

I. RECOMMENDATIONS FOR A CHLORINE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to chlorine be controlled by requiring compliance with the following sections. The standard is designed to protect the health and safety of workers for up to a 10-hour workday, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should prevent adverse effects of exposure to gaseous or liquid chlorine in the workplace. The proposed environmental limit is measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. The standard will be subject to review and revision as necessary.

"Chlorine" is defined as liquid or gaseous molecular chlorine. Occupational exposure to chlorine is defined as exposure to airborne concentrations of chlorine at or above one-half of the recommended workplace environmental limit. Adherence only to sections 3, 4(a) (1,3, and 4), 4(b) (6, 7, 9, 10), 5, 6, and 7 is required when workplace environmental concentrations of chlorine are less than one-half of the recommended workplace environmental limit.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Exposure to chlorine shall be controlled so that no worker is exposed to chlorine at an airborne concentration greater than 0.5 parts of chlorine

per million parts of air (0.5 ppm) for any 15-minute sampling period. This shall be designated as a ceiling concentration.

(b) Sampling and analysis

Procedures for sampling, calibration of equipment, and analysis of chlorine samples shall be as provided in Appendices I and II, or by any method shown to be equivalent in precision, accuracy, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available as specified below for all workers subject to occupational exposure to chlorine.

(a) Preplacement examinations shall include as a minimum:

(1) Medical and occupational histories in sufficient detail to document the occurrence of cardiac disease as well as bronchitis, tuberculosis, pulmonary abscess, and other chronic respiratory diseases.

(2) A medical examination including but not limited to, simple tests of olfactory deficiency.

(3) A chest X-ray, 14 x 17 (posterior-anterior).

(4) An evaluation of the worker's physical capability to use respirators as defined in 29 CFR 1910.134.

(b) Pulmonary function studies and other objective indicators of normalcy or lack thereof may be performed at the discretion of the examining physician.

(c) A worker with evidence of respiratory impairment shall be evaluated by a physician and, if appropriate, counseled on the possibility

of an increased health risk resulting from exposure to chlorine.

(d) Periodic Examinations

(1) Periodic examinations shall be made available on an annual basis or at an interval to be determined by the responsible physician.

(2) If it is suspected that a worker has been exposed to high concentrations of chlorine and if he exhibits signs or symptoms of respiratory tract irritation, he shall be referred to a physician.

(e) Medical Records

All pertinent medical records shall be maintained at least 5 years after the individual's employment is terminated. These records shall be available to the medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee at his request.

Section 3 - Labeling (Posting)

(a) All shipping containers of chlorine shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances:

CHLORINE
DANGER! HAZARDOUS GAS OR LIQUID UNDER PRESSURE
EXTREMELY IRRITATING
MAY BE FATAL IF INHALED
CAUSES BURNS
SEVERE EYE HAZARD

Do not breathe gas; use only with adequate ventilation. In case of inhalation, remove to uncontaminated atmosphere, get medical attention immediately. If breathing has stopped, start artificial respiration.

Do not get in eyes, on skin, or on clothing. In case of contact, immediately flush skin or eyes with plenty of water for at least 15 minutes, and get medical attention immediately.

OPEN CONTAINERS WITH CARE AFTER SECURING THE CONNECTION TO THE DISTRIBUTION LINE INTO WHICH THE GAS IS TO PASS.
HAVE SUPPLIED AIR RESPIRATORS OR SELF-CONTAINED BREATHING APPARATUS AVAILABLE FOR EMERGENCY. DO NOT HEAT CONTAINERS. AVOID CONTACT WITH OTHER MATERIALS.
STORE ONLY IN AUTHORIZED AREAS.

(b) The following warning sign shall be affixed in a readily visible location at or near entrances to areas in which chlorine is present in containers or systems. This sign shall be printed both in English and in the predominant language of non-English-speaking workers. All employees shall be trained and informed of the hazardous areas, with special instruction given to illiterate workers.

CAUTION!
CHLORINE HAZARD AREA
UNAUTHORIZED PERSONS KEEP OUT
CAUSES BURNS, SEVERE EYE HAZARD
MAY BE FATAL IF INHALED
PROTECTIVE MASKS FOR CHLORINE LOCATED AT _____
(specific locations to be supplied by employer)

(c) All chlorine piping systems shall be plainly marked for positive identification in accordance with American National Standard

A13.1-1975. Associated vessels and critical shut-off valves shall be conspicuously labeled. Chlorine containers in use shall be plainly marked "in use" to distinguish them from those not in use. No container shall ever be presumed to be empty and therefore nonhazardous.

Section 4 - Personal Protective Equipment

(a) Protective Clothing

(1) Personnel working with, or exposed to, liquid or gaseous chlorine containers or systems where chlorine contact with the eyes can occur shall have eye protection. Unless eye protection is afforded by a respirator hood or facepiece, chemical goggles and face shields shall be worn.

(2) In addition to wearing the respiratory protective devices specified in Table I-1, personnel performing nonroutine operations where escape of liquid chlorine occurs or emergency operations involving escaping liquid chlorine should wear 1-piece suits which are impervious to chlorine and sealed at the ankles, wrists, and around the face. The suits shall be ventilated with supplied air, or stay time in the work area shall be limited with due consideration of the heat stress factors involved. Impervious gloves and boots should also be worn. Such protective clothing shall be kept readily available for emergencies.

(3) Impervious gloves shall be worn by persons connecting or disconnecting cylinders of chlorine.

(4) The employer shall supply and maintain all protective

clothing in a clean, sanitary, and usable condition.

(b) Respiratory Protection

Engineering controls shall be used wherever feasible to maintain airborne chlorine concentrations at or below the environmental limit recommended in Section 1 of this document. Compliance with the permissible exposure limit by the use of respirators is only allowed when airborne chlorine concentrations are in excess of the workplace environmental limit while required engineering controls are being installed or tested, when nonroutine maintenance or repair is being accomplished, or during emergencies. When a respirator is thus permitted, it shall be selected and used in accordance with the following requirements:

(1) For the purpose of determining the type of respirator to be used, the employer shall measure, when possible, the airborne concentration of chlorine in the workplace initially and thereafter whenever process, worksite, climate, or control changes occur which are likely to increase the airborne concentration of chlorine.

(2) The employer shall ensure that no worker is overexposed to chlorine because of improper respirator selection, fit, use, or maintenance.

(3) A respiratory protection program meeting the requirements of 29 CFR 1910.134 which incorporates the American National Standard Practices for Respiratory Protection Z88.2-1969 shall be established and enforced by the employer.

(4) The employer shall provide respirators in accordance with Table I-1 and shall ensure that the employee uses the respirator provided.

(5) Respiratory protective devices described in Table I-1

TABLE I-1
RESPIRATOR SELECTION GUIDE

Chlorine Concentration	Respirator Type
Less than or equal to 25 ppm	(1) Chemical cartridge respirator with full facepiece and cartridge(s) and filter(s) providing protection against chlorine (2) Full-face gas mask, chest- or back-mounted type, with industrial-size chlorine canister (3) Any supplied-air respirator with a full facepiece, hood, or helmet with shroud (4) Any self-contained breathing apparatus with a full facepiece
Greater than 25 ppm and Emergencies	(1) Self-contained breathing apparatus with full facepiece, pressure-demand or other positive pressure type (2) Combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode, and an auxiliary self-contained breathing apparatus, pressure-demand or other positive pressure type
Evacuation or Escape	(1) Self-contained breathing apparatus with full facepiece (2) Full-face gas mask with industrial-size chlorine canister

shall be those approved under the provisions of 30 CFR 11.

(6) The employer shall ensure that employees are instructed on the use of respirators assigned to them and on how to test for leakage.

(7) Each indoor area required to be posted in accordance with Section 3(b) shall have emergency respiratory protective devices readily available in nearby locations which do not require entry into a contaminated atmosphere for access. Certain outdoor locations may be exempted from this requirement depending upon such factors as chlorine capacity, accessibility to facility, nearness to other occupied locations, and ease of evacuation. A decision regarding an exemption shall be made by an OSHA compliance officer. Respiratory protective devices provided shall consist of at least two self-contained breathing apparatus as described in Table I-1.

(8) Respirators specified for use in atmospheres of higher concentrations of chlorine may be used in atmospheres of lower concentrations.

(9) The employer shall ensure that respirators are cleaned, maintained, and stored in accordance with 29 CFR 1910.134.

(10) Canisters shall be discarded after use or whenever an odor or taste is detected, and replaced with fresh canisters. Unused canisters shall be discarded and replaced when the seal is broken or when the shelf life recommended by the manufacturer ends.

Section 5 - Informing Employees of Hazards from Chlorine

At the beginning of employment, workers whose jobs may involve

exposure to chlorine at concentrations greater than one-half of the environmental limit, or who will work in areas required to be posted in accordance with Section 3(b), shall be informed of the hazards, signs, symptoms, and effects of overexposure, emergency procedures, and precautions to take to ensure safe use of chlorine and to minimize exposure to chlorine. Information pertaining to first-aid procedures shall be included. The information shall be posted in the workplace and kept on file, readily accessible to workers at all places of employment where chlorine is involved in unit processes and operations, or is released as a product, byproduct, or contaminant.

A continuing educational program, conducted by a person or persons qualified by reason of experience or special training, shall be instituted to ensure that all workers have current knowledge of job hazards, first-aid procedures, maintenance procedures, and cleanup methods, and that they know how to use respiratory protective equipment and protective clothing. Retraining shall be repeated at least annually.

In addition, members of emergency teams and employees who work adjacent to chlorine systems or containers where a potential for emergencies due to chlorine exists shall be subjected to periodic drills simulating emergency situations appropriate to the work situation. These shall be held at intervals not exceeding 6 months. Drills should cover, but should not be limited to, the following:

Evacuation procedures.

Handling of spills and leaks, including decontamination
and use of emergency leak-repair kits.

Location and use of emergency firefighting equipment, and handling of chlorine systems and containers in case of fire.

First-aid and rescue procedures, including procedures for obtaining emergency medical care.

Location, use, and care of protective clothing and respiratory protective equipment.

Location and use of shut-off valves.

Location, reason for, and use of safety showers, eyewash fountains, and other sources of water for emergency use.

Operating procedures.

Entry procedures for confined spaces.

Emergency phone numbers.

Deficiencies noted during the drill shall form the basis for a continuing educational program to ensure that all workers have current knowledge. Records of drills and training conducted shall be made available for inspection by authorized personnel as required.

Information as required shall be recorded on the "Material Safety Data Sheet" shown in Appendix IV or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Emergency Procedures

For all work areas in which there is a potential for emergencies,

procedures specified below, as well as any other procedures appropriate for a specific operation or process, shall be formulated in advance and employees shall be instructed and drilled in their implementation.

(1) Procedures shall include assignment of individual or team responsibilities and prearranged plans for:

(A) Immediate evacuation of workers with signs or symptoms of adverse effects resulting from exposure to chlorine.

(B) Transportation of injured persons to medical facilities.

(C) Any necessary calls to alert medical facilities of the impending arrival of injured persons or to people who have been identified as being able to provide assistance.

(D) Designation of medical receiving facilities and names of physicians trained in chlorine emergency procedures.

(2) Nonessential employees shall be evacuated from exposure areas during emergencies. Perimeters of areas of hazardous exposure shall be delineated, posted, and secured.

(3) Personnel who cannot be evacuated shall keep upwind of spills or leaks, if possible. Personnel who have appropriate training in the procedures and who are adequately protected against the attendant hazards shall take appropriate control action, eg, leak isolation and repair, cleanup of spills, etc.

(4) In case of fire, chlorine containers shall be removed to a safe place or cooled with water if leaks do not exist. Fusible plugs in chlorine containers melt at 70-74 C (158-165 F). Every effort shall be

made to prevent containers from reaching this temperature.

(5) Water may not be used on chlorine leaks because accelerated corrosion, resulting from the formation of hydrochloric acid when water is present, may quickly make the leak worse. Water spray or fog may, however, be used to help suppress the size of a chlorine cloud near the leak.

(6) Containers leaking liquid chlorine should be oriented so that gaseous chlorine is discharged through the leak until it is controlled.

(7) If possible, in emergency situations chlorine should be discharged to the industrial process through the regular chlorination equipment or by running a line directly to the consuming equipment or other control vessel or equipment.

(8) If the process cannot handle chlorine under emergency conditions, a standby alkali absorption system shall be made available for emergency use.

(9) Chlorine in contact with skin or eyes shall be removed by immediate washing with copious quantities of water, and immediate medical attention shall be obtained. Remove contaminated clothing immediately. If chlorine is inhaled, remove victim to uncontaminated atmosphere, give artificial respiration if required, and get immediate medical attention in accordance with Section 6(a)(1).

(b) General Work Practices

(1) Control of Airborne Chlorine

Engineering controls shall be used to maintain chlorine

concentrations within the limits of the recommended environmental limit. The use of completely enclosed processes is the preferred method of control for chlorine. Local exhaust ventilation may also be effective, either when used alone or in combination with process enclosure. Ventilation systems shall be designed to maintain airborne chlorine concentrations within the limits of the recommended environmental limit to prevent accumulation of chlorine in the workroom, and to remove chlorine from the breathing zones of workmen. Ventilation systems shall be subject to regular preventive maintenance and cleaning to ensure maximum effectiveness. This effectiveness shall be verified by periodic airflow measurements.

(2) Storage

(A) Chlorine shall be stored in adequately ventilated unoccupied rooms or outdoors shielded from the direct rays of the sun, unless the container is properly insulated and designed for unshaded outdoor storage. Indoor storage areas shall be cool and dry.

(B) At least two exits, remote from each other and opening outward of the building, should be provided for all chlorine storage rooms.

(C) Chlorine storage enclosures shall be provided with an inspection window to permit viewing of the interior without entry.

(D) Chlorine storage enclosures shall be completely isolated from work areas. If separated from a work area by a common wall, all holes, ducts, doors, and passthroughs which could allow chlorine to enter other parts of the plant shall be secured and sealed. Central cooling and heating ducts may not extend to chlorine storage areas, but

such areas may be cooled by terminal ducts with one-way flap or other appropriate valves to prevent significant reflux of air from the storage area into the duct system. If an enclosed storage area is cooled in this way, the pressure within the enclosure shall be maintained slightly below the atmospheric pressure by forced exhaust to the outside of the area.

(E) Ventilation switches and emergency respiratory protection shall be located outside storage areas in readily accessible locations which will be free of chlorine in an emergency. Fan switches shall be equipped with indicator lights.

(F) Containers shall be secured so they will not fall, upset, or roll.

(G) Chlorine containers shall be protected from flame, heat, corrosion, and mechanical damage.

(H) Incompatible materials which may react violently with chlorine such as hydrogen, ammonia, acetylene, fuel gases, ether, turpentine, most hydrocarbons, finely divided metals, and organic matter, may not be stored immediately adjacent to chlorine. The degree of separation required will be dictated by quantities stored and the type of storage facility (outdoor vs indoor, concrete walls vs wood, etc).

(I) Storage areas should not have low spots in which chlorine could accumulate in case of a leak, unless such places have been designed and constructed for such a purpose.

(J) Containers of chlorine shall be used on a first-in-first-out (FIFO) basis.

(K) Full and empty shipping containers shall be so marked, and containers in use shall be plainly marked "in use" to distinguish them from those not in use.

(3) Handling

(A) Areas containing chlorine containers and systems shall be checked daily for leaks. All newly made connections shall be checked for leaks immediately after chlorine is admitted. Required repairs and adjustments shall be promptly made. No water shall be applied to the source of leaking chlorine.

(B) Steel and iron in contact with chlorine may not be heated, welded, or flame-cut. Steel and iron will ignite and burn in an atmosphere of chlorine at about 251 C (484 F).

(C) Written operating instructions shall be formulated, posted, and up-dated periodically where chlorine is handled or used.

(D) Every precaution shall be taken to keep chlorine and chlorine equipment free of moisture. Piping, valves, and containers shall be capped or closed when not in use to keep atmospheric moisture out of the system.

(E) Transportation and use of chlorine shall comply with all applicable federal, state, and local regulations.

(F) When moving chlorine containers, valve protection hoods shall be in place. Containers shall be moved only with the proper equipment (eg, lifting bars and hand trucks) and shall be secured to prevent dropping or loss of control while moving. No slings or

magnetic devices shall be used to move chlorine containers.

(G) Containers and valves may not be modified, altered, or repaired except as normally intended by the supplier.

(H) Discharge rates may not be increased by use of hot water, radiant heat, or application of flames or heated objects to the containers. Air circulated around the containers at workroom temperature may be used. Properly designed chlorine vaporizing equipment (as distinct from storage and shipping containers) may be heated.

(I) The amount of chlorine used shall be determined by a positive method, eg, weighing the container.

(J) New gaskets shall be used each time chlorine system connections are made.

(K) Cylinder and ton-container valves may not be opened more than one complete turn. Wrenches longer than 8" shall not be used.

(L) Piping systems for chlorine shall be properly designed and manufactured from approved materials meeting or exceeding the provisions of American National Standard B31.1 1973, and shall be equipped with appropriate expansion chambers or pressure relief valves or rupture discs discharging to a receiver or safe area. All precautions shall be taken to prevent hydrostatic rupture of chlorine systems and containers.

(M) Before chlorine is admitted to a new or repaired system, the system shall be thoroughly cleaned, dried, and pressure-tested, using approved procedures. Pressure testing of cylinders designed for portable use shall be repeated at not longer than 5-year intervals.

(N) Materials for handling moist chlorine shall be selected with great care, considering the enhanced corrosiveness of the chlorine, and the requirements for strength.

(O) A vacuum placed on a chlorine line shall be broken with dry air or nitrogen rather than with chlorine to prevent rendering expansion chambers ineffective.

(P) No liquid chlorine containers shall be directly connected to containers of other liquids unless backflow is prevented by suitable check valves, traps, or vacuum breakers. Suckback may cause a violent reaction or explosion.

(Q) No personnel shall work alone when chlorine is first admitted to a newly designed or installed system, or while repairing leaks. Replenishment of chlorine to a previously properly functioning system is permitted.

(R) Any odor of chlorine from a normally closed system shall be reported without delayed to responsible supervisory personnel.

(S) Containers and systems shall be handled and opened with care. Approved skin, eye, and respiratory protection shall be worn while opening, connecting, or disconnecting chlorine containers and systems. When opening containers or systems, adequate ventilation shall be available to remove inadvertent discharges of chlorine.

(T) Inadvertent entry of chlorine into disconnected containers and systems while work is in progress shall be prevented by blanking off chlorine supply lines. Repairs of leaks may not be

accomplished on chlorine systems while the systems are in service, except when a chlorine repair kit utilized by trained and protected emergency team personnel can be used with reasonable safety.

(4) Work Areas

(A) Where chlorine is handled or used, eyewash fountains and safety showers shall be located immediately outside the chlorine work area. They shall be kept readily accessible and shall be inspected frequently and kept in good working order.

(B) Enclosed chlorine work areas shall be equipped with at least two exits, remote from each other, to allow escape into uncontaminated areas in case of emergency. Doors shall open outward.

(C) No unauthorized personnel shall be permitted to enter areas where chlorine is handled or used.

(D) No nonessential combustible or flammable materials shall be stored or processed in areas where chlorine is handled or used. All elements of chlorine systems shall be protected from fire hazards.

(E) At least two self-contained breathing apparatus shall be located outside of each facility handling or using chlorine. In case of emergency, they shall be readily accessible without entering contaminated atmospheres. Employees shall be trained and drilled in their use.

(F) Critical isolation valves shall be conspicuously marked, and employees shall be familiarized with their use. Access to shutoff valves shall be kept unobstructed.

(G) Work areas and means of egress shall be kept clean and orderly.

(5) Waste Disposal

(A) Disposal of waste chlorine shall conform to all applicable local, state, and federal regulations.

(B) Discharges of chlorine into the atmosphere shall first be rendered neutral or harmless, or shall be prevented by proper absorbing devices.

(C) Discharges of chlorine solutions shall be neutral or mildly alkaline, or adequately diluted.

(D) No discharges shall be allowed which will be harmful to humans, vegetation, animals, materials, or sewerage systems.

(6) Confined Spaces

(A) Entry into confined spaces such as tanks, pits, tank cars, barges, process vessels, tunnels, and sewers shall be controlled by a permit system. Permits shall be signed by an authorized employer representative certifying that preparation of the confined space, precautionary measures, and personal protective equipment are adequate, and that predetermined procedures will be followed.

(B) Confined spaces which have contained chlorine shall be thoroughly cleaned, tested for oxygen deficiency and the presence of chlorine, and inspected prior to entry.

(C) Inadvertent entry of chlorine into a confined space while work is in progress shall be prevented by disconnecting and blanking off chlorine supply lines.

(D) Confined spaces shall be ventilated while work is in progress to keep any chlorine concentration below the environmental limit and to prevent oxygen deficiency.

(E) Personnel entering confined spaces where they may be exposed to chlorine shall be equipped with the necessary personal protective equipment and a lifeline tended by another worker outside the space who shall be trained and equipped to perform rescue.

(7) Enclosed Spaces

Enclosed spaces (rooms, buildings, etc) which are not constantly occupied and which are ordinarily safe to enter, but because of the failure of a system inside could contain hazardous concentrations of chlorine, should have a continuous automatic monitor set to sound an alarm outside the enclosed space if chlorine concentrations exceed the recommended standard. If such areas are not monitored in this way, the enclosed space shall be entered only if the worker is under observation by a coworker and if the worker has in his possession a respirator suitable for escape.

(8) Miscellaneous

No hypochlorite solutions shall be mixed with acidic materials, such as toilet-bowl cleaners or vinegar, because chlorine will be generated with the potential for hazardous exposure. Custodial and maintenance personnel shall be alerted to this potential chlorine exposure.

Chlorinators in use at public swimming pool facilities should be located away from entrance and egress areas.

Section 7 - Sanitation Practices

(a) Plant sanitation shall meet the requirements of 29 CFR 1910.141.

(b) Appropriate locker rooms shall be available for changing into required protective clothing in accordance with 29 CFR 1910.141(e).

(c) Good personal hygiene shall be enforced. Hands, arms, and face shall be thoroughly washed prior to eating and at the end of the shift. Facilities shall be provided for this purpose in conformance with 29 CFR 1910.141(d).

(d) No food shall be stored, prepared, dispensed (even from vending machines), or eaten in areas where occupational exposure to chlorine may occur. Drinking, smoking, and chewing tobacco or gum shall be prohibited in chlorine exposure areas. The employer shall furnish an uncontaminated area for these purposes in conformance with 29 CFR 1910.141(g). A source of drinking water protected from contamination may be provided in hot environments.

(e) After each use, protective clothing shall be neutralized, washed, dried, and inspected before reissue.

Section 8 - Monitoring and Recordkeeping Requirements

Workers will not be considered to have occupational exposure to chlorine if environmental concentrations, as determined on the basis of a professional industrial hygiene survey conducted within 6 months of the promulgation of this standard, do not exceed one-half of the recommended ceiling concentration (ie, action level). Surveys shall be repeated at

least once every 3 years and within 30 days after any process change likely to result in increases of airborne concentrations of chlorine. Records of these surveys, including the basis for concluding that airborne concentrations of chlorine are at or below the action level, shall be maintained. If the survey indicates that airborne concentrations of chlorine exceed the action level, then the following requirements apply:

(a) Personal Monitoring

(1) A program of personal monitoring shall be instituted to identify and measure or permit calculation of the exposure of all employees who are occupationally exposed to chlorine. Monitoring of employee exposure to airborne concentrations of chlorine shall be conducted at least every 6 months. If monitoring of an employee's exposure to chlorine reveals that he is exposed at concentrations in excess of the recommended environmental limit, the exposure of that employee shall be measured at least once every 30 days, control measures shall be initiated, and the employee shall be notified of his exposure and the control measures being implemented to correct the situation. Such monitoring shall continue until two consecutive samplings, at least a week apart, indicate that employee exposure no longer exceeds the environmental limit in Section 1(a). Semiannual monitoring may then be resumed.

(2) In all personal monitoring, samples of airborne chlorine that, when analyzed, will provide an accurate representation of the concentration of chlorine in the air breathed by the worker shall be collected. Procedures for sampling, calibration of equipment, and analysis of chlorine in samples shall be as provided in Appendices I and II, or by

any method shown to be equivalent in precision, accuracy, and sensitivity to the methods specified.

(3) For each ceiling determination, a sufficiently large number of samples shall be taken to characterize every employee's peak exposure during each workshift. Variations in work and production schedules shall be considered in deciding when samples are to be collected. The number of representative ceiling determinations for an operation or process shall be based on the variations in location and job functions of employees in relation to that operation or process.

(b) Recordkeeping Procedures

Records shall be maintained and shall include sampling and analytical methods, types of respiratory protective devices used, and ceiling concentrations found. Each employee shall have access to data on his own environmental exposures and records of such data shall be included in his medical records. Pertinent records of required medical examinations, including records of occupational accidents and environmental exposures within the workplace, shall be maintained for 5 years after the worker's employment has ended and shall be available to the designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education and Welfare, of the employer, and of the employee or former employee.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational disease arising from exposure to chlorine. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health of workers from exposure to hazardous chemical and physical agents. It should be pointed out that any criteria for a recommended standard should enable management and labor to develop better engineering controls, resulting in more healthful work environments. Mere compliance with the recommended standard should not be used as a final goal.

Chlorine is a pungent, gaseous (at normal temperatures and pressures) element produced primarily by electrolysis of common salt. Its bleaching power and disinfecting action as well as its reactivity and its ability to form highly reactive organic compounds lead to wide use in the synthesis of solvents, plastics, and resins, in the pulp and paper and textile

industries, and in the treatment of sewage and water. The irritating properties of chlorine make it a serious respiratory hazard, as well as a skin and eye irritant. Its distinctive odor provides an indication of its presence.

These criteria for a standard for chlorine are part of a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, use, and handling of chlorine as applicable under the Occupational Safety and Health Act of 1970.

The standard was not designed for the population-at-large, and any extrapolation beyond occupational exposures is not necessarily warranted. It is intended to (1) protect against injury from chlorine, (2) be measurable by techniques that are valid, reproducible, and available to industry and official agencies, and (3) be attainable with existing technology.

Although the effects of massive exposure to airborne chlorine have been documented, and a limited number of experimental and epidemiologic studies have been conducted to determine the relationship between airborne chlorine concentrations and resulting effects, at the present time insufficient data exists to present a definitive correlation between chlorine exposure concentrations and acute and chronic effects observed in humans and in animals. Further research is needed to determine this correlation as well as to assess the possibility of chlorine tolerance at low concentrations, and to precisely define exposure symptoms.