CHLORINE (Cl_2)

SAFETY PRECAUTIONS

This translation is provided

for guidance. The governing

text is the Arabic text

1) Purpose

Establish the correct procedures for safe handling of chlorine in order to provide a safe work environment.

2) Object

It is the knowledge of workers in the concerned departments in water purification plants and sewage treatment plants how to properly deal with chlorine.

3) Responsibilities

The concerned department in water purification plants and sewage treatment plants, everyone whose work is related to chlorine.

4) Natural and Chemical Properties

The chlorine chemical formula is (CL2), molecular weight (70,906), freezing point (-101 ° C), boiling point (-34 ° C), vapor pressure: 6.64 and atmospheric pressure.at (20 ° C).

Chlorine is an element and member of the halogen family. Chlorine gas is toxic, greenish-yellow, with a distinctive and pungent smell, and two and a half times heavier than air, so when a chlorine leakage occurs, the substance is concentrated in the lowest level of the leakage area.

Liquid chlorine is yellowish reddish (amber in color), and it is 1.5 times heavier than water, and chlorine is rarely seen in liquid form because it boils at (- 34 ° C) at atmospheric pressure

5) Synonyms: N/A

6) Classification: According to the international classification, chlorine gas is a toxic, hazard and harmful gas for the environment. It is also shall be classified by the National Fire Protection Association (NFPA) as a lethal gas (see Table 1)

Hazard and Harmful to the Environment

Toxic Gas

Hazard rating	NFPA	
HEALTH	4 = Lethal	
FLAMMABILITY	0 = Minimal	
REACTIVITY	0 = Stable	
OXIDIZER POISONOUS GASES ARE PRODUCED IN FIRE CONTAINERS MAY EXPLODE IN FIRE		

Table 1: American Fire Protection Center Classification of Chlorine

7) Usage of Chlorine

Chlorine shall be used to sterilize and purify water by oxidizing algae and harmful pathogenic microorganisms such as normal bacteria and microbes so that it does not cause any harm to human or animal health and without altering the taste, color and water smell.

8) Chlorine Cylinders and Containers

Table shows weights and dimensions of chlorine cylinders and containers, of which there are three types:

1) Cylinders with a capacity (45 kg).

2) The cylinders with a capacity (68 kg) (see figure 1).

3) Ton containers with a capacity of (250 kg) (see figure 2).

There are also other types of chlorine containers which are (Cargo Tanks (Trailers)) and (Tank Cars (Rail)) (see figure 3)

Size		Container Weight is Empty		External Diameter		Overall Height or Length	
Pound	Kg	Pound	Kg	Inch	Mm	Inch	Mm
100	45	63-115	29-52	8.75-10.75	210-283	39.75 -59	1003-1499
150	68	85-140	36-39	10.25-10.75	260-273	53-56	1346-1422
2000	907	1300-1650	590-748	30	762	79.75-82	2026-2083

Table 9: Chlorine Cylinders and Containers Weights and Dimensions

The container weight is empty (that is, the weight of the container is empty with the valve and the plug without the protective valve cap), and the general height or length (the length of the container from the bottom to the top of the protective valve cap)

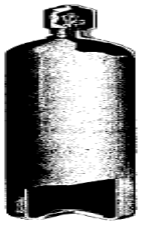

Figure (1): A 68 kg Chlorine Cylinder

Figure (2): Ton Chlorine Container

Figure (3): Tank Car

Containers' valves shall be equipped with a metal fusible plug (Figure. 6) designed for fusion between (20 ° C) and (8 ° C) to reduce pressure and prevent the container from exploding in the event of exposure to high temperature.

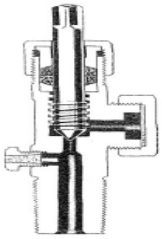

Figure 4: Cylinder Valve

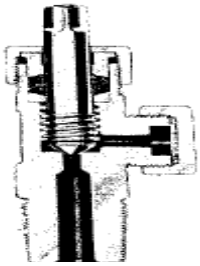

Figure 5: Ton Container Valve

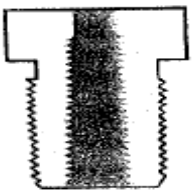

Figure 6: Metal Plug

9) Chlorine Hazards

9:1) Relationship between Gas and Liquid Volume

One volume of chlorine liquid produces approximately 460 volumes of chlorine gas, for example a kilogram of chlorine liquid produces 0.2 m 100% of chlorine gas when it evaporates at the normal temperature (21.1 C) and atmospheric pressure.

9:2) Reactions with Water

When chlorine reacts with water or air humidity, acids are formed that cause corrosion of minerals. Therefore, chlorine and chlorine equipment shall be kept away from water and hydrometeorology.'

9:3) Fire

Chlorine (gas or liquid) is non-flammable and non-explosive, but it helps to burn.

9:4) Chemical Reactions

Chlorine shall be isolated from ammonia and ammonia compounds because strong and violent reactions can occur when leaked, and it also reacts with organic compounds, and some of these

reactions are explosive, including oils, greases, solvents, and hydrocarbons. These substances shall be isolated during the use and storage of chlorine as this is a necessity for safety.

9:5) Health Effects

Chlorine is irritating to the eyes, skin, and mucous membranes as well as the respiratory, where the chlorine effects appear first on the respiratory and then on the eyes, and the effect of chlorine depends on two factors, concentration and time, young people, the elderly, and those with breathing problems shall be exposed to the chlorine effects, the Table No.3 shows the toxic effects when exposed to chlorine, while Table No. 4 shows the limits of occupational exposure permitted during specific periods of time.

Concentration (p.p.m)	Health Effects
0.03-1	Smell Sensation.
1-3	It causes mild irritation to eyes, nose, and throat.
3-5	It causes burns and bites in the eyes, nose, and throat, and may cause headache, coughing, sneezing and difficulty breathing.
5-15	Severe irritation of eyes, nose and respiratory system.
30-60	Difficulty breathing, which may lead to a pulmonary crisis and possibly suffocation and death.
430	Lethal after 20 minutes.
1000	Lethal and cause immediate death after several breaths

Table 3: Toxic Effects of Chlorine

Level of Exposure	Exposure Limit
0.5	The highest concentration allowed for an 8 hour exposure
1	The highest concentration allowed to be exposed for a short period not exceeding 15 minutes
10 or More	Immediate hazard to health and life.

Table 4: Occupational Exposure Limits to Chlorine

Note: You cannot see chorine gas as a greenish yellow cloud when the concentration is less than 1,000 parts per million (ppm).

Figure 7: A Yellow-Green Cloud of Chlorine, with a Chlorine Percentage More than (1000 ppm)

10) Construction and building requirements

10:1) Design and Building

- ✓ Chlorine chambers and warehouse shall be constructed from incombustible substances.

- ✓ Chlorine chambers and warehouse shall not be free of combustible substances, and when they are stored combustible substances in the same building, a fire-resistant wall shall be built to separate them from the chlorine dosing devices.
- ✓ The building shall be designed to protect the chlorine equipment from the hazard fire.
- ✓ Chlorine chambers and warehouse shall be equipped with alarms for chlorine leakage, emergency treatment equipment leakage, personal protective equipment, compressed air respirators, and fire extinguishing system (water taps).
- ✓ Signs of exits shall be clear.
- ✓ All doors shall open to the outside and be easy to open.
- ✓ All windows shall be fire resistant and not subject to breakage.
- ✓ The upper windows' frames shall be made of aluminum so that they can be easily opened from the bottom in an emergency.
- ✓ Chlorine chambers and warehouse shall be provided with a mechanical ventilation system, as in clause (2:10).
- ✓ A recover vessel shall be attached to the chlorine chambers and warehouse, to which the defective cylinder or container from which the chlorine leakage shall be transferred to isolate it from the plant atmosphere
- ✓ There shall be no drainage of the wash water.

A) Specifications for Chlorine Dosing Chamber

A building containing chlorine dosing equipment shall have the following specifications:

- ✓ The length of the room shall not be less than 5 meters and the width depend on the number of chlorine dosing devices.
- ✓ The ceiling height of the chamber shall not be less than 3.2 meters.
- ✓ It shall have one entry door.
- ✓ The chlorine chamber shall contain at least one window through which one can be seen without entering it
- ✓ It shall be adjacent to the storage of cylinders or containers.
- ✓ The space shall be sufficient to accommodate the dosing devices (injection), taking into account the following:
    - The distance between the chlorine dosing devices shall not be less than 1 meter.
    - The distance behind the dosing devices and the wall shall not be less than 1.75 meters

B) Specifications for Chlorine Warehouse:

The warehouse is the place where the chlorine cylinders or containers are warehoused in complete safety and the storage is in a proper manner so that it does not affect the safety of the site and the workers, and it shall meet the following specifications:

1) It shall be adjacent to the operating chamber of cylinders, containers, or dosing devices.

2) It shall be near or on a main street inside the plant for easy transportation and handling.

3) It shall be far from fuel warehouse, workshops and any source of heat.

4) It shall be far from administrative buildings and workers' gatherings.

1) The warehouse shall be designed according to engineering principles related to hazardous substances.

2) The area and size of the warehouse shall be suitable to accommodate cylinders or containers.

3) The distance between the axles of the cylinders or containers shall be 120 cm, and the space in front and behind the containers is not less than 1.5 meters.

4) The height of the warehouse's ceiling shall not be less than 5.5 meters from the floor of the container warehouse.

5) The warehouse of chlorine containers shall be equipped with an electric winch with a load of not less than 2.5 tons, suspended on a steel beam, letter I size 30 cm, with a height of not less than 5 meters from the floor of the warehouse and 2 meters outside the entrance to the warehouse, allowing the handling of containers from and to the back of the tanker.

6) A winch shall be used for each container row or a winch with a circular beam over two rows is used.

7) The warehouse shall have a concrete floor, a strong concrete structure, and a concrete roof.

8) It shall have efficacy to isolate direct sunlight on cylinders or containers so that the air temperature inside does not rise above 45 ° C.

9) Anti-chemical finishing substances shall be required to make acid-resistant ceramic floors

10:2 Ventilation and Suction Fans

Chlorine gas is heavier than air, when a leakage occurs; the gas collects at the ground level. Therefore, two sets of fans shall be installed, one of which is suction at a level (0.5-0.7 meters) from the ground surface, and the other is expelling at a level (1 meter) from the ceiling to deal with light gas leakage, whether inside the warehouse or inside the dosing equipment chambers, it shall be at a height of not more than 50 cm from the building floor and its opening is not less than 35 x 35 cm and that the distance between each two openings does not exceed 2 meters, it shall also work to change the air of the warehouse once every 4 minutes at most, and the exhaust of the hoods shall be directed to the equalizer tank through openings near the building floor level.

10:3 Protection System against Gas Leakage

Chlorine chambers and warehouse shall be equipped with a protection system against gas leakage with leakage treatment to ensure the safety and security of site workers, especially in sites where no employees work 24 hours a day.

The system shall consist of the following elements:

The system for measuring the chlorine concentration in the chamber shall be on the basis of giving an alarm when the chlorine concentration reaches 0.3 parts per million and operating the protection system completely when the concentration reaches 0.5 parts per million and this is done by means of chlorine gas leakage detection devices placed in the chlorine equipment chamber.

2) The protection system (naturalization tank) includes:

2-1 Pumping a caustic soda solution from the tank through a special tower for that through a pipe with side holes.

2-2 Air suction fans installed inside the building operate in an emergency situation so that they draw polluted air and direct it to the neutralization tank where there are sprinklers of caustic soda solution, and the following conditions shall be met in the naturalization tower:

- ✓ The rule for installing the tie tank shall be at a height of not less than 2 meters from the building floor
- ✓ The hole for fixing the tank shall be lined with an airtight sealant.

3) CLORGURAD

An automatic shut-off valve shall be installed on the cylinders or containers valves and works automatically through the detector or via a remote device, as it works to close the valves of cylinders or containers when leakage occurs.

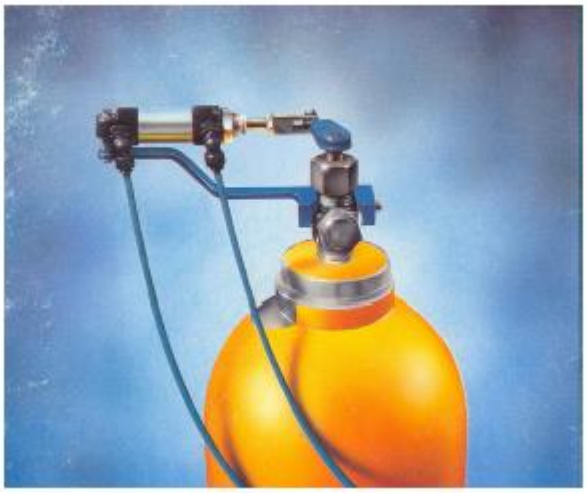

Figure 8 A: CLORGURAD for Cylinders

Figure 8 B: CLORGUARD for One Ton Containers

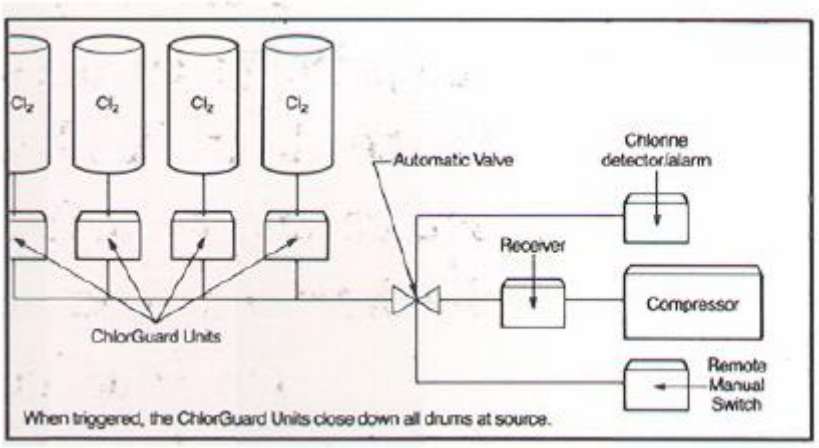

Figure 8 C: DIAGRAM of CLORGUARD System

10: 4) Temperature and Heating

The chlorine chambers in which the dosing cylinders are located shall be kept at (an Indoor temperature) ranging between (15-20 ° C) to facilitate the dosing of chlorine gas, and the temperature in the areas of chlorine use and heating shall not exceed (45 ° C).

10: 5) Electrical Systems

Chlorine gas shall be classified as a flammable gas, so there are no special requirements with regard to electrical systems, but in the event of a chlorine gas leakage with the presence of moisture or water, corrosion may occur to the electrical systems and any other system.

10: 6) Firefighting Systems

Since chlorine chambers shall be constructed from non-combustible substances, and as these buildings shall be free of flammable substances, fire extinguishing systems, including, for example, automatic sprinklers, shall be used only for purposes of extinguishing the fire or cooling containers threatened by fire, and they shall not be used to stop the leakage because it shall only make the situation worse.

10: 7) Security Procedures

The building's need shall be assessed through the possibility of it being threatened or sabotaged, the quality of securing the site depends on several factors, including the location of the building and its proximity to other buildings. The following shall also be taken care of:

- Place warning signs on the chlorine chamber.
- Protecting the chlorine building from accidental entry or entry by unauthorized persons
- The doors of the building shall be closed when work inside them is finished
- At the very least, there shall be a fence around the building.

11) Components of a Chlorine Dose Chamber

The chlorine dosage chamber shall be consisted of the following devices and equipment:

1) Dosing devices and equipment for dosing a chlorine solution

This system shall be used in small compact water plants with a capacity that does not exceed 100 m3 / hour and consists of:

a) Solution preparation basins.

It consists of a number of basins for preparing a chlorine solution, whether it is calcium hypochlorite or sodium hypochlorite, and these basins shall be made of fiberglass, propylene, rubber or any other substance that is not affected or oxidized by chlorine.

b) Metering pumps shall be of standard type

c) Connection pipes from solution basins to injection sites

2) Chlorine Gas Dosing Devices

A) Pressure Type

B) Vacuum type

It is recommended to use the second type due to complete safety in its uses as it draws air from the air in the event of any cracks or defects in the device and thus does not cause any leakage

3) Chlorine cylinders or containers previously referred to in Clause No. (8)

4) Injector

5) Injection pumps

6) Injection devices in pipes or tanks.

12) Preventive Operational Procedures

12:1) Preventive Handling Procedures

1) Chlorine gas shall not be dealt with alone, and there shall be at least two people trained and equipped to deal with chlorine.

2) Handling of chlorine gas shall be done with great care and care.

3) Personal protective equipment shall be worn at all times to prevent gas inhalation or contact with eyes or skin.

4) Cylinders shall be individually restricted and installed when transporting or discharge.

5) A forklift can be used when transporting or discharging cylinders.

6) It is shall not to raise the cylinders through the protection cap.

7) It is shall not to drop or withdraw containers.

8) It shall be ensured that containers are not moved during their transportation.

9) Using a hydraulic crane to transport and unload the ton containers (Figure 9).

10) Containers shall not be rolled empty or packed.

11) All empty containers shall have the word (empty) written on them.

12) Do not expose empty containers to direct flame or to direct heat.

13) The valve protection cap shall be in place when cylinders or containers, whether full or empty, are not used.

14) Chlorine cylinders and containers shall be inspected when there are impacts, deterioration, or loss of the protection cap or the main washer.

15) The receipt of doubtful cylinders or containers shall be prevented.

16) The serial numbers of containers received or delivered for monitoring purposes shall always be recorded.

17) Valves shall be checked before containers are placed in the supply line.

18) Containers of doubtful safety shall be marked for re-shipment by the supplier.

Figure 9: Method of Lifting the Ton Containers Using the Iron Column (1) or Using the Chain (2)

12: 2) Protective Storage Procedures

1) It is possible to store the chlorine containers indoor or outdoor.

2) When storing chlorine outdoor the chamber, it shall be ensured that the area is free from waste, debris and flammable substances in order to avoid the fire hazard.

3) The outdoor storage area shall be shaded to protect the containers from the sun's rays.

4) The substance shall be stored in a warm, dry and well-ventilated place.

5) Chlorine shall be stored in the appropriate and appropriate places to store compressed gas, away from organic compounds, organic substances, flammable substances and easily oxidized substances (acetylene, fuels, oils, hydrogen gas, ammonia, ... etc).

6) The cylinders shall be stored in a vertical (vertically) position and fixed to the wall (Figure 10) so that they can be easily accessed, and make sure that the valve protection cap is in place.

7) Containers shall be stored in a horizontal position with securing them from falling or rolling and the valve protection cap shall be in place (Figure 11).

8) Containers shall be stored in two or four parallel rows depending on the size of the terminal and the number of containers handled.

9) Chlorine containers shall not be stored away from high traffic sites.

10) Containers shall not be stored near elevators, heaters, ventilation devices, or air-conditioning equipment, because they help to spread gas when a leakage occurs.

11) Containers shall be stored in places easily accessible in the event of a leak.

12) Care shall be taken to avoid storing containers underground (basement) because in the event of a gas leak, it is difficult to ventilate the place.

13) Containers shall not be left on site for more than six months.

14) The stored containers shall be inspected at least weekly to check for any signs of leakage or any other defects.

15) Unauthorized persons shall be denied entry.

16) It prevents containers storage in stagnant water.

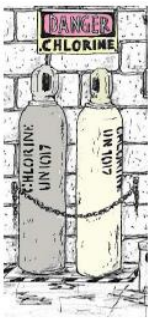

Figure 10: Store Chlorine Cylinders Vertically and Secure to the Wall with the Valve Cap in its Place

Figure 11: Store Ton Containers Horizontally with the Valve Guard Cap in its Place

12:3) Preventive Procedures for Exchanging Containers

1) The containers shall be replaced by at least two trained persons who are fully aware of the proper procedures for dealing with chlorine gas.

2) Appropriate personal protective equipment and respirators shall be used.

3) Ensure that the chamber is safe before entering it.

4) Exhaust fans (ventilation system) shall be turned on before entering the chamber.

5) Close the valve of the empty container.

6) The system shall be left to empty itself of chlorine and verify that the reading is zero.

7) When the reading indicates that the chlorine liquid gas is empty or zero, close the valve of the main piping system.

8) Remove the (Yoke).

9) Check that the (Out Gasket) is in place, and replace the (Valve Outlet Cap).

10) The chlorine line and the (Yoke Adapter) shall be protected from humidity.

11) Place the (Valve Protection Cap) into place on the container.

12) The container shall be marked with the word "empty" and moved to the empty container storage location.

13) Move the filled container to its place.

14) When removing the (Valve Protection Cap), inspect for damage or spoilage.

15) Make sure the (The Packing Nut) is tight, if it is, contact the supplier.

16) Make sure the valve is closed before removing the valve outlet cap.

17) When removing the valve outlet cap, make sure that there is no leakage using ammonia vapor (Figure 12). If a white cloud appears, this means that there is a leakage and that the valve is installed incorrectly, tighten the valve and re-check the leakage again, if the white cloud appeared again, replace the outlet cap and valve protection cap, and inform the supplier of the defective valve.

Figure 12: Method for Detecting Chlorine Leakage Using Ammonia Vapor

18) Make sure the valve faces are clean and smooth

19) A new Ring Gasket shall be used to connect the (Yoke) and the (Yoke Adapter) to the valve.

20) Check the Yoke tighten, when the solution may have an exit of chlorine gas, use ammonia vapor and a portable chlorine meter to make sure there is no gas before continuing the switching process.

21) Using an appropriate screwdriver or wrench to open and close the valve and check for leakage. If there is a leakage, it shall be treated before continuing.

22) Opening the container valve for chlorine dosing and the valve of the main piping system.

23) Ensuring that the system is operating, and then adjust the chlorine percentage as required.

24) The presence of leakage shall be checked again with ammonia vapor.

25) When the system is operating normally, turn off the lights, turn off the suction fans, and close the chlorine chamber door.

26) Taking off, cleaning and storing personal protective equipment for another use.

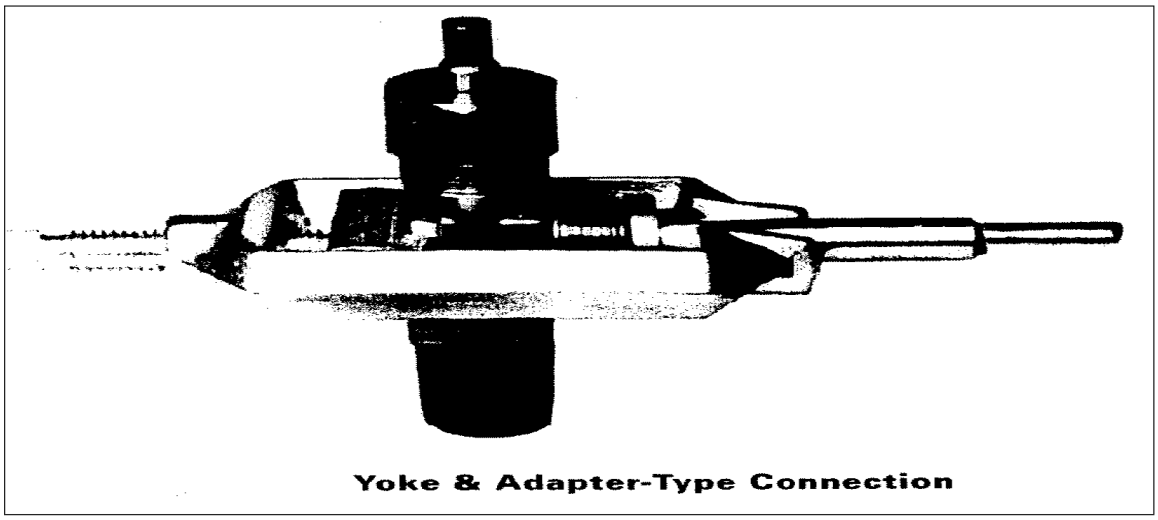

Figure 13: Yoke & Adapter-Type Connection

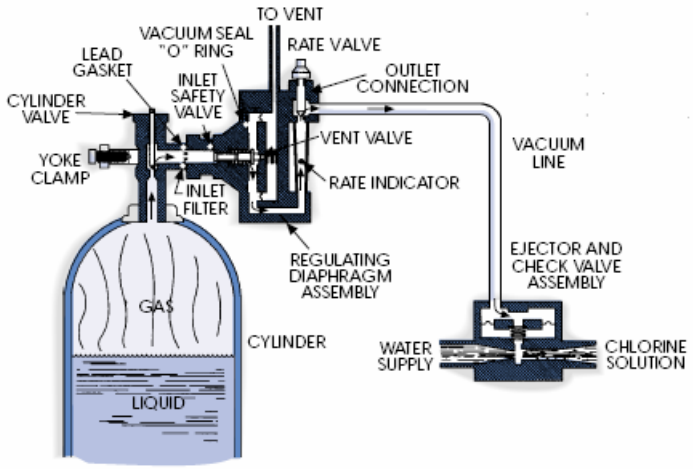

Figure 14: Method of Adding Chlorine to Water through Cylinder 68 kg

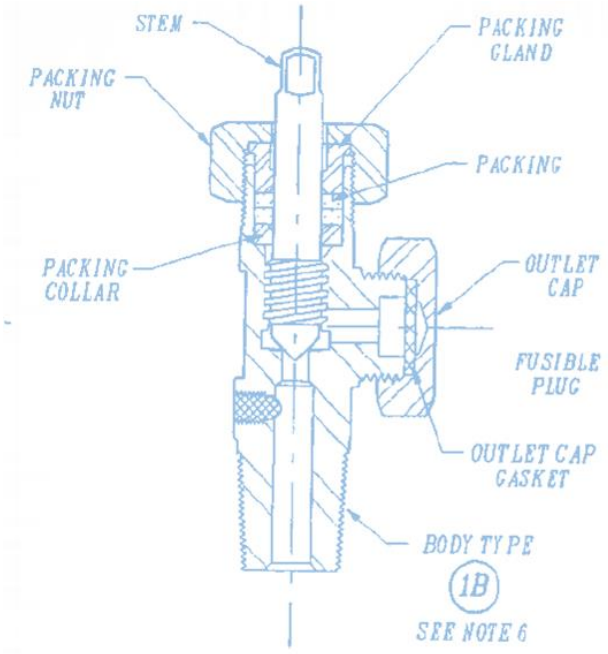

Figure 15: Main Valve Parts

13) Emergency Procedures in Case of Leakage:

1) In the event of accident, you shall call the ambulance immediately.
2) Apply the emergency plan for chlorine gas.
3) Full protective clothing shall be worn.
4) You shall not touch or walk over the leaked substance.
5) Turn off all ignition sources (if time permitted).
6) Combustible materials shall be kept away from the leakage area.
7) If possible, leakage shall be stopped without exposure to risk.
8) Non-specialist persons shall be removed from the site of the leak.
9) You shall stay away from low places as the gas is present there.
10) Water sprinklers shall be used to reduce vapors resulting from leakage.
11) Water shall not be directed to the source of leakage directly.
12) Try to direct the containers in a way that allows only the gas to exit without the liquid.
13) Prevent the substance from entering sewage and closed places.
14) The closed places, where the leakage occurred there, shall be ventilated before entering them.
15) The leakage area shall be insulated until any traces of gas are gone.
16) As a precaution, isolate the area of leakage or spillage for a distance of at least 100 meters from all directions.
17) All persons in the evacuation area shall be in the upwind location.
18) A full report shall be made about the accident and submitted to the competent department.

14) Emergency Procedures in Case of Fire

- ✓ For small fires, use only water and do not use dry chemicals, halons and CO2.
- ✓ For large fires, use water sprinklers, mist and foam.
- ✓ Fire shall be resisted from a safe distance.
- ✓ Shall not direct water to the source of leakage or safety devices as it may cause freezing.

- ✓ If possible, move containers out of the fire area.
- ✓ Cool containers with large amounts of water.
- ✓ Shall stay away from containers that have been exposed to fire.
- ✓ Containers damaged due to fire shall be handled by professionals.
- ✓ In the event that there are tanks for the substance or trucks carry containers, the isolation shall be done for a distance of 800 meters from all directions.

15) Leakage Area Evacuation

- ❖ In the event of a leakage from the cylinders or a small amount of leakage from the ton chlorine containers, the area shall be isolated for a distance of 100 meters from all directions.
- ❖ In the event of a large amount of chlorine containers or a number of cylinders leakages, the area shall first be isolated for a distance of 300 meters from all directions, and secondly, the isolation shall be done in the windward 2100 meters in width and 3300 meters in length.

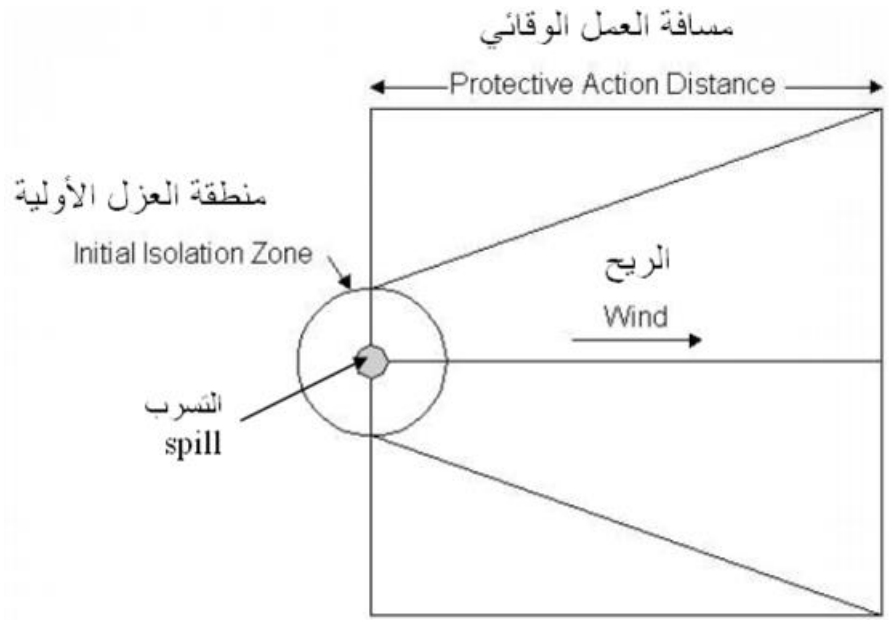

Figure 16: Initial Isolation Zone and Protective Action Distance

16) Chlorine Leakage Treatment Tools

Chlorine gas container leakage shall be treated in the following ways:

16:1) First Method: Emergency Kit

It is a bag with a set of tools that can be carried from one location to another, and it is the easiest method used to treat and stop leakage, and three types are used according to Table 5 (for more detailed information see Appendix (A) and Appendix (B)).

Container Type	Kit Type
Cylinder with a capacity of 45 kg and 68 kg	Emergency kit "A"
Ton Container with a capacity of 907 kg	Emergency kit "B"
Rail cars, tank cars or barges	Emergency kit "C"

Table 5: Emergency Kit

Figure 17: Emergency Kit "A"

Figure 18: Emergency Kit "B"

16:2) Second Method: Recover Vessel

It is a container used to contain the leakage, where the cylinder in which there is a leakage is inserted into the recover vessel through a belt as shown in Figure (21), then; it is sealed to be used as another chlorine container. There are two types of it used depending on the size of the chlorine container which is on the site, either cylinders (68 Kg) as shown in Figure (19) or ton containers (907 kg) as shown in Figure (20).

Figure 19: Recover Vessel for Cylinders

Figure 20: Recover Vessel for Ton Containers

Figure 21: Retrieval Belt

17) Personal Protective Equipment:

Chlorine is an irritant to the eyes, the skin, and the respiratory system, so these organs shall be protected when handling with chlorine gas.

17: 1) Eye Protection

When chlorine gas is in the air, safety glasses or face respirators do not protect the eyes, so a full face respirator shall be worn.

17:2) Skin Protection

Full body protective clothing (chemical handling suit) shall be worn.

17:3) Respiratory System Protection

There are several tools that can be used when chlorine leakage, depending on the type of work and the strength of concentration of the substance (see Table 6).

Caution: When a leakage of unknown concentration occurs, leave the chamber immediately.

17:4) Personal protection Equipment from chlorine gas, which shall be available at sites

1) Compressed Air Breathing Cylinders.
2) Full face and half face respirators.
3) Face and eyes protective respirator are tight against chemicals.
4) Chemical-proof hand gloves.
5) Chemical resistant full-body suit.
6) Apron or coat to cover the chest against chemicals.
7) Safety shoes and never use open shoes.
8) Emergency shower bath equipped with an eye wash.
9) Portable device for measuring the percentage of chlorine gas.

Figure 22: Respirators Shall Be Available Outside the Chlorine Building

Situation	Chlorine Concentration	Proper Respirators
Do a regular job inside the chlorine chamber	-	Respirators to scape.
Working on the chlorine system	-	Half face respirator with tight chemical goggles or full face respirator.
Leakage occurrence and entry to stop it	Up to 5 ppm	Half face respirator with tight chemical goggles or full face respirator.
	Between 5 and 10 ppm	Full face respirator
	Higher than 10 ppm	Closed circuit (compressed air breathing apparatus)
	Not known Always assume that it is	closed-circuit escape respirators (compressed air breathing

	dangerous to health and life	apparatus)

Table 6: Cases of choosing the proper respirators

18) First Aid

When a person is injured when handling with chlorine, you shall follow the following procedures:

1) Do not freak out or panic.

2) Make sure that there is no other danger to you or the injured person.

3) Transfer the injured person from the contaminated area to a fresh air area.

4) Ask for help.

18:1) Chlorine Inhalation

When a person inhales chlorine gas, he may lose consciousness, or may have difficulty breathing, or may stop breathing completely. Follow these steps to rescue someone who has inhaled chlorine:

1) Evaluate the injured person's breathing condition.

- In the event of breathing stops, start artificial respiration using pocket masks until the injured person's breathing returns.
- In the event of difficulty breathing (severe breathing or coughing), place the victim in a more comfortable place and in a half-sitting position.

2) If an oxygen therapy unit and trained personnel are available, the injured person shall be given 10 liters of oxygen.

3) Keep the injured person in a warm place and reassure him until the arrival of the ambulance team.

18:2) Skin Contact

When the chlorine contacts the skin, it causes severe burns, and before treating the contaminated skin:

1) You shall make sure that the injured person is breathing normally.

2) Start with washing injured person's skin and clothes with a large amount of water for 30 minutes.

3) Take him off all contaminated clothes during the washing period.

4) Continue washing until all traces of chlorine are removed.

5) Bandage the severe burns with sterile gauze.

6) Apply cold towels on the burns to relieve pain.

7) Transfer the patient to the hospital.

Cautions:

1) Do not try to neutralize the chlorine with other chemicals.

2) Do not apply ointments and medicines unless prescribed by a doctor.

3) Skin contact with the chlorine liquid coming out of the container causes frostbite (freezing of the contact area). In this case, separate the clothes that have been frozen and stick to the skin of the injured person with heating before removing them.

18:3) Eye Contact

Short-term eye contact with chlorine (gas or liquid) may cause a permanent disability. Therefore, it shall be washed within 30 seconds of the time of injury and follow these steps:

1) Wash the eye directly with a large amount of running water for 30 minutes.

2) After removing traces of chlorine by washing, cover the eyes with enough sterile and wet gauze to keep the eyes away from light.

3) Apply cold towels to relieve pain.

4) Transfer the patient to the hospital.

Cautions:

1) Do not try to neutralize the chlorine with other chemicals.

2) Do not apply ointments and medicines unless prescribed by a doctor.

19) Training

At a minimum, everyone who handles with chlorine gas shall be trained on the following topics:

- ✓ Chlorine properties and reactions.
- ✓ Chlorine hazard.
- ✓ How to treat a chlorine leakage.
- ✓ Basics of container transportation, handling and storage.
- ✓ Procedures for replacing safe chlorine cylinders and containers.
- ✓ Evacuation and emergency plans for a chlorine leakage.
- ✓ Use of personal protective equipment.
- ✓ First aid.

20) Appendices: Emergency Kit

Appendix (A): Emergency Kit "A"

It contains a set of numbered and red colored tools and is used to stop the leakage from the chlorine cylinder of 68 kg capacity when the leakage is from the valve or from the fusible plug or from one of the side walls of the cylinder, and it consists of the following kits:

Kit No. (1): It is designed to contain leakage from or around the valve, as shown in Figure 23.

Kit No. (2): A kit used to seal the leakage from or around the fusible plug.

Kit No. (8) A patch kit which is designed to patch leakage from the side walls of the cylinder.

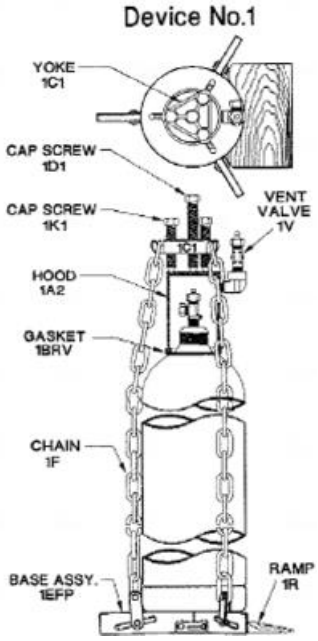

Figure 22: Kit No. (2)

Parts List for Emergency Kit A

Part Number	Description	Quantity Per Kit
1A2	Hood Assembly, with (1V) Vent Valve	1
1BRV	Gasket, molded from Viton® 5-7/8" OD × 4-5/8" ID × 3/16" wall	2
1C1	Yoke	1
1D1	Cap Screw	1
1K1	Cap Screws	3
1EFP	Base Assembly with Chains	1
1R	Ramp	1
2	Clamp Assembly (2A,2C,2D)	1
2B	Gasket, Garlock	5
2BB	Gasket, Garlock 1" × 3" × 1/16"	5
8A	Chain	1
8B	Yoke	1
8C	Cap Screw	1
8D	Steel Patch	1
8EV	Gasket, molded from Viton®, 3" sq. × 1/8" Th.	2
200A	Wrench, 3/8" sq. box, 1-1/4" open end × 7-1/4"	1
201	Wrench, straight open end, 1-1/4" × 1-1/8" × 12-1/8"	1
203	Wrench, double box, 7/16" × 9/16" × 8-3/8"	1
A-1	Hammer, Machinist 3 lb.	1
A-2	Hacksaw, 10", and 3 blades	1
A-3	Drift Pin, 5/32" × 1/2" × 6"	2
A-4	Drift Pin, 7/8" × 1-1/4" × 8"	2
A-5	Ring, vent valve packing, 7/8" OD × 15/32" ID 1/4" sq.	5
A-6	Kit Box Seals	15
A-7	Gasket Sack	1

A-8	Paint Scraper, 1-1/4 blade	1
A-9	Valve Yoke	1
A-10	Valve Adapter (820-hose)	1
A-12	Washer, valve outlet, 15/16" OD × 9/16" ID 1/16"	5
A-13	Small Gasket Plastic Storage Box	1
A-14	File, 8"	1
144	Tool Roll	1
151A	Kit Box 35" × 13-3/4" × 14-1/4"	1
-	Instruction Booklet	2
-	Chlorine Manual	1
-	Parts list	1
- Note:	Emergency Kit “A” weighs 115 lbs.	

Appendix (B): Emergency Kit "B"

It contains a set of numbered and red colored tools and is used to stop the leakage from the chlorine cylinder of 68 kg capacity when the leakage is from the valve or from the fusible plug or from one of the side walls of the cylinder, and it consists of the following kits:

Kit No. (4): It is a covering tool used to contain leakage from or around the fusible plug, as shown in Figure 24.

Kit No. (12): It is designed to contain leakage from or around the valve, as shown in Figure 25.

Kit No. (8) A patch kit which is designed to patch leakage from the side walls of the ton container, as shown in Figure 26.

Part Number	**Description**	**Quantity Per Kit**
4A	Hood Assembly	1
4C	Yoke	1
4D	Gasket, Garlock 3000, 1-1/4" OD × 11/16" ID × 1/16"	3
4E	Stud	1
4F	Cap Nut	1
4G	Gasket, Garlock 3000, 115/16" dia. × 1/16"	5
9A	Chain	1
9B	Yoke	1
9C	Cap Screw	1
9D	Steel Patch	1
9EV	Gasket, Viton®, 3" sq. × 1/8"	2
12A	Hood Assembly with (12V) Vent Valve	1
4-12BMV	Gasket, Molded Viton®, 4" OD × 2-5/8" ID × 1/4"	2
12BBV	Gasket, Viton, 5" OD × 2" ID × 1/2" Th.	1
12C	Bar Assembly	1
12MV	Gasket, Molded Viton®, 5-1/4" OD × 2-1/4" ID × 3/4"	1
101	Wrench, straight open end, 1-1/4" × 12"	1
104	Wrench, socket, 1-1/4" hex	1
104A&C	Wrench extension, 1" sq. drive × 9" with adaptor	1

104B	Wrench bar, 1" dia. × 20"	1
106	Wrench, crowfoot special, 1-5/32" × 11"	1
200	Wrench, 3/8" sq. box, 1-1/4" open end × 7-1/4"	1
B-1	Drift Pin, 5/32" × 1/2" × 6"	2
B-2	Drift Pin, 7/8" × 1-1/4" × 8"	2
B-3	Drift Pin, 1-1/16" × 1-7/16" × 8"	2
B-4	Ring, vent valve packing, 7/8" OD × 15/32" ID 1/4" sq.	5
B-5	Paint Scraper, 1-1/4 blade	1
B-6	Hammer, Machinist 3 lb.	1
B-7	Metal Railroad Car Seal	15
B-8	Gasket Sack	1
B-9	Valve Yoke	1
B-10	Valve Adapter (820-hose)	1
B-11	Gasket Garlock 3000, 15/16" OD × 9/16" ID 1/16"	5
B-12	Plastic Box	1
153	Tool Roll	1
151B	Kit Box 35" × 13-3/4" × 14-1/4"	1
	Instruction Booklet	2
	Chlorine Manual	1
	Parts list	1

Using Method for Emergency Kit "B"

Using method for kit No. (4): It is a covering tool used to contain leakage from or around the plug

The following instructions shall be followed:

1) The YOKE-4C is installed on the plug outer structure.

2) The GASKET-4G is then installed on the plug nozzle when the leakage is through it, then, tighten the STUD NUT-4F screw until the leakage is stopped.

3) When the leakage is on the side wall around the plug, the HOOD-4D cap is used after placing the GASKET-4-12BMV.

4) Then, install the GASKET-4D to the fastening screw, install the CAP NUT-4F, and tighten the nut until the leakage is stopped.

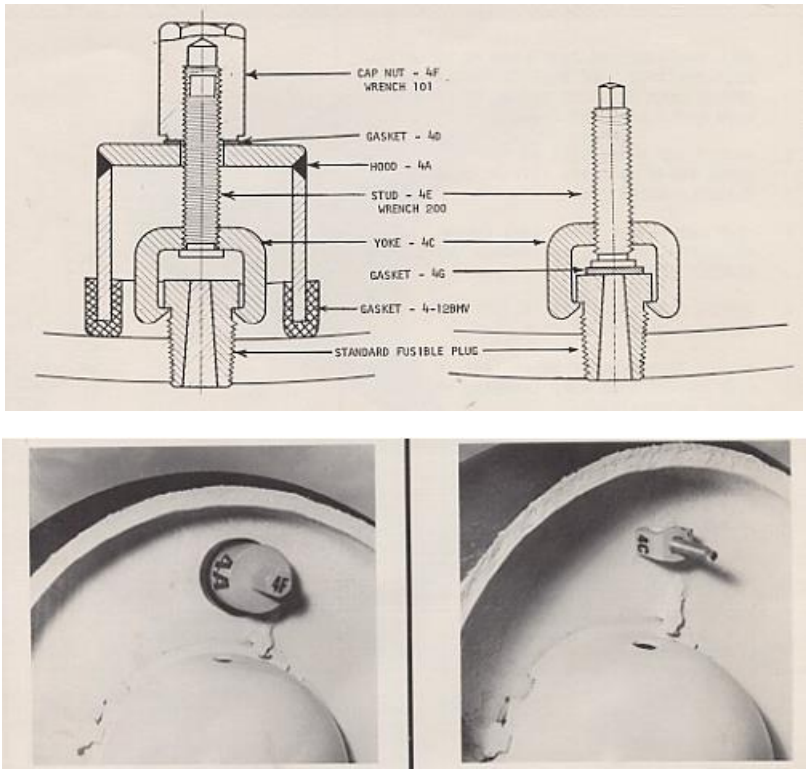

Figure 24: Using Method for Kit No. (4)

Installing method for kit No. (12): It is designed to contain leakage from or around the valve.

The following instructions shall be followed:

1) 1) Firstly, the GASKET No. 4-12BMV, 12BBV or 12MV is placed on the HOOD which is marked with "12A".

2) Then, the special valve HOOD is opened and the cylinder valve to be leaked is covered.

3) The kit marked with "12C" shall be placed perpendicular to the face of the ton container so that it fits tightly inside container chime.

4) Tighten equally of the two JACK SCREWS-12E shown in the drawing, bearing in mind that the CAP SCREW 12F shall be matched to the HOOD.

5) Tighten the two screws ADJUSTING SCREW 12F.

6) Tighten the CAP SCREW 12C of HOOD, close its valve, and then make sure that there are no leaks.

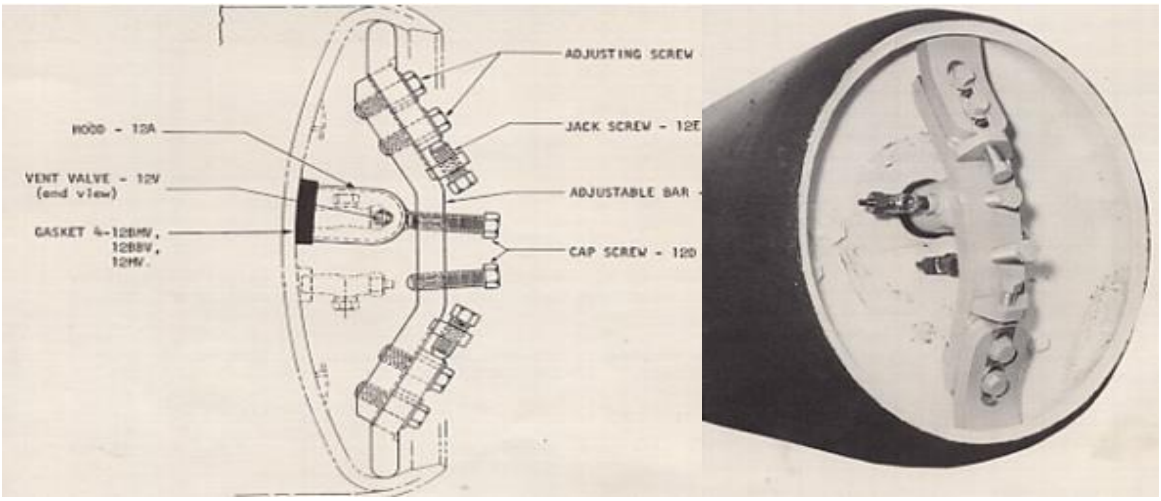

Figure 25: Using Method for Kit No. (12)

Using method for kit No. (8): A patch kit which is designed to patch leakage from the side walls of the ton container

The following instructions shall be followed:

1) Firstly, the leakage site shall be cleaned.

2) Enclose the chlorine container to the CHAIN-9A.

3) Place both ends of the chain in YOKE-9B.

4) Install the PATCH-9D.

5) Install the GASKET-9E and equating it on the leakage site.

6) Tighten CAP SCREW-9C, and then note that there is no other leakage.

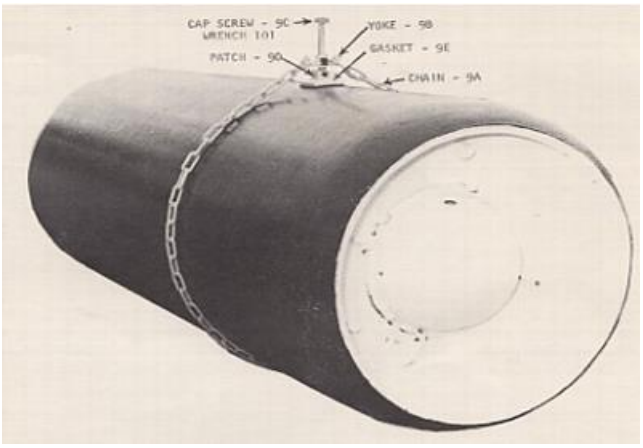

Figure 26: Using Method for Kit No. (8)

** When the leakage is in one of the two main chlorine container valves from the opposite side of the chlorine gas exit line (Fig. 27), the following shall be done:

1) The YOKE B9 shall be installed on the leakage site.

2) The GASKET shall then be placed.

3) Tighten the screw of the device until the leakage is stopped.

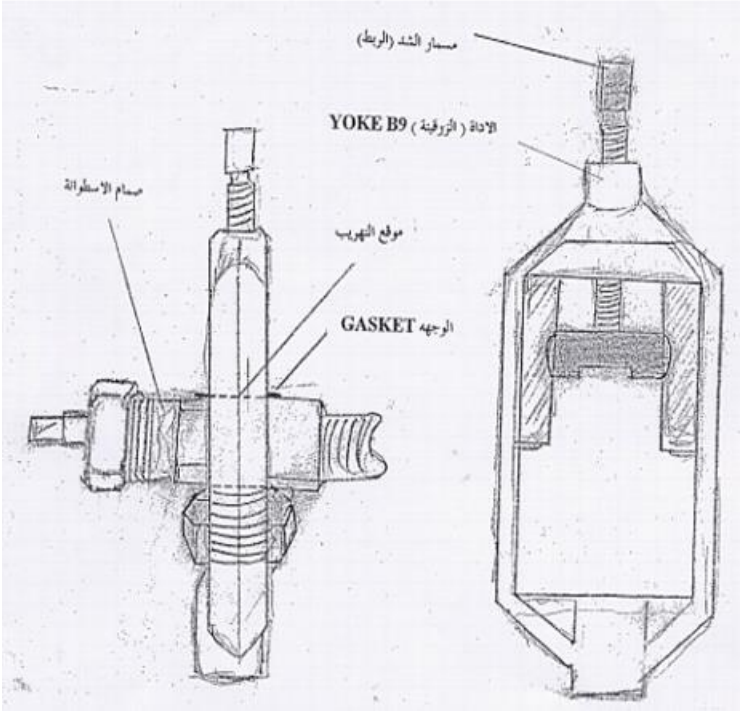

Figure 27: Leakage Stopping Method for the Main Valve of the Container

* There are some rarely used methods to stop the leakage of chlorine, which is the use of a hammer and a chisel with the emergency kit "B", and this is only done by professionals, as these methods treat the following cases:

1) When the leakage is from the plug.

2) Complete exit of fusible plug structure.

3) Complete exit of the main valve structure of the ton container.

21) Laws Based on it:

1) The Environmental Law issued by Royal Decree No. M / 34 on 7/28/1422 AH, based on Council of Ministers Resolution No. (193) dated 7/7/1422 AH.

2) The Environmental Assessment System of the Cooperation Council for the Arab States of the Gulf issued by Royal Decree No. M / 3 on 2/4/1421 AH Council of Ministers Resolution No. (23) dated 1/26/1421 AH.

22) References:

The Egyptian Code of Principles and Conditions for Executing Drinking Water Purification and Sanitary Drainage Plants and Lifting Stations, Volume Two and Three

The Chlorine Institute U.S

NIOSH National Institute for Occupational Safety and Health.

OSHA Occupational Safety and Health Administration.

NFPA National Fire Protection Association.

DOT Department of Transport

Worksafe BC