IS 6156 (1971): Code of safety for chlorosulphonic acid
[CHD 8: Occupational Safety, Health and Chemical Hazards]

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IS : 6156 - 1971
(Reaffirmed 2009)

Indian Standard

CODE OF SAFETY FOR CHLOROSULPHONIC ACID

(Second Reprint JUNE 1996)

UDC 614.878 : 547.431.6 - 113

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 6 ***January*** **1972**

AMENDMENT NO. 1 DECEMBER 2006
TO
IS 6156 : 1971 CODE OF SAFETY FOR CHLOROSULPHONIC ACID

(*Page* 4, *clause* **3.1**) — Insert the following under 'Reactivity' at the end:

'Reacts exothermically with many organic and combustible materials, nitrates, chlorates, carbides, sulfides, cyanides, and metallic powders.'

(CHD 8)

Reprography Unit, BIS, New Delhi, India

IS : 6156 - 1971
(Reaffirmed 1986)

Indian Standard

CODE OF SAFETY FOR CHLOROSULPHONIC ACID

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Indian Standard

CODE OF SAFETY FOR CHLOROSULPHONIC ACID

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 21 June 1971, after the draft finalized by the Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

0.2 Chlorosulphonic acid, represented by the formula $ClSO_3H$, may also be named as sulphuric chlorohydrin. It is a slightly cloudy liquid with a penetrating odour. It is highly corrosive to most metals, generating hydrogen, a highly flammable and explosive gas. Chlorosulphonic acid itself is not flammable but may cause ignition by contact with combustible liquids and solids.

0.2.1 On contact with the skin or eyes, chlorosulphonic acid produces severe burns. Swallowing may cause severe injury or death. Inhalation of concentrated vapour or mist may be injurious to the lungs.

0.3 In the preparation of this standard, considerable assistance has been derived from The Safety Data Sheet SD-33 published by Manufacturing Chemists Association, Washington, D C, USA.

1. SCOPE

1.1 This standard describes the properties of chlorosulphonic acid, nature of hazards associated with it and the essential information on storage, handling, packing, labelling, waste disposal, cleaning and repair of tanks, selection and training of personnel, personal protective equipment, and first-aid.

1.1.1 This standard does not deal with specifications for design of buildings, chemical engineering plants, storage vessels and various safety equipment.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definition of terms given in IS : 4155-1966* shall apply.

*Glossary of terms relating to chemical and radiation hazards and hazardous chemicals.

3. PROPERTIES OF CHLOROSULPHONIC ACID

3.1 Some of the important properties of chlorosulphonic acid are:

Physical state	Liquid, clear or cloudy. Fumes with heavy white vapours when exposed to atmosphere.
Colour	Colourless to pale yellow.
Odour	Sharp, acrid, penetrating odour.
Boiling point	151.5°C at 760 mm.
Freezing point	–80°C
Corrosivity	Corrosive to most metals; highly so when exposed to atmospheric moisture, with evolution of hydrogen gas which is flammable and explosive.
Density (grams per millilitre)	1.768 at 10°C 1.752 at 20°C 1.736 at 30°C
Vapour pressure	1 mm at 32°C
Flammability	Nonflammable. However the acid may cause ignition by contact with combustible materials.
Hygroscopicity	Very hygroscopic
Reactivity	Dangerously reactive. With water or moisture, it breaks down into sulphuric and hydrochloric acids. In addition to attacking many metals, the acid is a strong oxidizing agent and will react with water and organic materials with evolution of heat and large quantities of dense white fumes.

4. HAZARDS ASSOCIATED WITH CHLOROSULPHONIC ACID

4.1 Health Hazards

4.1.0 *General* — Due to its corrosive, oxidizing and sulphonating properties, chlorosulphonic acid produces rapid destruction of tissues and severe burns on contact with bodily tissues of any kind. Through the action of moisture in air or water, it is broken down into hydrochloric and sulphuric acids, both of which are extremely irritating to the eyes, lungs, and mucous membranes.

4.1.0.1 A threshold limit value (TLV) has not been set for chlorosulphonic acid. Since the acid breaks down into hydrochloric and sulphuric

acids, a TLV of 1 mg/m^3 (which corresponds to value set for sulphuric acid) may be used as a guide.

4.1.1 *Acute Toxicity*

4.1.1.1 *Systemic effects* — No systemic effects are noted except those due to the irritating or corrosive character of the material.

4.1.1.2 *Local effects* — Chlorosulphonic acid is dangerous when improperly handled. Concentrated solutions are rapidly destructive to any body tissues with which they come in contact.

Contact with the eyes very rapidly causes severe damage which may be followed by total loss of slight.

Inhalation of concentrated vapour or mist from hot acid will cause damage to the upper respiratory tract and even to the lung tissue proper and may cause loss of consciousness.

4.1.2 *Chronic Toxicity*

4.1.2.1 *Systemic effects* — No systemic effects are noted, except those secondary to tissue damage.

4.1.2.2 *Local effects* — Repeated contact with low concentration of the acid may cause skin irritation. Repeated inhalation of mist may cause an inflammation of the upper and lower respiratory tract.

4.2 Fire Hazards — The acid itself is not flammable but it may cause ignition by contact with combustible liquids and solids.

4.2.1 Hydrogen, a highly flammable and explosive gas, is generated by the action of the acid on most metals.

5. STORAGE

5.1 Chlorosulphonic acid attacks most metals but it may be stored satisfactorily in steel tanks designed and fabricated for the purpose, or in drums and glass bottles in which it is received. The storage period in steel tanks or drums should be kept as short as possible as acid discolours and become contaminated with sediment. Glass-lined steel tanks, are most preferred storge tanks for chlorosulphonic acid, although stainless steel tanks may be used if nominal iron pick-up can be tolerated.

5.2 Due to the low freezing point of chlorosulphonic acid, heated storage is neither necessary nor desirable.

5.3 Buildings may be constructed of wood, concrete, or steel. Open steel work should be protected by an acid resistant paint. Provision should be made for drainage and washing down spills with large quantities of water. Brick or tile floors are recommended.

5.4 Chlorosulphonic acid should not be stored with or near other chemicals with which it might violently react, thereby causing fires or explosions. It should be isolated from organic materials and such products as nitrates, carbides, chlorates and metallic powders.

5.5 Electrical fixtures should be of the vapour-proof type. All wiring should be in tight, rigid metal conduits.

5.6 Hydrogen will be formed by the action of chlorosulphonic acid on iron. Each storage tank, therefore, should be provided with a vent of sufficient size. The vent should be of a type which will maintain the tank at atmospheric pressure, and which is capable of being cleaned readily.

5.7 Drums should be stored with plugs up. Storage periods of chlorosulphonic acid in drums should be kept at a minimum. They should be vented once a week, or oftener in hot weather, to relieve accumulated internal pressure of hydrogen formed by action of the acid on the iron.

5.7.1 Drums should not be stored in or exposed to direct sunlight.

5.8 Tank storage should be in two or more tanks of suitable capacity. Maximum storage should be of such quantity that a leaking storage tank may be emptied into another sound storage unit.

5.8.1 Chlorosulphonic acid tanks should be equipped with sumps and sump pumps. Bottom outlet tanks should never be used.

5.8.2 A periodic inspection schedule for all storage facilities is recommended.

5.9 Storage should be located in open or in well ventilated buildings or sheds. Natural ventilation should be sufficient.

5.10 Venting of Storage Tanks — As acid is pumped into the tank, fumes are displaced and will go out of the vent. These fumes are quite visible and may create a local annoyance. The extent of this problem will vary depending on the relative location of the tanks, operating departments, and property lines. In some jurisdictions, the visible plume would not be allowed. A tall stack for the displaced fumes may be desirable to prevent local problems in the immediate storage area. The stack should be high enough to clear nearby buildings, ventilation inlets, etc. Where the visible plume is not allowed, it may be necessary to vent the fumes through mist eliminators or through scrubbers.

6. HANDLING

6.0 Unauthorised persons shall be kept away from the place where the acid is handled and suitable sign denoting this shall be posted in a prominent place.

6.1 Glass Bottles — Employees handling glass bottles should be equipped with personal protective equipment, especially for eye protection. Both boxes and bottles should be handled carefully to avoid breakage.

6.2 Drums

6.2.1 Personnel should be equipped with protective clothing. Protective clothing should consist of head covering or safety hard hat with brim, rubber gloves, chemical goggles with or without face shields, rubber apron and rubber safety-toe shoes. A supply of water should be close at hand.

6.2.2 Inspect drums for loose plugs and signs of leakage or damage before moving. Set aside for special handling if damage is found. Tighten loose plugs.

6.2.3 Avoid rough handling of drums. Do not drop. Drums should be handled carefully to and from their place of storage. Before emptying contents, substantially support drums and block them to prevent movement.

6.2.4 To remove the body plug, place plug up and use a pipe wrench or preferably a plug wrench with a long handle. Stand to one side and face away during the operation. After the plug is loosened turn slowly, and open not more than one full turn. If accumulated internal pressure vents, allow it to reduce to atmospheric pressure. Only then should the plug be slowly loosened further or removed.

6.2.5 Drums should be emptied by gravity only, using a faucet or safety siphon fabricated of material resistant to chlorosulphonic acid. Application of pressure to the drum is extremely dangerous and should never be attempted.

6.2.6 Smoking should be strictly forbidden while handling, working on, or emptying drums because of the hydrogen hazard.

6.2.7 Since drums may contain gas they should never be struck with a spark-producing tool.

6.2.8 Employees handling leaking drums should wear full protective equipment, such as rubber safety-toe boots, gloves and suit, safety glasses covered by a face shield and brimmed hat. If extreme conditions exist, an acid hood should be worn.

6.2.9 Move the defective drum to a well-ventilated or outdoor area. Clear the immediate area of non-essential personnel and material.

6.2.10 Neutralize spills with soda ash. Wash the area thoroughly with water. If necessary, sand or a mixture of soda ash and sand can be used to soak up the acid. This should be shoveled up for disposal.

6.2.11 Protect or remove material in the area which may be affected by fumes. The effect of fumes on neighbouring property should also be taken into account.

6.2.12 When transferring acid, make sure that the receiving container is clean and that when filled it is adequately labelled.

6.2.13 Pumps which can pressurize drums should not be used when transferring acid. Pumps shall be cleaned after use. A self-starting (bulb-activated) siphon may be used. The siphon hose should be firmly anchored before starting transfer operations.

6.3 Tank Tracks

6.3.1 No open flame of any kind should ever be permitted near an opening of the tank for any purpose.

6.3.2 Smoking shall be forbidden within ten metres radius of tanks and trucks. A suitable 'NO SMOKING' sign shall be posted at the top of them.

6.3.3 All tools used in connection with unloading shall be kept free from oil, dirt, and grit. During use they should be kept wet with water to avoid sparking.

6.3.4 Never strike tank fittings with tools or other hard objects. Do not use hammer and chisel at any time. Failure to observe these precautions may result in the ignition of hydrogen gas and create an explosion.

6.3.5 *Damage En Route* — In case a tank truck becomes damaged *en route* so that it cannot proceed safely to destination, every effort should be made to park it where it will not endanger traffic or property. The truck should be parked, if possible, in a vacant lot and away from an area in which there is a concentration of people. If leaking, the acid should be trapped in a depression or pit and if possible, neutralized with soda ash or lime and the neutralized material subsequently thoroughly washed away. Litmus paper should be used to determine that the spill has been adequately neutralized. If available, another authorized tank truck should be brought to the disabled vehicle to 'pump off' the leaking acid.

6.3.6 *Unloading* — Unloading should preferably be performed during day-light hours. When it is necessary to unload at night, proper and adequate lighting should be provided around the tank truck and the working areas involved in the operation. The electrical fittings should be of vapour proof type. The pump switch should be located not less than 4 metres from the unloading point.

6.3.6.1 Only qualified and properly instructed employees should operate the truck and make the hook-up of the hose from the tank truck to the receiving tank.

6.3.6.2 Contents of the tank truck should be checked before they are transferred. If a sample is required for testing purposes, the truck driver should open the manhole or filling opening. The person taking the sample should wear the prescribed protective equipment.

6.3.6.3 It shall be made sure that all valves are properly set and that the overflow line on the storage tank will discharge to a safe location, and also that there is room in the receiving tank for the amount of acid to be transferred.

6.3.6.4 Before connecting for unloading, the truck engine should be stopped and not started again during the entire unloading operation unless it is necessary to operate the pump by power take-off or to use the truck engine to operate compressors as a source of air for air pressure unloading.

6.3.6.5 Truck parking brakes should be set and, where necessary, the wheels blocked.

6.3.6.6 A sign should be placed near truck stating in effect 'Danger-Unloading Acid' to caution others to stay away from the operation.

6.3.6.7 Whether unloading by pump or air, the piping should, if possible, be arranged so the acid will drain toward the storage tank when the pump is shut down or when the discharge valve is closed.

6.3.6.8 When unloading line shall be run across a walkway, suitable warning signs should be provided to denote the hazard.

6.3.6.9 Before starting to vent or connect, a water hose should be connected and kept ready for emergency use and the emergency shower should be tested.

6.3.6.10 Wherever practicable, unloading should be accomplished by pumping. Whether pumping or unloading by dry air pressure, observe the following procedure. Operate relief valve or dry air Valve to vent the tank using precautions to avoid possible acid spray. Remove blind flange from the dry air inlet line. Leave this line open during pumping. After making certain that there is no dry air pressure, remove blind flange from standpipe and connect unloading line to standpipe.

6.3.6.11 If transfer is by means of dry air pressure, connect dry air line and apply air slowly until there is a normal flow of acid into the storage tank. The air pressure must not exceed the safe working pressure of the tank or the start-to-discharge pressure of the relief valve. A pressure reducing valve should be provided in the air line when higher pressures are possible. When the tank truck is empty, shut off the air and operate the relief valve to vent off the pressure. After pressure has been vented, disconnect the dry air line. Do not disconnect the acid unloading line until

the tank truck is at atmospheric pressure and the tank truck standpipe is drained. After disconnecting the acid unloading line replace blind flanges on standpipe and dry air line.

6.3.6.12 If a spill or overflow should occur during a transferring operation, the pump or supply of air should be stopped, valves shut off and spill cleaned up before other actions are taken.

6.4 Tank Cars

6.4.1 Precautions given in **6.3.1** to **6.3.4** also apply here. Protective clothing as required snail be used (*see* **8.4.5**). Suppliers instructions shall be followed.

6.4.2 Tank shall not be used for a product other than that which it last contained, as injury to the tank or an explosion may result.

6.4.3 Under no circumstances should air pressure in excess of 2.1 kg/cm^2 be used for unloading car tank. Use of air beyond this pressure may produce tank damage or bursting.

6.4.4 Discharge connections shall be detached immediately after tank is unloaded. Unloader shall stay with car throughout the unloading operation and until all discharge fittings are disconnected and car fittings replaced and closed.

6.4.5 Should any hazardous conditions arise, immediately close air supply and do not reopen until repairs have been completed.

6.4.6 Unloading dock should be in the open and located so as to dissipate vapours to fresh air.

Brakes should be set and wheels blocked on all cars being unloaded.

6.4.7 Standard details and warning flags and lights should be placed. In addition, caution signs shall be so placed as to give necessary warning to persons approaching from open track or siding end, and should be left in place until after car is unloaded and disconnected.

6.4.8 If it is necessary to move a partly unloaded tank car, all openings should be closed and the car moved carefully as considerable force can be exerted by the movement of the acid in the tank.

6.4.9 Do not use a rubber hose for the acid discharge connection. Discharge of contents through the bottom of the tank should never be attempted. Under no circumstances should the discharge pipe be opened until all pressure in the tank hat been released. Carefully read all caution markings on tank and dome before discharge.

6.4.10 *Unloading by Pump* — The pump should be constructed of materials not readily affected by the product. A self-priming centrifugal pump is preferred over the positive displacement type. If the later is used, it should be provided with an un-valved by-pass from outlet to inlet with properly rated rupture disc of suitable material. Also, car must be vented to prevent a vacuum and to permit air to displace the acid as car is unloaded.

All connections to the pump should be made in such a manner as to avoid excessive stresses at the pump. The pump packing should be checked prior to unloading to avoid the danger of acid leakage. Where a relief valve is required on a centrifugal pump, it should be arranged to discharge to a safe location or into the suction side of the pump. In all cases, the relief valve should be large enough to handle the full pump capacity to avoid pressure building up beyond the safe limits for the pump or piping system.

6.4.11 *Unloading by Air* — When unloading by air, the air line should be earthed and bonded to avoid any sparks in the vapour space which may ignite hydrogen, if present. Compressed air used for unloading shall be as free as possible from oil, excess moisture and foreign matter. To ensure this, the air supply should be taken from the top of the air receiver (reservoir). This receiver should be drained at regular intervals. The air line leading to tank car — usually a dead and idle line between receipts — should be thoroughly blown clear before making connection to the tank car. Any moisture so admitted may readily generate heat and accelerate corrosion of the tank. It is recommended that purchaser install an air dryer or water separator in the air line, adjacent to and preceding the air shut-off valve.

6.5 Leaks and Spills — Spilled chlorosulphonic acid shall not be left unattended. Avoid drainage to sewers. All spillage should be removed immediately by flushing the contaminated area with copious quantities of water. Care should be taken as water and chlorosulphonic acid react violently. As hydrochloric acid gas is evolved, water should be added from a distance and the person flushing with water should have the wind at his back. No one should be allowed on the opposite side of the contaminated area while the flushing is taking place. If the use of water is impossible, the contaminated area should be covered with dry sand, ashes, or gravel. Remaining traces of acid should be neutralized with soda ash or lime. Combustibles, such as clothes, sawdust, or other organic material, should not be used for mopping up. Wear appropriate protective equipment while cleaning up spills.

6.6 Disposal and Return Precautions

6.6.1 If containers are to be scrapped, enough sulphuric acid, 93 percent or stronger, should be added to the containers to dilute the chlorosulphonic acid. They should then be drained and washed well with water by alternately filling and emptying them. Introduce water remotely and ayoid standing above the opening. A five percent soda ash solution should be used for the last wash.

6.6.2 Before any shipping containers are returned to supplier, the usual percautions regarding complete drainage of contents should be observed and all openings tightly closed.

6.6.3 *Bottles* — Before bottles are returned to the supplier, they shall be stoppered, and the white acid labels on the cases shall be removed,

obliterated, destroyed, or completely covered by a square white EMPTY label.

6.6.4 *Drums* — Before drums are returned to the supplier, they should be completely drained, and all openings shall be tightly closed. Acid labels shall be removed, obliterated, destroyed or completely covered by a EMPTY label. Under no circumstances should drums be used for any other liquid.

6.6.5 *Tank Cars* — As soon as a tank car is completely unloaded, the unloading connections shall be removed and all closures made tight.

6.6.5.1 Empty tank cars should be returned as promptly as possible, in accordance with instructions received from the supplier's routing instructions should always be followed strictly.

7. LABELLING

7.1 All containers shall bear a label or stencil depicting the symbol given in Fig. 7 of IS : 1260-1958* and the following text shall be printed in the lower half of the label. Other statements or labels as required by laws or regulations in force may also be shown in combination or separately.

CHLOROSULPHONIC ACID

DANGER! CAUSES SEVERE BURNS ! REACTS VIOLENTLY WITH WATER HARMFUL IF INHALED AND MAY CAUSE DELAYED LUNG INJURY CONTACT WITH WATER OR MOIST AIR RELEASES IRRITATING GAS

Do not get in eyes, on skin, on clothing.

Do not breath vapour or mist.

Use with adequate ventilation.

Keep from contact with clothing and other combustible materials to avoid fire.

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes; for eyes, call a physician. Remove and wash contaminated clothing before re-use.

If inhaled, remove to fresh air. If not breathing, give artificial respiration preferably mouth-to-mouth. If breathing is difficult, administer oxygen. Call a physician.

Do not allow water to get into container. Violent reaction may occur.

Keep up wind of leak or spill. Flush away spill by flooding with water applied quickly to entire spill. Provide ventilation if indoors.

*Code of symbols for labelling of dangerous goods.

8. PREVENTIVE MEASURES

8.1 Physical Examination

8.1.1 *Preplacement Examinations* — It may be desirable to exclude from potential exposure to chlorosulphonic acid, prospective employees with the following conditions:

a) Those with only one functioning eye.

b) Those with uncorrected, severe faulty vision.

c) Those who have chronic diseases of the upper respiratory tract or lung.

d) Those with severe pre-existing skin lesions.

8.1.2 *Periodic Health Examination* — No special type of examination is necessary.

8.2 Employee Training

8.2.1 Safety in handling chlorosulphonic acid depends, to a great extent, upon the effectiveness of employee education, proper training in safe practices and the use of safety equipment, and intelligent supervision.

8.2.2 The education and training of employees to work safely and to use the personal protective equipment provided for them is the responsibility of supervision. Training classes for both new and old employees should be conducted periodically to maintain a high degree of safety in handling procedures. Employees should be thoroughly informed of the hazards that may result from improper handling of chlorosulphonic acid. They should be cautioned to prevent spills, and thoroughly instructed regarding proper action to take in case they occur. Each employee should know what to do in an emergency, and should be fully informed as to first-aid measures.

8.2.3 In addition to the above, employee education and training should include the following:

a) Instruction and periodic drill or quiz regarding the locations, purpose, and use of emergency fire fighting equipment, fire alarms and emergency shutdown equipment, such as valves and switches;

b) Personal equipment;

c) Instructions to avoid all unnecessary inhalation of vapours of chlorosulphonic acid and oil direct contact with liquid; and

d) Instructions to report to the proper authority all cases of equipment failure.

8.3 Safety Showers and Eye Wash Fountains — Readily accessible, well marked, rapid-action safety showers and eye wash fountains shall be available in the areas where chlorosulphonic acid is being handled.

Showers should have deluge type heads, easily accessible, plainly marked and controlled by quick-opening valves of the type that stay open. They should be capable of discharging at least 50 and preferably 80 gpm at normally available pressures. Blankets should be located near the safety showers. Eye wash fountains or hose with a gentle flow of water should be immediately available for eye irrigation. All safety equipment should be inspected and tested at regular intervals, preferably daily and especially during freezing weather, to make sure it is in good working condition at all times.

8.4 Personal Perotective Equipment

8.4.1 *Eye Protection*

8.4.1.1 *Chemical safety goggles* — Cup-type, rubber, or soft plastic framed goggles, equipped with approved impact-resistant glass or plastic lenses, should be worn whenever there is danger of chlorosulphonic acid coming in contact with the eyes. Goggles should be carefully fitted to ensure maximum protection and comfort.

8.4.1.2 *Spectacle-type safety goggles* — Metal or plastic rim safety spectacles with side shields which can be obtained with prescription safety lenses or suitable all-plastic safety goggles may be used where continuous eye protection is desirable, as in laboratories. These types, however, should not be used where complete eye protection against chlorosulphonic acid is needed.

8.4.1.3 *Face shields* — Plastic shields (full length, eight inch minimum) with forehead protection may be worn in addition to chemical safety goggles where complete face protection is desirable. Chemical safety goggles should always be worn as added protection where there is danger of material striking the eyes from underneath or around the sides of the face shield.

8.4.2 *Respiratory Protection* — Severe exposure to chlorosulphonic acid may occur during equipment cleaning and repairs, when decontaminating areas following spills, or in case of failure of piping or equipment. Employees who may be subject to such exposures should be provided with proper respiratory protection devices and trained in its use and care. Available types are described below briefly.

8.4.2.1 *Self-contained breathing apparatus* — This permits the wearer to carry a supply of oxygen or air compressed in the cylinder, and the self-generating type which produces oxygen chemically. These allow considerable mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air, oxygen or regenerating material carried. Compressed oxygen should not be used where there is danger of contact with flammable liquids, vapours, or sources of ignition, especially in confined spaces, such as tanks or pits.

8.4.2.2 *Positive pressure hose masks* — In this air is supplied by blowers requiring no internal lubrication. The wearer should be able to use the same route for exit as for entrance and shall take precautions to keep the hose line free of entanglement. The air blower shall be placed in an area free of contaminants.

8.4.2.3 *Air-line masks* — Supplied with clean compressed air. Unless equipped with 'demand' valve and a small reserve cylinder of compressed air, these are suitable only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied with air from a plant air system or from a compressor. The safer method is a plant air system which is specified and carefully maintained to furnish 'breathing air'. Local oil separators may be needed even with such a system. Local compressors may be used but care is needed to make sure that the air intake is safely located. Compressors not requiring internal lubrication are preferred for this service.

8.4.2.4 *Industrial canister type gas masks* — Equipped with full face pieces and fitted with the proper canister for absorbing chlorosulphonic acid. These will afford protection against concentrations not exceeding 2 percent by volume when used in accordance with the manufacturer's instructions. The oxygen content of the air shall not be less than 16 percent by volume. The masks should be used for relatively short exposure periods only. They may not be suitable for use in an emergency, since, at that time, the actual vapour concentration is unknown' and an oxygen deficiency may exist. The wearer shall be warned to leave the contaminated area immediately on detecting the odour of a harmful vapour. This may indicate that the mask is not functioning properly, the vapour concentration is too high, the canister is exhausted or the mask is not properly fitted.

8.4.3 *Head Protection* — Hard hats should be worn where there is danger from failing objects. If hard hats are not considered necessary, soft-brimmed hats or caps may be worn to give protection against liquid leaks and splashes.

8.4.4 *Foot Protection* — Rubber safety shoes with built-in-steel toe caps are recommended for workers handling drums and carboys of chlorosulphonic acid. Rubbers worn over leather safety shoes should be thoroughly cleaned after contamination.

8.4.5 *Body, Skin and Hand Protection* — Skin contact with liquid chlorosulphonic acid will produce burns at the site of contact. Creams and ointments do not afford adequate protection. Rubber gloves and aprons should be worn when there is a possibility of body contact. Protective clothing contaminated by chlorosulphonic acid should be flushed with flowing water promptly and cleaned inside and out each time it is used. Affected areas of the body should be flushed thoroughly with water.

As a general hygienic measure, facilities for personal cleanliness should be provided, and washing before lunch and at the end of the work day should be encouraged.

9. FIRST-AID

9.0 General — Speed in removing chlorosulphonic acid is of primary importance. It is important to remove the patient from a contaminated area as soon as possible.

9.1 Contact with Skin — Immediate removal by the use of large amounts of water is urgent. If the skin contact is extensive and an emergency shower is available, the employee should get under the shower immediately. Clothes can be removed while under the shower. In other instances, flushing with large amounts of running water together with soap and water washing should be continued for at least fifteen minutes. It is important to remove all clothing including shoes, socks, etc, which may be contaminated. Subsequent medical treatment is the same as for thermal burns.

9.2 Contact with Eyes — If even small amounts of chlorosulphonic acid enter the eyes, they should be irrigated immediately with large amounts of water for a minimum of fifteen minutes. This can be done with an eye bath, if available, a gentle stream of water from a hose, or by pouring water from any clean container. The eyelids should be held apart during the irrigation to ensure contact of water with all of the tissues of the surface of the eyes and lids. If pain is still present after the first fifteen-minute period of irrigation, the irrigation should be continued for fifteen minutes longer. It is permissible as a first-aid measure to instill two or three drops of an effective aqueous local eye anesthetic for relief of pain after, irrigation has been completed. If this is done, cover the eye with a patch. No oils or oily ointments should be instilled. The employee should be sent to a physician, preferably an eye specialist, as promptly as possible after the irrigation has been completed.

9.3 Ingestion — If a person has swallowed any chlorosulphonic acid, he should drink large amounts of water immediately in order to reduce the concentration of chemical. Medical attention should, of course, be obtained immediately.

9.4 Inhalation

9.4.1 If a worker has been exposed to chlorosulphonic acid mist or to the vapours arising from hot chlorosulphonic acid, he should be at once removed to an uncontaminated area and a physician called. He should be kept under observation until the possibility of developing a delayed pulmonary reaction is no longer present. If oxygen inhalation apparatus is available, oxygen may be administered but only by person authorized by a physician.

9.4.2 If breathing has apparently ceased, artificial respiration should be started immediately. Have some one call a physician immediately.

10. EQUIPMENT CLEANING AND REPAIRS

10.1 Preparation of Tanks and Equipment

10.1.1 The hazardous nature of tank inspection, cleaning or repairs, requires that the supervisor and crew be selected, trained and drilled carefully. They should be thoroughly familiar with the hazards, and the safeguards necessary for the safe performance of the work. Written approval of the supervisor should be procured by repair or cleaning crews.

10.1.2 Wherever possible enclosures should be cleaned from the outside, using clean-out doors.

10.1.3 Pipelines, including vent lines, into or out of the tank or other apparatus should be shut off, disconnected, preferably by removing a complete small section and installing a blind flange on the open end to protect against human error and unsuspected leaks. Valves, cocks and blind flanges in the pipeline should not be relied on.

10.1.4 Warning signs should be displayed to indicate when employees are in the tank or other apparatus.

10.1.3 Make sure that it will be safe to leave the tank by the original entrance.

10.1.6 All fuses or safety jacks shall be pulled, switches tagged off and locked out with multiple locks on agitators, pumps or any other power driven equipment. Belts shall be removed on multiple line shaft driven equipment.

10.1.7 Drain the tank as completely as possible, using the pump.

10.1.8 Disconnect all the tank charging lines, overflow lines and vent lines. Have discharge line from pump arranged so that the material can be pumped either to the sewer or a quenching tank.

10.1.9 Add sufficient 100 percent sulphuric acid to cover the sludge in the bottom of the tank. Agitate this mixture with air, by inserting an iron line from the compressed air supply to the bottom of tank.

10.1.10 After agitating the mixture for one hour, drain tank as completely as possible with the sump pump. The waste acid mixture should be quenched by running it into a wooden tank containing crushed ice. The acid-water solution is run from the wooden tank to another tank where the acid is neutralized by adding lime or caustic soda solution before it is run into the sewer.

10.1.11 Add cautiously sufficient 96 percent sulphuric acid to wash bottom and to cover any sludge remaining in the tank. Agitate and repeat procedure as described in 10.1.10.

10.1.12 Add a second wash of 96 percent sulphuric acid and repeat procedure as described in **10.1.10.**

10.1.13 Inspect tank to make certain it is drained completely. It may not be possible to remove all the sludge with the sulphuric acid washes but most of the chlorosulphonic acid will have been leached from the sludge by this treatment.

10.1.14 Remove all manhole covers on the tank.

10.1.15 Make ready to add caustic soda by hooking up a portable pump with discharge line entering the tank and the feed to the pump connected to a 250 litres drum of 34 percent caustic soda solution. The control switch for the portable pump should be as far from the tank area as possible.

10.1.16 Tie the nozzle of a fire hose in an open manhole on the tank. With all personnel as far away from the tank area as possible and from a remote location, turn on full stream of water to tank through the fire hose.

10.1.17 When the initial reaction has subsided or when the tank is about half full, and with a full stream of water still going into the tank, throw the remote control switch on the portable pump, and add the caustic soda solution to the tank. Continue adding water to the tank until it is completely flooded and overflows out of the top manhole opening. When flooded, the water solution in the tank should be alkaline. Add more caustic soda solution, if required.

10.1.18 Pump the water solution out of the tank directly to the sewer. Wash the walls of the empty tank by directing a stream of water from a hose through an open manhole cover. This wash, which should be alkaline, is pumped to the sewer.

10.1.19 Before the tank is again used to store chlorosulphonic acid, the tank bottom and pump should be completely dry. If it is impracticable to completely clean the tank with rags, 100 percent sulphuric acid may be added. This will remove the last trace of water and will prevent a reaction which might cause the pump or lines to rupture when the chlorosulphonic acid comes in contact with them.

10.2 Entering Tank

10.2.1 Before entering a tank and during the course of the work, tests should be made by a qualified person to determine that no further washing is necessary, that no oxygen deficiency exists, and that no harmful gas or vapour is present.

10.2.2 Before directing men to enter a tank, an inspection of the interior should be made by the supervisor, who should be equipped with a supplied* air respirator or self-contained breathing apparatus, together with rescue harness and life line.

10.2.3 One man on the outside of the tank should keep the men in the tank under constant observation during inspection and performance of work. At least two other men should be available to aid in rescue if any of those in the tank are overcome.

10.2.4 Only authorized persons should be permitted to enter a tank or vessel.

10.2.5 A supplied-air respirator or self-contained breathing apparatus, together with rescue harness and life line, should be located outside the tank entrance. This equipment should be used for rescue, regardless of the type of respiratory protection or air supply which is provided for employees inside the tank.

10.2.6 In addition to protecting the employees actually engaged in cleaning and repairing the tank, attention should be paid to the protection of workers in near by areas. Where there is a hazard of objects falling from overhead, barricades should be erected, with appropriate warning signs.

10.2.7 Electrical lights and power tools should be of the three-wire ground type approved for use in Class I, Group B hazardous locations. They should be maintained in excellent condition.

10.3 Emergency Rescue

10.3.1 Under no circumstances should a rescuer enter a tank to remove a victim of over-exposure without proper respiratory protection, a safety harness and an attached life line. The end of the life line should be manned by an attendant located outside the tank. This end of the life line should be secured so that it becomes impossible to pull it into the tank inadvertently.

10.3.2 Another attendant should be immediately available to assist in the rescue, if needed. The rescuer should be in view of the outside attendant at all times or in constant communication with him.

10.3.3 Emergency procedures should be established for summoning ambulance, physician, or other agency promptly, so that such assistance will be en route to the location before the rescue is accomplished.

10.4 Exterior Repair Work

10.4.1 All hot work on tanks or equipment which have contained chlorosulphonic acid should be done only after such containers have been thoroughly purged, due to the possible hazard of hydrogen being present. Steam or inert gas may be used for purging when outside welding or burning work is scheduled. To ensure that no hydrogen is present in the tank, test with an explosivity meter before starting welding.

10.4.2 In all cases, if repair work is interrupted, the tank atmosphere should be checked thoroughly and a new work permit issued before resumption of work. Intermittent tests while work is in progress may be necessary to assure that a safe atmosphere is maintained.

11. WASTE DISPOSAL

11.1 All local and state regulations concerning waste disposal to streams, municipal treatment plants or impounding basins should be determined and followed.

11.2 Dilution of large quantities of chlorosulphonic acid may be successfully accomplished by cautiously adding the acid to an ice and water quench contained in an agitated and ventilated wooden or rubber-lined vessel. Temperature should be maintained at 10 to 15°C with additional ice. The diluted acid may then be neutralized with lime or caustic soda solution.

11.3 Small quantities of chlorosulphonic acid may be disposed of by dilution with large volumes of water and neutralized, if necessary.

11.4 Disposal of neutralized solutions of chlorosulphonic acid to a water course is dependent upon the assimilative capacity of the stream. The only effects upon the stream would be those of adding dissolved solids. Method of disposal and quantity of discharges are subject to the approval of the applicable control authority.

11.5 Neutralized and diluted solutions may be safely sewered to biological treatment plants. Restrictions on quantities that may be sewered are matters of agreement with the treatment plant operators.

(*Continued from page* 2)

Panel for Drafting Safety Codes for Hazardous Chemicals, CDC 18:4:1

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