section 65-67	Mechanical and Exhaust Ventilation
	<i>Occupational Health and Safety (Chemical and Biological Substances and WHMIS)</i>	Parts XXI and XXII	Chemical Substances, Biological Substances and Controlled Products
		Section 322	Identification of Controlled Products in Piping System and Vessels
		Section 318	WHMIS training
			Material Safety Data Sheets
		Section 325 and 327 - 328	Respiratory Protection Devices
	<i>Occupational Health and Safety</i>	Section 309 88 and 89	Notification of Accident and Dangerous Occurrences
		Part XIII (old Regs) Section 8 and 9	Serious Injuries
		Section 122 (old Regs) 8	Dangerous Occurrences
		Section 123 (old Regs) 9	Personal Protection Equipment
		Part VII & Section 353	Eye Protection
		Section 93 - 94	Working in Dangerous Atmosphere (SCBA)
		Section 88 - 90	Eye Flushing Equipment
		Section 313	Hoists, Cranes and Lifting Devices
		Part XIII	Heat, Fire, Explosion, Hot Work
Part XXVII & XXV, Sections 18, 25, 359, 370		Pressurized Gases	
Section 371		Working in Confined Spaces	
		Part XVIII Section 266--->275	