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**CHLORINE GAS DISPERSION:
AWARENESS ON EMERGENCY RESPONSE OF TRAINED RESIDENTS
LIVING NEAR WATER TREATMENT PLANT**



By
MOHD ASHRAF BIN ZAKARIA

**Thesis Submitted to
School of Business Management
Universiti Utara Malaysia
in Partial Fulfilment of the Requirement for the Master of Science
(Occupational Safety and Health Management)**



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ABSTRACT

With socio-economic growth in this era, the use of hazardous chemicals chlorine has increased proportionally with the increasing population and demand for potable water worldwide. Chlorine gas leakage frequently happens causing dispersion that poses life threat and can lead to many health problems among the people living near the potential source of leakage. This research aimed to assess the awareness of emergency response in the event of chlorine gas dispersion for trained residents living near the water treatment plant. A qualitative study was conducted at residences near the plant subjected to the Occupational Safety and Health Act (Control of Industrial Major Accident Hazards) Regulation 1996. The sampling method employed in this study is purposive, targeting individuals who have participated in the Information to Public (ITP) program. Five interviews were conducted, each assessing six factors; demographic characteristics, hazard knowledge, attitudes to risk, previous emergency experience, exposure towards awareness degrees, and ability to respond. Demographic aims to identify the characteristics of the person being interviewed. Meanwhile hazard knowledge is to determine the basic awareness regarding the chlorine gas. Attitudes to risk is to understand the cognitive and interpretive of the interviewees. Previous experience of emergencies objective is to explore the feeling of people related emergency response. Besides, the exposure towards awareness degrees aims to discover what would they do to increase the awareness. Finally, ability to respond is test their basic preparedness of emergency response. The findings show that the majority of respondents demonstrated a positive awareness by indicating their knowledge towards emergency response of chlorine gas dispersion. It is essential to assess their awareness to prevent and mitigate the effects of major accidents involving chlorine which can cause harm to the near community. Large quantified surveys can be performed in the future to truly represent the population and reduce systematic sampling error.

Keywords: chlorine gas dispersion, emergency response, awareness, trained residents, water treatment plant

ABSTRAK

Dengan pertumbuhan sosio-ekonomi pada era ini, penggunaan bahan kimia berbahaya iaitu klorin terus meningkat secara langsung dengan peningkatan populasi dan permintaan air yang terawat di seluruh dunia. Kebocoran gas klorin kerap kali berlaku menyebabkan penyebaran gas klorin yang boleh mengancam nyawa dan boleh membawa banyak masalah kesihatan di kalangan penduduk yang tinggal berdekatan dengan kawasan yang berpotensi berlaku kebocoran. Kajian ini bertujuan untuk menilai kesedaran tindak balas kecemasan terhadap kejadian penyebaran gas klorin bagi penduduk terlatih yang tinggal berhampiran loji rawatan air. Kajian kualitatif telah dijalankan di perumahan berhampiran loji yang tertakluk di bawah Akta Keselamatan dan Kesihatan Pekerjaan (Kawalan Terhadap Bahaya Kemalangan Besar Dalam Perindustrian) Peraturan 1996. Kaedah persampelan secara bertujuan yang mensasarkan mereka yang telah menghadiri program Maklumat Kepada Umum (ITP). Lima temu bual telah dijalankan terdiri daripada enam faktor; ciri demografi, pengetahuan bahaya, sikap terhadap risiko, pengalaman kecemasan terdahulu, pendedahan terhadap tahap kesedaran, dan keupayaan bertindak balas. Demografi bertujuan untuk mengenal pasti ciri-ciri orang yang ditemu bual. Sementara itu, pengetahuan bahaya adalah untuk menentukan kesedaran asas mengenai gas klorin. Sikap terhadap risiko adalah untuk memahami kognitif dan tafsiran orang yang ditemuduga. Pengalaman kecemasan terdahulu bertujuan untuk meneroka perasaan berkaitan tindak balas kecemasan. Selain itu, pendedahan terhadap tahap kesedaran bertujuan untuk mengetahui perkara yang akan mereka lakukan sekiranya berlaku penyebaran gas klorin. Terakhir, keupayaan untuk bertindak balas adalah menguji kesediaan asas mereka untuk tindak balas kecemasan sekiranya berlaku penyebaran gas klorin. Dapatan kajian mendapati bahawa kebanyakan responden menunjukkan kesedaran yang positif dengan menunjukkan pengetahuan mereka dalam tindak balas kecemasan penyebaran gas klorin. Tinjauan kuantiti yang berskala besar boleh dilakukan pada masa hadapan untuk benar-benar mewakili populasi serta mengurangkan ralat pensampelan sistematik.

Kata kunci: penyebaran gas klorin, tindak balas kecemasan, kesedaran, penduduk terlatih, loji rawatan air

ACKNOWLEDGEMENTS

Alhamdulillah. Learning in the field of Occupational Safety and Health (OSH) is one of my greatest challenges in life so far, and I could not do it better without the blessing of Allah, the Almighty, the most gracious and merciful. The first thanks go to my beloved mother and family. They are my biggest supporters and believe in me to pursue my master. I dedicate this dissertation to them as my token of appreciation for the sacrifices they had made for me.

Next, my greatest appreciation goes to my graceful and sole supervisor, Assoc. Prof. Dr. Nor Azimah Chew Abdullah for the precious time and willingness she gave me for my dissertation. I would like to thank her for the advice, wisdom, and encouragement to ensure that I will always focus on my study. I owe a great deal of my progress in this learning process to her unwavering support.

Last but not least, my appreciation goes to my fellow lecturers at the School of Business Management (SBM) Universiti Utara Malaysia (UUM), my beloved postgraduate friends in Master of Science (Occupational Safety and Health Management), and those who helped me to finish my study. Thank you for all the good memories and endless support.

May Allah bless all of us. Thank you.

MOHD ASHRAF BIN ZAKARIA

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LIST OF ABBREVIATIONS

CEM	Chemical Exposure Monitoring
CHRA	Chemical Health Risk Assessment
CIMAH	Control of Industrial Major Accident Hazards Regulation 1996
CPR	Cardiopulmonary Resuscitations
DOSH	Department of Occupational Safety and Health
ERP	Emergency Response Plan
ITP	Information to Public
MHI	Major Hazard Industries
MLD	Million Litre per Day
OSHA	Occupational Safety and Health Act 1994
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
ppm	Part Per Million
SCBA	Self Contain Breathing Apparatus
SDS	Safety Data Sheet
SHO	Safety and Health Officer
SOP	Safe Operating Procedure
USECHH	Use and Standards of Exposure of Chemicals Hazardous to Health 2000
WTP	Water treatment plant

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Since ancient times, water resources have been an enthusiastic area. Safe water infrastructure is important since it supports the industrial, home, and agricultural sectors. In this regard, the water treatment plant is tasked to provide safe potable water to inhabitants (Godo, 2020). However, there are numerous physical and chemical processes involved in the plant. According to Cosgrove and Loucks (2015), various studies have been conducted on the analysis of water webs from raw to potable water. Essentially, the primary goal of water treatment is to purify dirty water and make it appropriate for human consumption by removing and destroying pathogenic organisms and removing taste, odour, unappealing brownish discharge, part of the excess dissolved metals, and a variety of other contaminants (Obi et al., 2008). This is the part that involves chemicals in the water treatment process.

Nevertheless, it should be highlighted that several hazardous compounds in the chemical industry can harm human health. The same goes for water treatment plants that use some chemicals such as sodium fluoride (NaF), alum, calcium carbonate (CaCO_3), floerger, and chlorine (Cl_2). Chlorine is a critical item in most chemical-related industries. It is extensively used as a bleaching and disinfecting agent for many sectors, such as fabric, paper manufacturing, and water treatment. Given chlorine's long history of use in water and wastewater disinfection, the term chlorination has become synonymous with disinfection (Ruj & Chatterjee, 2012).

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MALAY-SINO CHEMICAL INDUSTRIES SDN. BHD. (16055-T)
SAFETY DATA SHEET (SDS)
CHLORINE (Cl₂)

SECTION 1 – THE IDENTIFICATION OF THE HAZARDOUS CHEMICAL AND OF SUPPLIER

CAS NO

7782 – 50 – 5

PRODUCT NAME

CHLORINE

PROPER SHIPPING NAME

CHLORINE

PRODUCT USE

Water purification; bleaching agent, particularly for paper and textiles; manufacture of bleaching powder; manufacture of chemicals such as chlorinated hydrocarbons, glycerine, tetraethyl lead and as intermediate.

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SECTION 2 – HAZARD IDENTIFICATION

ICOP Classification

Gases under pressure Liquefied gas
Oxidizing gases category 1
Acute Toxicity (inhalation) category 3
Serious eye damage or eye irritation category 2
Specific target organ toxicity-single exposure category 3
Skin corrosion or irritation category 2
Hazardous to the aquatic environment - acute hazard category 1



EMERGENCY OVERVIEW

Signal Word : DANGER

DETERMINED BY USING ICOP CRITERIA

HAZARD STATEMENT

H280	Contains gas under pressure; may explode if heated.
H270	May cause or intensify fire; oxidizer
H331	Toxic if inhaled.
H319	Causes serious eye irritation.
H335	May cause respiratory irritation (respiratory tract irritation).
H315	Causes skin irritation.
H400	Very toxic to aquatic life.

PRECAUTIONARY STATEMENTS

Prevention

Code	Phrase
P220	Keep/store away from clothing/ combustible materials.
P244	Keep reduction valves free from grease and oil.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P264	Wash hand / skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P273	Avoid release to the environment.
P280	Wear protective gloves / protective clothing/ eye protection/ face protection.

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Response

Code	Phrase
P302+P352	IF ON SKIN: Wash with plenty of soap and water.
P304+P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P311	Call a POISON CENTER or doctor / physician.
P312	Call a POISON CENTER or doctor/physician if you feel unwell.
P321	Specific treatment is urgent.
P332+P313	If skin irritation occurs: Get medical advice/attention.
P337+P313	If eye irritation persists: Get medical advice/attention.
P370+P376	In case of fire: Stop leak if safe to do so.
P362	Take off contaminated clothing and wash before reuse.

Storage

Code	Phrase
P403	Store in a well-ventilated place.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.
P410+P403	Protect from sunlight. Store in a well-ventilated place.

Disposal

Code	Phrase
P501	Dispose of contents/ container to designated and secure place/area only.

SECTION 3 – THE COMPOSITION AND INFORMATION OF THE INGREDIENTS OF HAZARDOUS CHEMICAL

NAME	Formula	CAS No	%
Liquid Chlorine	Cl ₂	7782-50-5	> 99.5 % min

SECTION 4 – FIRST AID MEASURES

INGESTION

- Not considered a normal route of entry.

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EYE CONTACT

- If product comes in contact with the eyes remove the patient from gas source or contaminated area.
- Take the patient to the nearest eye wash, shower or other source of clean water.
- Open the eyelid(s) wide to allow the material to evaporate.
- Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners.
- The patient may be in great pain and wish to keep the eyes closed. It is important that the material is rinsed from the eyes to prevent further damage.
- Ensure that the patient looks up, and side to side as the eye is rinsed in order to better reach all parts of the eye(s).
- Transport to hospital or doctor.
- Even when no pain persists and vision is good, a doctor should examine the eye as delayed damage may occur.
- If the patient cannot tolerate light, protect the eyes with a clean, loosely tied bandage.
- Ensure verbal communication and physical contact with the patient.
- DO NOT allow the patient to rub the eyes.
- DO NOT allow the patient to tightly shut the eyes.
- DO NOT introduce oil or ointment into the eye(s) without medical advice.
- DO NOT use hot or tepid water.

SKIN CONTACT

- If skin or hair contact occurs:
 - Immediately flush body and clothes with large amounts of water, using safety shower if available.
 - Quickly remove all contaminated clothing, including footwear.
 - Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre.
 - Transport to hospital or doctor without delay.
- In case of cold burns (frost-bite):
 - Move casualty into warmth before thawing the affected part; if feet are affected carry if possible
 - Bathe the affected area immediately in luke-warm water (not more than 35 deg C) for 10 to 15 minutes, immersing if possible and without rubbing
 - DO NOT apply hot water or radiant heat.
 - Apply a clean, dry, light dressing of "fluffed-up" dry gauze bandage
 - If a limb is involved, raise and support this to reduce swelling
 - If an adult is involved and where intense pain occurs provide pain killers such as paracetamol
 - Transport to hospital, or doctor
 - Subsequent blackening of the exposed tissue indicates potential of necrosis, which may require amputation.

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INHALATION

- Inhalation of vapours or aerosols (mists, fumes) may cause lung edema.
- Corrosive substances may cause lung damage (e.g. lung edema, fluid in the lungs).
- As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.
- Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered.
- This must definitely be left to a doctor or person authorised by him/her.
- Following exposure to gas, remove the patient from the gas source or contaminated area.
- NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer.
- Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures.
- If the patient is not breathing spontaneously, administer rescue breathing.
- If the patient does not have a pulse, administer CPR.
- If medical oxygen and appropriately trained personnel are available, administer 100% oxygen.
- Summon an emergency ambulance. If an ambulance is not available, contact a physician, hospital, or Poison Control Centre for further instruction.
- Keep the patient warm, comfortable and at rest while awaiting medical care.
- MONITOR THE BREATHING AND PULSE, CONTINUOUSLY.
 - Administer rescue breathing (preferably with a demand-valve resuscitator, bag-valve mask-device, or pocket mask as trained) or CPR if necessary.

NOTES TO PHYSICIAN

- Treatment is symptomatic. Because there is no known antidote for chlorine gas inhalation, effective and immediate relief of symptoms is the primary goal. Steroid therapy, if given early, has been reported effective in preventing pulmonary edema.

SECTION 5 – FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

- Water spray or fog.
- Foam.
- Dry chemical powder.
- Carbon dioxide.

Do not apply water directly to a chlorine leak.

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FIRE FIGHTING

▪ **GENERAL**

- Excessive pressures may develop in a gas cylinder exposed in a fire; this may result in explosion.
- Cylinders with pressure relief devices may release their contents as a result of fire and the released gas may constitute a further source of hazard for the fire-fighter.
- Cylinders without pressure-relief valves have no provision for controlled release and are therefore more likely to explode if exposed to fire.

▪ **FIRE FIGHTING PROCEDURES:**

- Alert Fire Brigade and tell them location and nature of hazard.
 - May be violently or explosively reactive.
 - Wear full body protective clothing with breathing apparatus.
 - Fight fire from a safe distance, with adequate cover.
 - If safe, switch off electrical equipment until vapour fire hazard removed.
 - Use water delivered as a fine spray to control fire and cool adjacent area.
 - DO NOT approach cylinders suspected to be hot.
 - Cool fire exposed cylinders with water spray from a protected location.
 - If safe to do so, remove cylinders from path of fire.
- Equipment should be thoroughly decontaminated after use.

▪ **FIRE FIGHTING REQUIREMENTS:**

- Positive pressure, self-contained breathing apparatus is required for fire-fighting of hazardous materials.
- Full structural fire-fighting (bunker) gear is the minimum acceptable attire.
- The need for proximity, entry and special protective clothing should be determined for each incident, by a competent fire-fighting safety professional.

FIRE/ EXPLOSION HAZARD

- Containers may explode when heated - Ruptured cylinders may rocket
- May burn but does not ignite easily.
- Fire exposed cylinders may vent contents through pressure relief devices thereby increasing vapour concentration.
- Fire may produce irritating, poisonous or corrosive gases.
- Runoff may create fire or explosion hazard.
- May decompose explosively when heated or involved in fire.
- Contact with gas may cause burns, severe injury and/ or frostbite.
- POISONOUS: MAY BE FATAL IF INHALED, SWALLOWED OR ABSORBED THROUGH SKIN.
- Decomposition may produce toxic fumes of: hydrogen chloride.
- Contains low boiling substance: Closed containers may rupture due to pressure buildup under fire conditions. Chlorine is non-flammable but supports combustion.

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- Oxidising agent causes fires or explosions upon contact with organic substances and many common chemicals. Emits highly toxic fumes upon heating.
- The main danger from a fire in a chlorine storage area is that a major chlorine escape may occur by rupture of containers at high temperatures.

FIRE INCOMPATIBILITY

- None known

SPECIAL HAZARDS

- Chlorine gas or liquid is non-explosive and non-flammable. However, like oxygen, it is capable of supporting combustion of certain substances. Reacts explosively, or forms explosive compounds, with many chemicals, such as acetylene, turpentine, ether, ammonia gas, hydrogen, and finely divided metals.

SECTION 6 – ACCIDENTAL RELEASE MEASURES

MINOR LEAKS

- Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.
- Check regularly for spills and leaks.
- Avoid breathing vapour and any contact with liquid or gas. Protective equipment including respirator should be used.
- DO NOT enter confined spaces where gas may have accumulated.
- Increase ventilation.
- Clear area of personnel.
- Stop leak only if safe to do so.
- Remove leaking cylinders to safe place. Release pressure under safe controlled conditions by opening valve to chlorine emergency unit or pollution control system
- Do not exert excessive pressure on the valve; do not attempt to operate a damaged valve
- Orientate cylinder so that the leak is gas, not liquid, to minimise rate of leakage
- Keep area clear of personnel until gas has dispersed.

MAJOR LEAKS

- Clear area of all unprotected personnel and move upwind.
- Alert Emergency Authority and advise them of the location and nature of hazard.
- Wear full body clothing with breathing apparatus.
- Prevent by any means available, spillage from entering drains and water-courses.
- Consider evacuation.
- Increase ventilation.
- Stop leak only if safe to do so.
- Water spray or fog may be used to disperse vapour.
- DO NOT enter confined space where gas may have collected.
- Keep area clear until gas has dispersed.

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CHLORINE (Cl₂)

- Remove leaking cylinders to a safe place.
- Fit vent pipes. Release pressure under safe, controlled conditions
- NOT exert excessive pressure on valve; DO NOT attempt to operate damaged valve.
- For gas spills:
 - Avoid spraying water directly onto leaking containers as this will increase gas hazard.

Personal Protective Equipment advice is contained in Section 8 of the SDS.

SECTION 7 – HANDLING AND STORAGE

PROCEDURE FOR HANDLING

- Consider use in closed pressurised systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal.
- The tubing network design connecting gas cylinders to the delivery system should include appropriate pressure indicators and vacuum or suction lines.
- Fully-welded types of pressure gauges, where the bourdon tube sensing element is welded to the gauge body, are recommended.
- Before connecting gas cylinders, ensure manifold is mechanically secure and does not contain another gas. Before disconnecting gas cylinder, isolate supply line segment proximal to cylinder, remove trapped gas in supply line with aid of vacuum pump.
- When connecting or replacing cylinders take care to avoid airborne particulates violently ejected when system pressurises.
- Consider the use of doubly-contained piping; diaphragm or bellows sealed, soft seat valves; backflow prevention devices; flash arrestors; and flow monitoring or limiting devices. Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and work areas for release.
- Use a pressure reducing regulator when connecting cylinder to lower pressure piping or systems.
- Use a check valve or trap in the discharge line to prevent hazardous back-flow into the cylinder
- Check regularly for spills or leaks. Keep valves tightly closed but do not apply extra leverage to hand wheels or cylinder keys.
- Open valve slowly. If valve is resistant to opening then contact your supervisor.
- Valve protection caps must remain in place unless container is secured with valve outlet piped to use point.
- Never insert a pointed object (e.g. hooks) into cylinder cap openings as a means to open cap or move cylinder. Such action can inadvertently turn the valve gas leak. Use an adjustable strap instead of wrench to free an over-tight or rusted cap.
- A bubble of gas may buildup behind the outlet dust cap during transportation, after prolonged storage, due to defective cylinder valve or if a cover nut is inserted without adequate evacuation of gas from the line. When loosening dust cap, preferably stand cylinder in a suitable enclosure and take cap off slowly. Never face the dust cap directly when removing it; point cap away from any personnel or any object that may pose a hazard. under negative pressure (relative to atmospheric gas).
- Do NOT heat cylinder by any means to increase the discharge rate of product from cylinder.
- If a cylinder valve will not close completely, remove the cylinder to a well ventilated location (e.g. outside) and, when empty, tag as FAULTY and return to supplier.

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- Obtain a work permit before attempting any repairs.
- DO NOT attempt repair work on lines, vessels under pressure.
- Atmospheres must be tested and O.K. before work resumes after leakage.
- DO NOT transfer gas from one cylinder to another.
- Reverse flow into containers must be prevented. Handle empty containers as if they were full.

PACKAGING MATERIAL INCOMPATIBILITIES

Chemical Name	compatible materials
Chlorine (dry)	"Acetal (Delrin)", Aluminum, Brass, Bronze, "Buna N (Nitrile)", "Carbon Steel", "Carpenter 20", "Cast iron", CPVC, Epoxy, Hastelloy – C, Hypalon, Hytrel, Kel – Fr, LDPE, "Natural rubber", Neoprene, Nylon, "Polyetherether Ketone (PEEK)", Polypropylene, Polyurethane, "PPS (Ryton)", PVC, Silicone, Titanium

SUITABLE CONTAINER

- Cylinder:
 - Ensure the use of equipment rated for cylinder pressure.
 - Ensure the use of compatible materials of construction.
 - Valve protection cap to be in place until cylinder is secured, connected.
 - Cylinder must be properly secured either in use or in storage.
 - Cylinder valve must be closed when not in use or when empty.
 - Segregate full cylinders from empty ones

WARNING: Suckback into cylinder may result in rupture. Use back-flow preventive device in piping. Use gases in cylinder sizes that will ensure complete usage of the cylinder content in a reasonably short amount of time.

STORAGE INCOMPATIBILITY

- Chlorine:
 - is a strong oxidizer.
 - reacts explosively with acetylene, boron, diborane, or other boron hydrides at ordinary temperatures.
 - forms easily ignited, sensitive explosive mixtures with gases and vapours such as anhydrous ammonia, benzene, butane, ethane, ethylene, fluorine, hydrocarbons, formaldehyde, hydrogen, hydrogen bromide, hydrogen chloride, oxygen, propane, propene in the presence of heat, hot surfaces, welding arc, sparks, strong sunlight, UV light, or a catalyst such as mercury oxide
 - contact with 2-carboxymethylisothiuronium chloride or s-ethylisothiuronium hydrogen sulfate may form nitrogen trichloride a dangerous explosive.
 - reacts violently with combustible materials, reducing agents, acetylene, molten aluminium (ignites on contact with the gas), alcohols, arsenic compounds, arsine, bismuth, boron, calcium compounds, carbon, diethylzinc, dimethylformamide, ether, ethyl phosphine, fluorine, germanium, hydrocarbons, hydrazine, hydrogen sulfide, hydroxylamine, iridium, lithium, lithium acetylide, magnesium, magnesium oxide, magnesium phosphide, mercury sulfide, methyl vinyl ether, metal carbides, molybdenum trioxide, potassium acetylide, sodium acetylide, sulfamic, sulfur dioxide, triethylborane and many other substances.
 - forms explosive mixtures with gasoline and petroleum products, such as mineral oil, greases,

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- phosphorus, silicones, turpentine, finely divided metals, organic compounds
- in its liquid form reacts explosively with carbon disulfide, linseed oil, propylene, rubber, wax, white phosphorus
- attacks some plastics and coatings
- may cause dangerous fires in contact with hot solid metals (especially steel - iron/ chlorine fire can cause the bursting of storage containers)
- when moist (150 ppm in water) is extremely corrosive to most metals especially in the presence of heat.
- reacts with water to give diluted hydrogen chloride, with carbon monoxide to form phosgene, and with sulfur dioxide to give sulfuryl chloride
- Chlorine storage areas shall be separated from anhydrous ammonia storage areas by a vapour path of at least 10 meters.
- Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous.
- Avoid storage with reducing agents.

STORAGE REQUIREMENTS

- Cylinders should be securely stored and kept upright all the times.
- Drums should be stored horizontally
- Cylinders should be stored in a purpose-built compound with good ventilation, preferably in the open.
- Such compounds should be sited and built in accordance with statutory requirements.
- The storage compound should be kept clear and access restricted to authorised personnel only.
- Cylinders (container) stored in the open should be protected against rust and extremes of weather.
- Cylinders in storage should be properly secured to prevent toppling or rolling.
- Cylinder valves should be closed when not in use.
- Where cylinders are fitted with valve protection this should be in place and properly secured.
- Gas cylinders should be segregated according to the requirements of the Dangerous Goods Act.
- Preferably store full and empty cylinders separately.
- Full cylinders should be arranged so that the oldest stock is used first.
- Cylinders in storage should be checked periodically for general condition and leakage.
- Protect cylinders against physical damage. Move and store cylinders correctly as instructed for their manual handling.

SAFE STORAGE WITH OTHER CLASSIFIED CHEMICALS



- +: May be stored together
O: May be stored together with specific precautions
X: Must not be stored together

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SECTION 8 – EXPOSURE CONTROLS AND PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA ppm
Use And Standard Of Exposure Of Chemical Hazardous To Health (OSHA Act 1994) Permissible Exposure Limits (PEL) of Toxic Substances	chlorine (Chlorine)	0.5

EMERGENCY EXPOSURE LIMITS

Material	Revised IDLH Value (mg/m ³)	Revised IDLH Value (ppm)
Chlorine	1	10

ODOUR SAFETY FACTOR (OSF)

OSF = 1.6 (CHLORINE)

- Exposed individuals are NOT reasonably expected to be warned, by smell, that the Exposure Standard is being exceeded.
- Odour Safety Factor (OSF) is determined to fall into either Class C, D or E.
The Odour Safety Factor (OSF) is defined as:
OSF = Exposure Standard (TWA) ppm / Odour Threshold Value (OTV) ppm
- Classification into classes follows:

Class	OSF	Description
A	550	Over 90% of exposed individuals are aware by smell that the Exposure Standard (TLV – TWA for example) is being reached, even when distracted by working activities
B	26 – 550	As "A" for 50 – 90% of persons being distracted
C	1 – 26	As "A" for less than 50% of persons being distracted
D	0.18 – 1	10 – 50% of persons aware of being tested perceive by smell that the Exposure Standard is being reached
E	<0.18	As "D" for less than 10% of persons aware of being tested

MATERIAL DATA

CHLORINE:

- NOTE: Detector tubes for chlorine, measuring in excess of 0.2 ppm, are commercially available. Long-term measurements (8 hrs) may be conducted to detect concentrations exceeding 0.13 ppm.
- Smell is not a good indicator of severity of exposure in the range 0.5 to 2 ppm. In this range subjects found exposure unpleasant with itching and burning of the throat reported and occasionally an urge to cough. Significant differences in the responses of males and females were also recorded with females often reporting headache and drowsiness.
- Exposure at 1 ppm chlorine for 8 hours produced significant changes in pulmonary function and

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- increased subjective irritation. Similar 8 hour exposures at 0.5 ppm produced no significant pulmonary function changes and less severe subjective irritation. Exposures for 2 hours at 2 ppm chlorine produced no significant changes in pulmonary irritation.
- An 8 hour exposure at 1.5 ppm produced increased mucous secretion from the nose and increased mucous in the hypopharynx. Exposure at or below the TLV-TWA and STEL is thought to protect the worker against annoying symptoms in nose, throat and conjunctiva and declines in pulmonary function. Odour Safety Factor(OSF)

PERSONAL PROTECTION



EYE / FACE

- Chemical goggles.
- Full face shield may be required for supplementary but never for primary protection of eyes.
- Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lens should be removed at the first signs of eye redness or irritation - lens should be removed in a clean environment only after workers have washed hands thoroughly.

HANDS/ FEET

- Neoprene gloves.
- When handling sealed and suitably insulated cylinders wear cloth or leather gloves.
- Insulated gloves.

SKIN

- Wear chemical resistant gloves such as rubber, neoprene or vinyl.
- Wash contaminated clothing and dry before reuse.
- Wear protective clothing to minimise skin contact.
- Whenever there is a possibility of splash or contact wear a chemical resistant
- full body suit and boots.

GLOVE SELECTION INDEX

- Glove selection is based on a modified presentation of the: "Forsberg Clothing Performance Index". The effect(s) of the following substance(s) are taken into account in the computer-generated selection: water, sodium hydroxide.
- Protective Material CPI*.

BUTYL/ NEOPRENE	A
NEOPRENE	A

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NITRILE	A
SARANEX – 23	A
VITON/ NEOPRENE	A
PE	B

- * CPI – Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion.

NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. –

* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

RESPIRATOR

- Type B-P Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent).
- Selection of the Class and Type of respirator will depend upon the level of breathing zone contaminant and the chemical nature of the contaminant. Protection Factors (defined as the ratio of contaminant outside and inside the mask) may also be important.

Required minimum Protection factor	Maximum gas/vapour concentration present in air ppm (by volume)	Half-face Respirator	Full-face Respirator
Up to 10	1000	b – AUS/ Class 1 p	-
Up to 50	1000	-	b – AUS/ Class 1 p
Up to 50	5000	Airline*	-
Up to 100	5000	-	b – 2 p
Up to 100	10000	-	b – 3 p
100+			Airline**

* - Continuous Flow ** - Continuous-flow or positive pressure demand

A (All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO₂), G = Agricultural chemicals, K = Ammonia(NH₃), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC).

- Positive pressure, full face, air-supplied breathing apparatus should be used for work in enclosed spaces if a leak is suspected or the primary containment is to be opened (e.g. for a cylinder change).
- Air-supplied breathing apparatus is required where release of gas from primary containment is either suspected or demonstrated.

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The local concentration of material, quantity and conditions of use determine the type of personal protective equipment required. For further information consult site specific CHEMWATCH data (if available), or your Occupational Health and Safety Advisor.

OTHER

- Overalls
- PVC Apron
- PVC protective suit may be required if exposure severe.
- Eyewash unit.
- Ensure there is ready access to a safety shower.

ENGINEERING CONTROLS

- Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
- The basic types of engineering controls are:
 - Process controls which involve changing the way a job activity or process is done to reduce the risk.
 - Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment. Ventilation can remove or dilute an air contaminant if designed properly. The design of a ventilation system must match the particular process and chemical or contaminant in use.
 - Employers may need to use multiple types of controls to prevent employee overexposure.
 - Areas where container are stored require good ventilation and, if enclosed, need discrete/controlled exhaust ventilation.
 - Secondary containment and exhaust gas treatment may be required by certain jurisdictions
 - Local exhaust ventilation is required in work areas.
 - Gas cabinets, with appropriate exhaust treatment, are recommended, as is automatic monitoring of the secondary enclosures and workplaces, for potential release.
 - Automated alerting systems with automatic shutdown of gas-flow may be appropriate and may in fact be mandatory in certain jurisdictions.
 - Respiratory protection in the form of air-supplied or self-contained breathing equipment must be worn if the oxygen concentration in the workplace air is less than 19%.
 - Cartridge respirators do NOT give protection and may result in rapid suffocation.

If inhalation risk exists, wear full face, self contained breathing apparatus in the positive pressure mode. Chlorine vapours will not be adequately absorbed by organic vapour respirators. [NSW D.I.R. 3 – 1982]

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE

- Packed as liquid under pressure and remains liquid only under pressure. Sudden release of pressure or leakage may result in rapid vapourisation with generation of large volumes of gas.
- Greenish-yellow gas or amber liquid when under pressure, with acutely irritating and pungent odour.

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Slightly soluble in water and alkalis. Soluble in many organic solvents but may react violently. Gas has a relative density of 2.5 and may collect in pits, depressions. Chlorine is an oxidising agent and may assist combustion. Properties at NTP: Gas density 2.980 g/L Liquid density 1.56 kg/l

- Vapour Pressure 689 KPa @ 21 °C. Relative gas density 2.473 @ 20 °C where air = 1.

PHYSICAL PROPERTIES

- Gas.
- Does not mix with water.
- Sinks in water / denser in water.
- Corrosive.
- Toxic or noxious vapours/gas.

State	: Liquefied gas	Molecular Weight	: 70.9
Appearance	: Greenish - Yellow	Odour	: Pungent irritating odour
Melting Range (°C)	: - 101	Viscosity	: Not available
Boiling Range (°C)	: - 34.6	Solubility in water (g/L)	: 0.7g/ 100ml
Flash Point (°C)	: Non Flammable	pH (1 % Solution)	: Not available
Decomposition Temp (°C)	: Not Available	pH (as supplied)	: Not applicable
Autoignition Temp (°C)	: Not Applicable	Vapour Pressure (kPa)	: 638 @ 20°C
Upper Explosive Limit (%)	: Not Applicable	Specific Gravity (water=1)	: 1.4 @ 20°C liq
Lower Explosive Limit (%)	: Not Applicable	Relative Vapour Density (air=1)	: 2.5 @ 20°C
Volatile Component (%vol)	: 100	Evaporation Rate	: Fast

SECTION 10 – STABILITY AND REACTIVITY

CONDITIONS CONTRIBUTING TO INSTABILITY

- Presence of incompatible materials.
- Product is considered stable.
- Hazardous polymerisation will not occur.

CHEMICAL STABILITY

☒ STABLE

☐ UNSTABLE

HAZARDOUS POLYMERISATION

☐ OCCURS

☒ WILL NOT OCCUR

REACTS WITH

☐ OXIDISERS
☐ ACIDS
☒ ALKALIS
☒ WATER

☒ METALS
☒ OTHERS
☐ NONE
☐ HEAT

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CHLORINE (Cl₂)

CONDITIONS TO AVOID

- **Exposure to Fire and Water/ moisture:**
 - Exposure to water and fire will cause corrosion to the containers, compromising its safety and integrity – leading to gas leakage.

INCOMPATIBLES

- No contact: with combustibles, acetylene, ammonia and finely divided metals.

COMMENTS

- Strong oxidiser:
 - Avoid contact with reducing agents, combustible materials. Keep away from materials such as acetylene, turpentine and other hydrocarbons, ammonia, hydrogen, ether, powdered metals, sulphur and aluminium.
 - Reacts with hydrogen sulphide and water forming hydrochloric acid. Combines with carbon monoxide and sulphur dioxide forming phosgene and suluryl chloride.
 - Moist chlorine is highly corrosive to most metals. Chlorine reaction to some organic compounds can be explosive.

For incompatible materials - refer to Section 7 - Handling and Storage.

SECTION 11 – TOXICOLOGICAL INFORMATION

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

- **INGESTION**
 - Overexposure is unlikely in this form.
 - Not normally a hazard due to physical form of product.
- **EYE**
 - The material can produce chemical burns to the eye following direct contact. Vapours or mists may be extremely irritating.
- **SKIN**
 - The material can produce chemical burns following direct contact with the skin.
 - Skin contact is not thought to produce harmful health effects (as classified under EC Directives using animal models). Systemic harm, however, has been identified following exposure of animals by at least one other route and the material may still produce health damage following entry through wounds, lesions or abrasions. Good hygiene practice requires that exposure be kept to a minimum and that suitable gloves be used in an occupational setting.
 - Open cuts, abraded or irritated skin should not be exposed to this material.
 - Entry into the blood-stream through, for example, cuts, abrasions, puncture wounds or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

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■ **INHALED**

- Inhalation of vapours or aerosols (mists, fumes), generated by the material during the course of normal handling, may produce toxic effects.
- Inhalation of the vapour is hazardous and may even be fatal.
- The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.
- Common, generalised symptoms associated with toxic gas inhalation include:
 - central nervous system effects such as depression, headache, confusion, dizziness, progressive stupor, coma and seizures;
 - respiratory system complications may include acute pulmonary edema, dyspnoea, stridor, tachypnoea, bronchospasm, wheezing and other reactive airway symptoms, and respiratory arrest;
 - cardiovascular effects may include cardiovascular collapse, arrhythmias and cardiac arrest;
 - gastrointestinal effects may also be present and may include mucous membrane irritation, nausea and vomiting (sometimes bloody), and abdominal pain.
- Chlorine vapour is extremely irritating to the upper respiratory tract and lungs.
- Symptoms of exposure to chlorine include coughing, choking, breathing difficulty, chest pain, headache, vomiting, pulmonary edema. Inhalation may cause lung congestion, bronchitis and loss of consciousness.
- Effects may be delayed. Delayed effects of exposure to chlorine vapour can include shortness of breath, violent headaches, pulmonary edema and pneumonia.
- Earlier reports suggested that concentrations around 5 ppm chlorine caused respiratory complaints, corrosion of the teeth, inflammation of the mucous membranes of the nose and increased susceptibility to tuberculosis in chronically-exposed workers. Recent studies have not confirmed these findings. Concentrations too low to effect the lower respiratory tract may however irritate the eyes, nose and throat.
- Amongst 29 volunteers exposed at 0.5, 1 or 2 ppm chlorine for 4 to 8 hours the following responses were recorded: itching or burning of the nose, itching or burning of the throat, production of tears, urge to cough, runny nose, nausea, headache, general discomfort, dizziness, drowsiness and shortness of breath.
- Material is highly volatile and may quickly form a concentrated atmosphere in confined or unventilated areas. Vapour is heavier than air and may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure.

CHRONIC HEALTH EFFECTS

- Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue. Gastrointestinal disturbances may also occur. Chronic exposures may result in dermatitis and/or conjunctivitis.
- Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.
- Principal route of occupational exposure to the gas is by inhalation.

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- Reduced respiratory capacity may result from chronic low level exposure to chlorine gas. Chronic poisoning may result in coughing, severe chest pains, sore throat and haemoptysis (bloody sputum). Moderate to severe exposures over 3 years produced decreased lung capacity in a number of workers.

TOXICITY AND IRRITATION

CHLORINE:

- Unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

SODIUM HYDROXIDE:

- Unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

IRRITATION

- Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

SECTION 12 – ECOLOGICAL INFORMATION

Chlorine 96 hr LC50 (0.84) mg/L Green sunfish Fish Source:

CHLORINE:

Marine Pollutant

Yes

0.44

Hazardous Air pollutant:

Fish LC50 (96 hr) (mg/l)

Daphnia magna EC50 (48 hr) (mg/l)

- Very toxic to aquatic organisms.

Do NOT allow product to come in contact with surface waters or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash-waters. Wastes resulting from use of the product must be disposed of on site or at approved waste sites.

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CHLORINE (Cl₂)

For chlorine:

■ Environmental fate:

- Atmospheric chlorine produced as a result of such process as disinfection forms hydrochloric (HCl) or hypochlorous (HOCl) acid in the atmosphere, either through reactions with hydroxy radicals or other trace species such as hydrocarbons. These acids are believed to be removed from the atmosphere primarily through precipitation washout (i.e. wet deposition as chlorine is scrubbed out by rain in the subcloud layer) or dry deposition as gaseous chlorine contacts and reacts with the earth's surface.
- Water chlorination, resulting from municipal and industrial wastewater treatment and cooling water disinfection, initially introduces chlorine into the water as chlorine gas, hypochlorite ion (OCl⁻), or its salt. These forms of chlorine are termed free residual chlorines (FRC). Chlorine in aqueous systems volatilises or quickly decays to residual forms such as hypochlorous acid, chloramine and chlorinated organics. Aquatic chemistry is determined by aquatic factors including pH, ammonium ion (which combines with chlorine to produce chloramine) and certain other reducing agents. Inorganic reducing agents in estuarine waters include sulfur, iron and manganese. Other organic compounds in water also contribute to chlorine decay rate. The reactions of chlorine or hypochlorites in water produce a number of by-products many of which have been implicated as genotoxic or tumourigenic.
- Chlorine, added to drinking water as chlorine gas (Cl₂) or hypochlorite salts (e.g., NaOCl), effectively inactivates bacteria in 20 minutes at concentrations of 0.03 to 0.06 mg/l at pH range of 7.0 to 8.5 and temperature range of 4 deg.C to 22 deg.C.
- Chlorine disinfectants in wastewater react with organic matters, giving rise to organic chlorine compounds such as AOX (halogenated organic compounds absorbable on activated carbon), which are toxic for aquatic organisms and are persistent environmental contaminants.
- Chlorine hydrolyses very rapidly in water (rate constants range from 1.5×10^{-4} at deg. C to 4.0×10^{-4} at 25 deg.C; half-life in natural waters, 0.005 seconds. In fresh and wastewaters at pH >6, complete hydrolysis occurs with the formation of hypochlorous acid (HOCl) and chloride ion (Cl⁻). The hypochlorous acid ionizes to hydrogen ion (H⁺) and hypochlorite ion (OCl⁻). At pH values >5, OCl⁻ predominates; at pH values <5, HOCl predominates. Free chlorine (Cl₂, HOCl, and OCl⁻) reacts rapidly with inorganics such as bromide and more slowly with organic material present in natural waters. These reactions yield chloride, oxidised organics, chloroorganics (including trihalomethanes), oxygen, nitrogen, chlorate, bromate and bromoorganics. Chlorine's ultimate aqueous fate is chloride.
- Vapourisation of molecular chlorine (Cl₂) from water to the atmosphere may be significant at low pH values and high concentrations (e.g., pH 2 and 3500 mg/l chlorine), but is insignificant at neutral pH and low concentrations.
- Vegetation acts as an important sink for chlorine air pollution. Plant exposure to elevated levels of chlorine can cause plant injury; however chlorine tends to be rapidly converted to other less toxic forms.
- Atmospheric: When chlorine, hypochlorous acid or hydrogen chloride mixes in the atmosphere with water vapour, dilute solutions of strong mineral acids are formed that fall to earth as acid rain, snow, and fog, or acidified dry particles.

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- Chlorine may react with soil components to form chlorides; depending on their water solubility, these chlorides are easily washed out from the soil.
- Bioaccumulation/ bioconcentration: There is no potential for the bioaccumulation or bioconcentration of chlorine.

Ecotoxicity:

Fish LC50 (96 h): 0.015 – 13.5 mg/l

- Chlorine has high acute toxicity to aquatic organisms; many toxicity values are less than or equal to 1 mg/l.
- Twenty-four-hour LC50 values range from 0.076 to 0.16 mg/l for *Daphnia magna* (water flea) and from 0.005 to 0.1 mg/l for *Daphnia pulex* (cladocern); 48-hour LC50 values range from 5.3 to 12.8 mg/l for *Nitocra spinipes* (snail); and 96-hour LC50 values range from 0.13 to 0.29 mg/L for *Oncorhynchus mykiss* (rainbow trout), from 0.1 to 0.18 mg/l for *Salvelinus fontinalis* (brook trout), and from 0.71-0.82 mg/l for *Lepomis cyanellus* (green sunfish)
- Papillomas of the oral cavity in fish have been associated with exposure to chlorinated water supplies.
- Chlorine is phytotoxic but is also essential to plant growth; crops need around 2 kg or more of chlorine per acre. Acute toxicity to plants is characterized by defoliation with no leaf symptoms and, in higher plant forms, by spotting of the leaves (at 1.5 mg/m³) and marginal and interveinal injury (at 150-300 mg/m³)
- Data from experimental studies indicate that injury to animals occurs only in the presence of high concentrations of chlorine, either in drinking water or the ambient atmosphere.
http://www.epa.gov/chemfact/s_chlori.txt
U.S. ENVIRONMENTAL PROTECTION AGENCY August 1994
- DO NOT discharge into sewer or waterways.
- The material is classified as an ecotoxin* because the Fish LC50 (96 hours) is less than or equal to 0.1 mg/l
- Classification of Substances as Ecotoxic (Dangerous to the Environment)
Appendix 8, Table 1: "Compiler's Guide for the Preparation of International Chemical Safety Cards: 1993 Commission of the European Communities".

Ecotoxicity

Ingredient	Persistence: Water/ Soil	Persistence: Air	Bioaccumulation	Mobility
Chlorine	No Data Available	No Data Available	LOW	

SECTION 13 – DISPOSAL INFORMATION

- Disposal method in accordance with all applicable federal, state and local environment laws & regulations.
- Evaporate residue at an approved site.
- Return empty containers to supplier. If containers are marked non-returnable establish means of disposal with manufacturer prior to purchase.
- Ensure damaged or non-returnable cylinders are gas-free before disposal.

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- Empty containers may have residues.
- Chlorine may be absorbed in dilute solutions of caustic (NaOH), soda ash (Na₂CO₃) or hydrated lime (Ca(OH)₂).

SECTION 14 – TRANSPORTATION INFORMATION



Land Transport UNDG:

Class or division:	2.3	Subsidiary risk:	5.1; 8
UN No:	1017	UN packing group:	None
Shipping Name:	CHLORINE	Hazchem code:	2XE

Air Transport IATA:

ICAO/ IATA Class:	2.3	ICAO/ IATA Subrisk:	5.1; 8
UN/ ID Number:	1017	Packing Group:	-
Special provisions:	A2		
Shipping Name:	CHLORINE		

Maritime Transport IMDG:

IMDG Class:	2.3	IMDG Subrisk:	5.1, 8 - P
UN Number:	1017	Packing Group:	None
EMS Number:	F - C, S - U	Special Provisions:	None
Limited Quantities:	0		
Shipping Name:	CHLORINE		

SECTION 15 – REGULATORY INFORMATION

REGULATIONS

Occupational Safety & Health (Classification, Labeling, and Safety Data Sheet of Hazardous Chemical) Regulation 2013.

The Industry Code of Practice on Chemical Classification and Hazard Communication 2014 (ICOP CCHC).

The Industry Code of Practice on Chemical Classification and Hazard Communication 2014 (Amendment 2019) Part 1

Occupational Safety & Health (Use and Standards of Exposure of Chemicals Hazardous to Health) Regulation 2000.

Environmental Quality Act 1974.

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chlorine (CAS: 7782-50-5) is found on the following regulatory lists;

"ASEAN Cosmetic Directive (ANNEX II - Part 1) List of Substances Which Must Not Form Part of the Composition of Cosmetic Products", "International Council of Chemical Associations (ICCA) - High Production Volume List", "OECD List of High Production Volume (HPV) Chemicals", "Singapore Environmental Protection and Management (Hazardous Substances) Regulations", "Singapore Environmental Protection and Management Act (EPMA) - Air Impurities", "Singapore Environmental Protection and Management Act (EPMA) - List of Controlled Hazardous Substances", "Singapore Odour Thresholds and Irritation Concentration of Chemicals", "Singapore Permissible Exposure Limits of Toxic Substances", "WHO Guidelines for Drinking-water Quality - Guideline values for chemicals that are of health significance in drinking-water"

SECTION 16 – OTHER INFORMATION

LEGEND

- ppm : Part per million
- CAS : Chemical Abstracts Service Registry Number
- PEL : Permissible Exposure Limit (OSHA)
- STEL : Short Term Exposure Limit (15 minutes)
- TLV : Threshold Limit Value (ACGIH)
- TWA : Time Weighted Average (8 hours)
- UV light : Ultraviolet (UV) light
- OSF : Odour Safety Factor
- CPI : Chemwatch Performance Index
- RTECS : Register of Toxic Effects of Chemical Substances.
- CPR : Cardiopulmonary resuscitation (CPR)
- OSHA : Occupational Safety & Health Act

MSDS SECTION CHANGES

- Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Malay-Sino Chemical Industries Sdn. Bhd. Classification committee using available literature references.
- The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.
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**CHLORINE GAS DISPERSION: AWARENESS ON EMERGENCY
RESPONSE OF TRAINED RESIDENTS LIVING NEAR WATER
TREATMENT PLANT**

INTERVIEW QUESTIONS

DEMOGRAPHIC CHARACTERISTICS

1. How old are you?
2. What is your highest education qualification?
3. Are you married? How many children do you have?
4. What is your occupation?
5. Distance to water treatment plant.

HAZARD KNOWLEDGE

1. Do you know if there is any utilization of chlorine gas in the WTP near your housing area?
2. Can you explain what the characteristics of chlorine gas are?
3. Do you know that there will be a potential event of chlorine gas leakage in the water treatment plant?

ATTITUDES TO RISK

1. What are the consequences if there is an event of chlorine gas dispersion occurs?
2. What are the possible impacts of chlorine gas leakage on your personal health?

PREVIOUS EXPERIENCE OF EMERGENCIES

1. Do you have any experience facing an emergency situation? If yes, what type of emergency?
2. What is the action taken during the emergency?
3. What are the consequences of that emergency to your life?

EXPOSURE TOWARDS AWARENESS DEGREES

1. How long have you been living in that housing area?

2. In what ways can you help to increase the awareness of chlorine gas among your community?
3. What are your initiatives in finding the relevant information regarding preparedness chlorine gas leakage after attending the open day?

ABILITY TO RESPOND

1. In case of chlorine gas dispersion, what will you do to save your life, your family members and community?
2. What are the organizations that you know that you could possibly refer and to get help in case there is an actual event of chlorine dispersion?

ADDITIONAL INFORMATION

Is there any information that you want to add?



Temubual 1

Bolehkah tuan / puan menyatakan berapakah umur sekarang?

Saya berumur 42 tahun.

Apakah tahap tertinggi pencapaian akademik tuan / puan?

Saya mempunyai Ijazah Sarjana Muda Pengurusan Perniagaan.

Adakah tuan / puan telah berkahwin? Jika ya, berapa orang anak?

Saya belum berkahwin.

Apakah pekerjaan tuan / puan sekarang?

Saya merupakan seorang penjawat awam di Putrajaya.

Berapa jauh tempat tinggal anda dengan loji rawatan air yang terdekat?

Tempat tinggal saya tidaklah terlalu dekat dengan loji rawatan air tetapi tempat kerja saya berdekatan dengan Loji Rawatan Air Semenyih.

Adakah anda tahu ada penggunaan klorin gas di loji rawatan air berdekatan kawasan anda?

Saya tahu setelah menghadiri Hari Terbuka Loji Rawatan Air yang diadakan baru-baru ini.

Bolehkah anda menerangkan sifat-sifat gas klorin?

Gas klorin ialah gas yang berbahaya dan ia merupakan gas yang berat iaitu akan cenderung berada di bawah. Gas klorin boleh menyebabkan kematian.

Adakah anda tahu bahawa kebocoron gas klorin di Loji Rawatan Air ini boleh berlaku?

Ya. Boleh berlaku bila-bila masa.

Apakah yang akan berlaku sekiranya berlaku penyebaran gas klorin di kawasan tersebut?

Boleh berlaku kematian dalam skala yang besar.

Apakah kesan-kesan kepada kesihatan sekiranya berlaku penyebaran gas klorin?

Kecacatan kekal pada mata dan kesukaran untuk bernafas.

Adakah anda pernah mengalami situasi cemas sebelum ini?

Ya.

Boleh terangkan?

Kebakaran di stor pejabat.

Apakah tindakan tuan / puan apabila berlaku perkara tersebut?

Saya memaklumkan kepada rakan sekerja dan keluar dari pejabat.

Adakah kejadian tersebut memberikan apa-apa kesan kepada hidup tuan / puan?

Ada. Ia memberikan trauma yang menyebabkan saya lebih mengambil langkah berjaga-jaga.

Boleh saya tahu sudah berapa lama anda tinggal / bekerja di kawasan berdekatan Loji Rawatan Air tersebut?

Hampir 14 tahun saya bekerja di kawasan yang berdekatan dengan Loji Rawatan Air tersebut.

Pada pendapat anda, cara apakah yang boleh anda lakukan untuk meningkatkan kesedaran tentang bahaya klorin dalam masyarakat setempat?

Melalui bercerita atau bersembang dengan rakan atau keluarga, kita boleh sampaikan maklumat tentang bahaya klorin ini. Juga melalui sosial media kita kongsikan maklumat berkaitan.

Adakah anda mempunyai inisiatif sendiri untuk mencari maklumat tambahan berkaitan dengan klorin selepas menghadiri Hari Terbuka di Loji Rawatan Air tempoh hari?

Bagi saya klorin ni satu perkara baru. Ada juga membaca sedikit kes-kes kebocoran klorin.

Sekiranya penyebaran klorin benar-benar berlaku, apakah tindakan tuan / puan untuk menyelamatkan keluarga dan masyarakat setempat?

Keluar dari pejabat dan dapatkan udara segar. Disebabkan klorin ini gas yang berat, kita perlu ke tempat yang lebih tinggi.

Siapakah yang tuan / puan akan hubungi sekiranya berlaku penyebaran gas klorin?

Bomba. Hubungi 999 dan kita akan disambungkan ke Bomba.

Ada apa-apa maklumat atau persoalan tambahan dari tuan / puan mengenai temuramah ini?

Saya rasa pihak berkaitan seperti Loji Rawatan Air atau Bomba perlu meningkatkan lagi penerangan dari masa ke masa untuk memastikan kesedaran tentang bahaya klorin ini dikalangan masyarakat. Masih ramai yang tak tahu.

Temubual 2

Bolehkah tuan / puan menyatakan berapakah umur sekarang?

Saya berumur 36 tahun.

Apakah tahap tertinggi pencapaian akademik tuan / puan?

Tahap tertinggi akademik saya ialah PhD dalam bidang sains fizik.

Adakah tuan / puan telah berkahwin? Jika ya, berapa orang anak?

Saya sudah berkahwin dan mempunyai seorang anak.

Apakah pekerjaan tuan / puan sekarang?

Saya merupakan penyelidik dalam bidang bateri di Universiti Kebangsaan Malaysia (UKM).

Berapa jauh tempat tinggal / pejabat anda dengan loji rawatan air yang terdekat?

Sekitar 1km. Dekat dengan Loji Rawatan Air Wangsa Maju dan Empangan Klang Gate.

Adakah anda tahu ada penggunaan klorin gas di loji rawatan air berdekatan kawasan anda?

Ya saya tahu. Mana-mana loji rawatan air pasti akan menggunakan klorin untuk tujuan nyah kuman.

Bolehkah anda menerangkan sifat-sifat gas klorin?

Gas klorin ialah gas yang beracun. Bau sangat menyengat seperti bau 'chlorox' dan ia merupakan gas yang berat. Gas klorin boleh menyebabkan kematian pada kepekatan yang sangat tinggi.

Adakah anda tahu bahawa kebocoron gas klorin di Loji Rawatan Air ini boleh berlaku?

Ya, boleh berlaku jika tidak diselenggara dengan baik.

Apakah yang akan berlaku sekiranya berlaku penyebaran gas klorin di kawasan tersebut?

Boleh berlaku kematian beramai-ramai seperti kes Bhopal di India.

Apakah kesan-kesan kepada kesihatan sekiranya berlaku penyebaran gas klorin?

Sakit kepala, kulit dan mata. Masalah pernafasan yang akhirnya boleh menyebabkan kematian.

Adakah anda pernah mengalami situasi cemas sebelum ini?

Ya.

Boleh terangkan?

Saya jumpa ayah yang pengsan di dapur.

Apakah tindakan tuan / puan apabila berlaku perkara tersebut?

Saya memaklumkan kepada suami dan menghubungi ambulan.

Adakah kejadian tersebut memberikan apa-apa kesan kepada hidup tuan / puan?

Trauma untuk meninggalkan orang tua bersendirian di rumah. Dan dalam masa yang sama, saya belajar untuk tidak panik bila berhadapan situasi cemas.

Boleh saya tahu sudah berapa lama anda tinggal / bekerja di kawasan berdekatan Loji Rawatan Air tersebut?

Tahun ke 7. Tapi sebelum ini saya membesar di kawasan ini juga.

Pada pendapat anda, cara apakah yang boleh anda lakukan untuk meningkatkan kesedaran tentang bahaya klorin dalam masyarakat setempat?

Kita perlu sampaikan maklumat mengenai keselamatan seperti ini kepada ahli keluarga sebaik sahaja kita tahu. Jika hubungan kejiiran baik, kita sampaikan kepada mereka juga. Melalui perjumpaan komuniti, ceramah-ceramah, hebahan media sosial dan sebagainya.

Adakah anda mempunyai inisiatif sendiri untuk mencari maklumat tambahan berkaitan dengan klorin selepas menghadiri Hari Terbuka di Loji Rawatan Air tempoh hari?

Pekerjaan saya sendiri ada melibatkan penggunaan bahan kimia termasuk klorin. Memang saya perlu tahu tentang bahaya gas ini.

Sekiranya penyebaran klorin benar-benar berlaku, apakah tindakan tuan / puan untuk menyelamatkan keluarga dan masyarakat setempat?

Terlebih dahulu kita perlu selamatkan diri dan ahli keluarga. Pastikan kita mendapat udara segar dengan cara keluar dari rumah. Jika ramai yang sesak nafas dan merasakan itu kebocoran gas klorin, kita perlu bergerak sejauh yang boleh dari Loji Rawatan Air tersebut kerana gas itu akan mencair.

Siapakah yang tuan / puan akan hubungi sekiranya berlaku penyebaran gas klorin?

Bomba.

Ada apa-apa maklumat atau persoalan tambahan dari tuan / puan mengenai temuramah ini?

Hebahan mengenai bahaya klorin ini sangat kurang. Tak ramai yang hadir ke Hari Terbuka Loji Rawatan Air. Sekiranya berlaku penyebaran gas klorin, pasti ramai yang tak tahu nak menyelamatkan diri.

Temubual 3

Bolehkah tuan / puan menyatakan berapakah umur sekarang?

Saya berumur 37 tahun.

Apakah tahap tertinggi pencapaian akademik tuan / puan?

Saya dahulu belajar di UPM dalam Ijazah Perniagaan Tani.

Adakah tuan / puan telah berkahwin? Jika ya, berapa orang anak?

Saya sudah berkahwin dan mempunyai tiga orang anak.

Apakah pekerjaan tuan / puan sekarang?

Saya merupakan guru di salah sebuah sekolah menengah di Gombak.

Berapa jauh tempat tinggal / pejabat anda dengan loji rawatan air yang terdekat?

Saya tak pasti tapi gak dekat juga dengan Loji Rawatan Air Wangsa Maju.

Adakah anda tahu ada penggunaan klorin gas di loji rawatan air berdekatan kawasan anda?

Ya. Saya baru tahu.

Bolehkah anda menerangkan sifat-sifat gas klorin?

Saya tak pasti. Tapi yang saya tahu gas klorin ini berbahaya.

Adakah anda tahu bahawa kebocoron gas klorin di Loji Rawatan Air ini boleh berlaku?

Ya. Ada diterangkan dalam Hari Terbuka Loji Rawatan Air.

Apakah yang akan berlaku sekiranya berlaku penyebaran gas klorin di kawasan tersebut?

Akan berlaku kematian kalau lebih berdekatan dengan Loji Rawatan Air tersebut.

Apakah kesan-kesan kepada kesihatan sekiranya berlaku penyebaran gas klorin?

Yang saya tahu sesak nafas. Dan mungkin menyebabkan mata menjadi pedih.

Adakah anda pernah mengalami situasi cemas sebelum ini?

Ya.

Boleh terangkan?

Anak saya yang masih bayi jatuh dari katil.

Apakah tindakan tuan / puan apabila berlaku perkara tersebut?

Saya terus bawa ke klinik selepas itu.

Adakah kejadian tersebut memberikan apa-apa kesan kepada hidup tuan / puan?

Saya lebih berjaga-jaga. Soal keselamatan amat saya titikberatkan selepas itu.

Boleh saya tahu sudah berapa lama anda tinggal / bekerja di kawasan berdekatan Loji Rawatan Air tersebut?

Sudah 3 tahun.

Pada pendapat anda, cara apakah yang boleh anda lakukan untuk meningkatkan kesedaran tentang bahaya klorin dalam masyarakat setempat?

Kita boleh menyebarkan maklumat secara media sosial, poster, flyers, ceramah di sekolah dan sebagainya.

Adakah anda mempunyai inisiatif sendiri untuk mencari maklumat tambahan berkaitan dengan klorin selepas menghadiri Hari Terbuka di Loji Rawatan Air tempoh hari?

Saya ada mencari sedikit maklumat berkaitan bahaya klorin ini untuk jadikan bahan mengajar di sekolah.

Sekiranya penyebaran klorin benar-benar berlaku, apakah tindakan tuan / puan untuk menyelamatkan keluarga dan masyarakat setempat?

Segera mendapatkan udara segar. Jika kawasan tertutup, pergi ke kawasan lapang.

Siapakah yang tuan / puan akan hubungi sekiranya berlaku penyebaran gas klorin?

999.

Ada apa-apa maklumat atau persoalan tambahan dari tuan / puan mengenai temuramah ini?

Tiada.



Temubual 4

Bolehkah tuan / puan menyatakan berapakah umur sekarang?

Saya berumur 62 tahun.

Apakah tahap tertinggi pencapaian akademik tuan / puan?

Saya memiliki Ijazah Sains Botani.

Adakah tuan / puan telah berkahwin? Jika ya, berapa orang anak?

Saya ibu tunggal dan mempunyai lima orang anak.

Apakah pekerjaan tuan / puan sekarang?

Saya merupakan pesara. Pekerjaan akhir saya di Suruhanjaya Syarikat Malaysia (SSM). Sekarang ialah suri rumah sepenuh masa.

Berapa jauh tempat tinggal / pejabat anda dengan loji rawatan air yang terdekat?

Kurang dari 1km dari Loji Rawatan Air Sg. Selangor Fasa 1 & 2.

Adakah anda tahu ada penggunaan klorin gas di loji rawatan air berdekatan kawasan anda?

Ya. Saya ada beberapa kali menghadiri Hari Terbuka Loji Rawatan Air.

Bolehkah anda menerangkan sifat-sifat gas klorin?

Gas yang bebas dalam udara. Boleh menyebabkan kematian kalau kita terhidu.

Adakah anda tahu bahawa kebocoron gas klorin di Loji Rawatan Air ini boleh berlaku?

Ya.

Apakah yang akan berlaku sekiranya berlaku penyebaran gas klorin di kawasan tersebut?

Siapa yang lebih dekat dengan Loji Rawatan Air lebih bahaya kerana akan menerima kepekatan yang tinggi dan membawa maut.

Apakah kesan-kesan kepada kesihatan sekiranya berlaku penyebaran gas klorin?

Sesiapa yang terhidu akan mengalami masalah pernafasan.

Adakah anda pernah mengalami situasi cemas sebelum ini?

Ya.

Boleh terangkan?

Kereta saya pernah mengalami kemalangan. Kereta saya dilanggar sebuah lori dan kereta saya terbalik.

Apakah tindakan tuan / puan apabila berlaku perkara tersebut?

Saya tidak mampu berbuat apa-apa. Saya menunggu untuk diselamatkan.

Adakah kejadian tersebut memberikan apa-apa kesan kepada hidup tuan / puan?

Saya mengalami trauma dan mengambil masa yang amat lama untuk berani pegang stereng kereta semula. Sejak dari itu, setiap kali nampak lori mesti akan jauhkan diri. Boleh saya tahu sudah berapa lama anda tinggal / bekerja di kawasan berdekatan Loji Rawatan Air tersebut?

Lebih 20 tahun.

Pada pendapat anda, cara apakah yang boleh anda lakukan untuk meningkatkan kesedaran tentang bahaya klorin dalam masyarakat setempat?

Penerangan seperti ini lebih baik dihebahkan secara televisyen dan radio. Biar semua orang tahu.

Adakah anda mempunyai inisiatif sendiri untuk mencari maklumat tambahan berkaitan dengan klorin selepas menghadiri Hari Terbuka di Loji Rawatan Air tempoh hari?

Tiada.

Sekiranya penyebaran klorin benar-benar berlaku, apakah tindakan tuan / puan untuk menyelamatkan keluarga dan masyarakat setempat?

Keluar dari rumah. Segera ke tempat yang lebih selamat.

Siapakah yang tuan / puan akan hubungi sekiranya berlaku penyebaran gas klorin?

Bomba.

Ada apa-apa maklumat atau persoalan tambahan dari tuan / puan mengenai temuramah ini?

Tiada.

Temubual 5

Bolehkah tuan / puan menyatakan berapakah umur sekarang?

Saya berumur 30 tahun.

Apakah tahap tertinggi pencapaian akademik tuan / puan?

Saya memiliki Ijazah Sarjana Muda Pengurusan Maklumat dari UiTM.

Adakah tuan / puan telah berkahwin? Jika ya, berapa orang anak?

Saya sudah berkahwin dan mempunyai seorang anak.

Apakah pekerjaan tuan / puan sekarang?

Saya merupakan agen insuran takaful.

Berapa jauh tempat tinggal / pejabat anda dengan loji rawatan air yang terdekat?

Saya tinggal bersebelahan dengan Loji Rawatan Air Sg. Langat. Dalam kuarters.

Isteri merupakan salah seorang pekerja syarikat air.

Adakah anda tahu ada penggunaan klorin gas di loji rawatan air berdekatan kawasan anda?

Sebelum ini tidak tahu. Selepas hadir taklimat baru saya tahu.

Bolehkah anda menerangkan sifat-sifat gas klorin?

Gas berbau macam kolam renang.

Adakah anda tahu bahawa kebocoron gas klorin di Loji Rawatan Air ini boleh berlaku?

Ya.

Apakah yang akan berlaku sekiranya berlaku penyebaran gas klorin di kawasan tersebut?

Menyebabkan orang akan menjadi sakit dan mati.

Apakah kesan-kesan kepada kesihatan sekiranya berlaku penyebaran gas klorin?

Akan mengalami masalah pernafasan.

Adakah anda pernah mengalami situasi cemas sebelum ini?

Ya.

Boleh terangkan?

Saya pernah dijangkiti Covid-19 pada tahun 2020. Pada ketika itu saya mengalami sesak nafas tiba-tiba semasa tidur. Saya ada mengesyaki tentang kebocoran klorin kerana duduk bersebelahan kawasan loji rawatan air. Tetapi hanya saya seorang yang sesak nafas pada ketika itu.

Apakah tindakan tuan / puan apabila berlaku perkara tersebut?

Saya minta isteri hantar ke hospital.

Adakah kejadian tersebut memberikan apa-apa kesan kepada hidup tuan / puan?

Tidak ada kesan serius dalam hidup saya memandangkan memang musim Covid-19 waktu itu. Cuma masih merasai kesan Covid-19 yang berpanjangan.

Boleh saya tahu sudah berapa lama anda tinggal / bekerja di kawasan berdekatan Loji Rawatan Air tersebut?

Lebih 3 tahun.

Pada pendapat anda, cara apakah yang boleh anda lakukan untuk meningkatkan kesedaran tentang bahaya klorin dalam masyarakat setempat?

Menggalakkan orang untuk menyertai program-program kesedaran tentang bahaya klorin ini.

Adakah anda mempunyai inisiatif sendiri untuk mencari maklumat tambahan berkaitan dengan klorin selepas menghadiri Hari Terbuka di Loji Rawatan Air tempoh hari?

Biasanya isteri yang memberi maklumat tentang klorin ini.

Sekiranya penyebaran klorin benar-benar berlaku, apakah tindakan tuan / puan untuk menyelamatkan keluarga dan masyarakat setempat?

Segera ke tempat yang lebih tinggi dan jauh dari loji rawatan air.

Siapakah yang tuan / puan akan hubungi sekiranya berlaku penyebaran gas klorin?

Bomba.

Ada apa-apa maklumat atau persoalan tambahan dari tuan / puan mengenai temuramah ini?

Saya rasa program-program seperti Hari Terbuka Loji Rawatan Air perlu diperluas kerana ramai yang masih belum tahu tentang bahaya klorin. Jumlah yang hadir juga kurang. Mungkin video yang menarik boleh disediakan untuk menarik minat orang ramai mengambil tahu tentang perkara ini.