

I. RECOMMENDATIONS FOR A PHOSGENE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to phosgene in the workplace 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 the standard should therefore prevent adverse effects of phosgene on the health and safety of workers. The standard 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.

"Phosgene" is defined as gaseous or liquified phosgene. Synonyms for phosgene include carbonyl chloride, carbon oxychloride, chloroformyl chloride, and CG (designation used by military agencies). "Occupational exposure to phosgene" is defined as exposure above half the recommended time-weighted average (TWA) environmental limit. Exposure at lower concentrations will not require adherence to the following Sections except for Sections 3, 4(a), 4(b), 4(c)(3), 4(c)(5), 4(c)(6), 5, 6, 7, and 8(a). "Overexposure" is defined as known or suspected exposure above either the TWA or ceiling concentrations, or any exposure which leads to development of pulmonary symptoms.

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to phosgene shall be controlled so that no worker is exposed to phosgene at a concentration greater than one-tenth part phosgene per million parts of air (0.1 ppm) determined as a TWA concentration for up to a 10-hour workday, 40-hour workweek, or to more than two-tenths part phosgene per million parts of air (0.2 ppm) as a ceiling concentration for any 15-minute period.

(b) Sampling and Analysis

Procedures for sampling, calibration of equipment, and analysis of environmental 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

(a) Comprehensive preplacement and annual medical examinations shall be made available to all workers to be occupationally exposed to phosgene unless a different frequency is indicated by professional medical judgment based on such factors as emergencies, variations in work periods, and preexisting health status of individual workers.

(b) These examinations shall include, but shall not be limited to:

(1) Comprehensive or interim medical and work histories.

(2) A comprehensive medical examination giving particular attention to pulmonary function. Preplacement and follow-up pulmonary function tests shall be performed and shall include the forced vital

capacity (FVC), the one-second forced expiratory volume (FEV 1), and the forced midexpiratory flow (FEF 25-75); a preplacement chest X-ray shall be obtained. The possibility of increased risk for workers with preexisting cardiovascular or pulmonary diseases should be considered and, when appropriate, the workers should be given counseling on the possibility of increased risk. Return to work after an absence for sickness due to phosgene overexposure shall require medical approval.

(3) A judgment of the worker's ability to use a negative or positive pressure respirator.

(c) Proper medical management shall be provided for workers overexposed to phosgene.

In case of known or suspected overexposure to phosgene, first aid measures shall be taken immediately, followed by prompt medical evaluation and care. Overexposed persons should not be permitted any unnecessary physical exertion. They should be carried to a vehicle for subsequent transportation to receive medical assistance. Pressurized oxygen and attendants trained in its use shall be available in the event they are needed for persons in respiratory distress. In case of skin or eye contact with liquid phosgene, contaminated clothing shall be removed immediately and the exposed body areas flushed with copious amounts of water. The plant physician or medical consultant shall be informed of any suspected overexposure to phosgene and shall determine the need for X-ray or pulmonary function studies or hospitalization. Because of the often-delayed onset of symptoms following overexposure to phosgene, surveillance or monitoring of the patient by a physician or by trained paramedical personnel is required for the 24-hour period following overexposure. A

posterior-anterior chest film should be taken in each instance of known or suspected overexposure to phosgene for comparison with preplacement chest films. Pulmonary function tests may be useful during convalescence.

(d) Medical records shall be maintained for all workers occupationally exposed to phosgene. All pertinent medical records with supporting documents, including chest films for at least the 5 years preceding termination of employment and the original preplacement chest films, shall be maintained for at least 5 years after the termination of the individual's employment. The designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee shall have access to these medical records.

Section 3 - Labeling (Posting)

All containers of phosgene and all areas where phosgene is stored, handled, used, or formed shall be labeled and placarded in accordance with An Identification System for Occupationally Hazardous Materials, a recommended standard published by NIOSH, and in accordance with the following subsections.

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

CONTAINS PHOSGENE

EXTREME HEALTH HAZARD

Harmful or fatal if inhaled, may cause delayed lung injury.
Do not breathe gas.
Do not get liquid in eyes, on skin, or on clothing.
Use only with adequate ventilation and/or in closed systems.
Open containers with care.
Have respiratory protection available for emergency.

FIRST AID

CALL A PHYSICIAN IMMEDIATELY

In case of inhalation, remove victim to uncontaminated atmosphere.
If breathing stops, administer artificial respiration.
Do not allow victim to walk or exercise.
In case of liquid contact, immediately flush skin or eyes with water.
Remove contaminated clothing without delay and dispose of liquid properly.

(b) The following warning sign shall be affixed in a readily visible location at or near entrances to areas in which phosgene is stored, handled, used, or formed:

CONTAINS PHOSGENE

EXTREME HEALTH HAZARD

Harmful or fatal if inhaled, may cause delayed lung injury.
In emergency, enter only if wearing respiratory, eye, and skin protection.
Phosgene respiratory protection located at (specific locations to be supplied by employer).
Unauthorized persons keep out.

This sign shall be printed both in English and in the predominant language of non-English-speaking workers, if any. All employees shall be trained and informed of the hazardous area with special instruction given to illiterate workers.

(c) All systems, piping, and associated equipment containing

phosgene shall be plainly marked for positive identification in accordance with American National Standard A13.1-1956. Shut-off valves shall be conspicuously labeled. Phosgene containers in use shall be plainly marked "In Use" to distinguish them from those not in use.

Section 4 - Personal Protective Equipment and Clothing

Engineering controls shall be used to maintain phosgene concentrations below the prescribed limits. When necessary, this shall be supplemented by the use of personal protective equipment. Requirements for personal protective equipment shall be in accordance with provisions of 29 CFR 1910 (Federal Register 39:23670, June 27, 1974).

(a) Skin Protection

(1) In addition to the respiratory protection specified in Table I-1, personnel performing emergency operations involving exposure to liquid phosgene shall wear one-piece suits, impervious to phosgene and tight at the ankles, wrists, and around the neck and face. The suits shall be ventilated with supplied air, preferably cooled, or time in the work area shall be limited with due consideration to the heat stress factors involved. Impervious gloves and boots shall also be worn. Such protective clothing shall be available at a convenient location outside the contaminated area.

(2) The employer shall insure a sufficient supply and adequate maintenance of protective clothing.

(b) Eye Protection

Personnel handling liquid phosgene in situations where eye contact can occur shall have eye protection afforded by full-face respiratory

protection as specified in Table I-1, since concentrations of phosgene sufficient to cause eye damage are also likely to cause respiratory tract damage.

(c) Respiratory Protection

(1) Compliance with the exposure limits may be achieved by the use of respirators only:

(A) during the time period necessary to install and test the controls required by Section 6(b) of this chapter;

(B) for nonroutine operations such as a brief exposure in excess of the TWA or ceiling concentration exposure limit as a result of maintenance or repair activities; or

(C) in emergencies when air concentrations of phosgene may exceed the TWA exposure limit.

(2) When a respirator is permitted by paragraph (1) of this subsection, it shall be selected from among those jointly approved by the Bureau of Mines, US Department of the Interior, and by the National Institute for Occupational Safety and Health, US Department of Health, Education, and Welfare, under the provisions of 30 CFR 11. The employer shall provide the respirator required and shall ensure its use. A respiratory protection program meeting the requirements of 29 CFR 1910.134, as amended, shall be established and enforced by the employer. Only appropriate respirators as described in Table I-1 shall be used.

TABLE I-1

RESPIRATOR SELECTION GUIDE

| Air Concentrations | Respirator Type* |
|---|--|
| Less than or equal to 1 ppm | (1) Any supplied-air respirator; or (2) Any self-contained breathing apparatus. |
| Less than or equal to 2ppm | (1) Any supplied-air respirator with a full facepiece, helmet, or hood; or (2) Any self-contained breathing apparatus with a full facepiece. |
| Greater than 2 ppm or emergency situations | (1) Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode; or (2) A 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 operated in pressure-demand or other positive pressure mode. |

TABLE I-1 (CONTINUED)

RESPIRATOR SELECTION GUIDE

| Air Concentrations | Respirator Type* |
|----------------------|--|
| Firefighting | Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. |
| Evacuation or escape | (1) Any gas mask providing protection against phosgene; or (2) Any escape self-contained breathing apparatus with full facepiece. |

* Approved by the Bureau of Mines and the National Institute for Occupational Safety and Health

(3) Each work area where there is potential for occupational exposure to phosgene shall have at least 2 sets of self-contained breathing apparatus readily available in nearby locations which do not require entry into, or passage through, a contaminated area for access.

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

(5) Employees shall be trained and drilled in the use of

respirators assigned to them and in testing for leakage.

(6) Canisters shall be discarded and replaced with fresh canisters after use. Unused canisters shall be discarded and replaced when the seal is broken or when the shelf life, as recommended by the manufacturer, is exceeded.

Section 5 - Informing Employees of Hazards from Phosgene

At the beginning of employment, workers who will work in areas required to be posted in accordance with Section 3(b) shall be informed of the hazards from phosgene, symptoms of overexposure, emergency procedures, and precautions to ensure safe use and to minimize exposure. First aid procedures shall be included. This information shall be posted in the work place and kept on file, readily accessible to the worker.

A continuing educational program shall be instituted for workers whose jobs may involve occupational exposure to phosgene. This is to ensure that all such workers have current knowledge of job hazards, maintenance procedures, and clean-up methods, and that they know how to use respiratory protective equipment and protective clothing. Workers should be advised that the detection of the odor of phosgene at any time indicates the need for immediate corrective procedures or withdrawal from the area. First-line supervisors shall be thoroughly informed of these hazards and procedures and should participate in the education of workers.

In addition, members of emergency teams and employees who work in areas adjacent to phosgene systems or containers, where a potential for emergencies exists, shall participate in periodic drills, simulating emergencies appropriate to the work situation. Drills shall be held at

intervals not exceeding 6 months. Drills should cover, but should not be limited to:

- Evacuation procedures.
- Handling of spills and leaks, including decontamination.
- Location and use of emergency firefighting equipment, and handling of phosgene and chlorinated hydrocarbon systems and/or containers in case of fire.
- First aid and rescue procedures, including prearranged procedures for obtaining emergency medical care.
- Location, use, and care of protective clothing and respiratory protective equipment.
- Location of shut-off valves or switches.
- Location, purpose, and use of safety showers and eyewash fountains.
- Operating procedures including communication procedures.
- Entry procedures for confined spaces.

Deficiencies noted during drills shall be included in the continuing educational program, together with the required remedial actions. Records of drills and training conducted shall be kept for one year and made available for inspection by authorized personnel as required.

Information as required shall be recorded on the US Department of Labor Form OSHA-20, "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 prearranged plans for:
 - (A) immediate evacuation of overexposed workers;
 - (B) transportation of overexposed workers;
 - (C) any necessary calls for assistance, including alerting medical facilities of the impending arrival of overexposed workers, and calls to suppliers or manufacturers of phosgene for any necessary technical advice;
 - (D) designation of medical receiving facilities and names of physicians trained in phosgene emergency procedures;
 - (E) reentry for maintenance or clean-up purposes of areas where phosgene leaks or spills have occurred.

(2) Approved eye, skin, and respiratory protection as specified in Section 4 shall be used by personnel essential to emergency operations.

(3) Nonessential employees shall be evacuated from hazardous areas during emergencies. Perimeters of these areas shall be delineated, posted, and secured. The employees in adjacent areas shall be trained in evacuation procedures in the event that their work areas become involved.

(4) Personnel who cannot be evacuated shall keep upwind of phosgene spills or leaks, if possible. Only personnel trained in the emergency procedures and protected against the attendant hazards shall shut off sources of phosgene, clean up spills, and control and repair leaks.

(5) In case of fire, phosgene containers shall be removed to a safe place, or cooled with water if leaks do not exist. Efforts shall be made to prevent phosgene cylinders from reaching temperatures above 50 C (122 F).

(6) Water shall not be used on phosgene leaks because accelerated corrosion of metal by phosgene in the presence of moisture will quickly make the leak worse.

(7) If possible, phosgene emissions shall be directed to an alkali scrubber or to process (ie, routed by means of appropriate valving within a closed system to a secondary holding vessel or neutralization system).

(8) Containers leaking liquid phosgene should be positioned so that gaseous phosgene is discharged through the leak until control is effected.

(9) If local emergency teams cannot cope with the emergency, assistance shall be requested from the supplier or the nearest phosgene-manufacturing facility. Telephone numbers of emergency help shall be prominently posted.

(10) Phosgene in contact with skin or eyes must be removed by immediate flushing with copious quantities of water, and immediate medical attention must be obtained. Contaminated clothing must be removed immediately. If the worker has inhaled phosgene, remove him to an uncontaminated atmosphere, give artificial respiration if required, and get immediate medical attention in accordance with Section 6(a)(1). Do not allow the victim to walk or exercise in any manner. Keep the victim quiet and warm.

(b) Control of Airborne Phosgene

Engineering controls shall be used to maintain phosgene concentrations at or below the prescribed limits. The use of completely enclosed processes is the preferred method of control for phosgene. Local

exhaust ventilation may also be effective, used alone or in combination with process enclosure. Ventilation systems shall be designed to prevent the accumulation or recirculation of phosgene in the workroom, to maintain phosgene concentrations within the limits of the recommended standard, and to remove phosgene from the breathing zones of workmen. Exhaust ventilation systems shall discharge to the outside air through a sorption or a decomposition system (eg, scrubbers containing an alkaline scrubbing medium, such as 5% sodium hydroxide solution). Ventilation systems shall be subject to regular preventive maintenance and cleaning to ensure effectiveness, which shall be verified by periodic air-flow measurements. Tempered makeup air shall be provided to workrooms in which exhaust ventilation is operating.

(c) Storage

(1) Phosgene shall be stored in unoccupied, adequately ventilated, cool, and dry rooms, or outdoors shielded from the direct rays of the sun and protected from moisture.

(2) Phosgene storage rooms shall be provided with an inspection window to permit viewing of the interior without entry.

(3) Phosgene storage areas 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 phosgene to enter other parts of the plant shall be secured and sealed. Central cooling and heating ducts shall not extend to phosgene storage enclosures.

(4) Ventilation switches and emergency respiratory protection shall be located outside storage areas in readily accessible locations which will be free of phosgene in an emergency. Fan switches

shall be equipped with indicator lights.

(5) Phosgene containers shall be secured to prevent falling, upsetting, or rolling, and shall be protected from mechanical damage, heat, moisture, and corrosion.

(6) Containers of phosgene should be used on a first-in, first-out (FIFO) basis. Storage of phosgene shall be limited to the minimum necessary for the operation.

(7) Used containers should not be stored with full containers. Full containers shall be so marked, and containers in use shall be plainly marked "In Use" to differentiate from those not in use.

(8) Other materials should not be stored with phosgene.

(9) Phosgene containers shall be frequently inspected for leaks and deterioration. If the hydrostatic test date stamped on cylinders is older than 5 years, the cylinder shall be returned to the vendor, or arrangements shall be made to have the necessary test performed.

(d) Handling and General Work Practices

(1) Written operating instructions and emergency medical procedures shall be formulated and posted where phosgene is handled or used.

(2) Prompt medical attention shall be obtained if there is known or suspected overexposure to phosgene, whether or not symptoms are present.

(3) Returnable phosgene containers shall not be washed out with water.

(4) Safety valves and vents for phosgene equipment shall discharge through absorbers or neutralizers (decomposition system).

(5) Phosgene containers and systems shall be inspected daily for leaks. All phosgene equipment including valves, fittings, and connections shall be checked for tightness and good working order. All newly made connections shall be checked for leaks immediately after phosgene is admitted. Needed repairs and adjustments shall be made promptly.

(6) Appropriate precautions shall be taken to keep phosgene and phosgene 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.

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

(8) When phosgene containers are being moved, or when they are not in use and are disconnected, valve protection covers shall be in place. Containers shall be moved only with the proper equipment and shall be secured to prevent dropping or loss of control while moving. Slings or magnetic devices shall not be modified, altered, or repaired except as normally intended by the supplier.

(9) Valves and pumps shall be readily accessible and should not be located in pits and congested areas.

(10) Discharge rates of containers of phosgene may be increased by use of warm air or warm water. Steam, boiling water, or direct flame shall not be used. Cylinder temperatures shall not exceed 50 C (122 F).

(11) Containers discharging liquid phosgene shall not be connected to manifolds. Phosgene delivery tubes and pipes from other than

high-pressure containers should not be immersed in other liquids without interposing a check valve or a trap to prevent back siphonage.

(12) The amount of phosgene used from a container shall be determined by a positive method (eg, weighing the preweighed container).

(13) New gaskets shall be used each time phosgene system connections are made.

(14) Welding or burning on tanks or equipment which have contained phosgene shall take place only after such tanks or equipment have been thoroughly purged with a dry inert gas, vented to a sorption or decomposition system. Steam or water shall not be introduced to the tanks, system, or equipment. Phosgene equipment, containers, or piping shall not be repaired while in service.

(15) Before phosgene is admitted to a system, the system shall be thoroughly cleaned, dried, and tested, using previously formulated procedures.

(16) Personnel shall not work alone when phosgene is first admitted to a system or while repairing leaks.

(17) Containers and systems shall be handled and opened with care. Approved eye, skin, and respiratory protection shall be worn while opening, connecting, and disconnecting phosgene containers and systems. When opening containers or systems, adequate ventilation shall be available to prevent inadvertent exposure to phosgene.

(18) Any odor of phosgene shall be reported to a responsible authority or an alarm sounded as soon as possible after the area has been vacated.

(e) Work Areas

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

(2) Enclosed phosgene work areas shall be equipped with at least 2 exits, remote from each other, to allow escape into uncontaminated areas in case of emergency. Doors shall open outward.

(3) Unauthorized personnel shall be prohibited from entering areas where phosgene is handled or used.

(4) Wherever possible, phosgene installations shall be outdoors. If it is necessary that such installations be indoors, workers should operate from a pressurized control room supplied with fresh air from an area remote from any possible source of phosgene contamination.

(5) For reentry purposes, at least 2 sets of self-contained breathing apparatus as specified in Table I-1 shall be located outside each work area where phosgene is handled, used, stored, or formed. In case of emergency, they shall be accessible without entry into contaminated areas. Employees shall be trained and drilled in their use.

(6) Phosgene shut-off valves shall be conspicuously marked and employees shall be familiarized with their use. Access to shut-off valves shall be unobstructed. Work areas shall be kept clean and orderly.

(f) Waste Disposal

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

(2) Phosgene shall not be allowed to enter drains or sewers.

(3) Appreciable discharges of phosgene shall be passed through an adequate decomposition system, such as a scrubbing tower utilizing sodium hydroxide or ammonium hydroxide, or through a sorbent system.

(4) Solid sorbents should be chosen so that desorption of phosgene is unlikely. Heating of the solid sorbent should be avoided.

(g) Confined Spaces

(1) Entry into confined spaces such as tanks, pits, tank cars, barges, process vessels, and tunnels 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 precautions have been taken to ensure that prescribed procedures will be followed.

(2) Confined spaces which have contained phosgene shall be inspected and tested for oxygen deficiency, phosgene, and other contaminants and shall be thoroughly ventilated, cleaned, neutralized, and washed, as necessary, prior to entry.

(3) Inadvertent entry of phosgene into the confined space while work is in progress shall be prevented by disconnecting and blanking of phosgene supply lines.

(4) Confined spaces shall be ventilated while work is in progress to keep the concentration of any phosgene present below the standard and to prevent oxygen deficiency.

(5) Individuals entering confined spaces where they may be exposed to phosgene shall be equipped with adequate respirators and suitable harnesses with lifelines tended by another worker outside the

space who shall also be equipped with the necessary protective equipment.

(h) Enclosed Spaces

Enclosed spaces (rooms, buildings, etc) which ordinarily are safe to enter but which, due to the failure of a system inside, could contain hazardous concentrations of phosgene should have a continuous automatic monitor (see Appendix III) set to sound an alarm which is audible inside and outside the enclosed space if phosgene concentrations exceed the ceiling concentration limit. A warning light is recommended as a substitute for a bell in noisy areas. If such areas are not monitored in this way, they 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.

(i) Miscellaneous

Unless the potential for inadvertent phosgene generation is anticipated and engineering controls are implemented, chlorinated hydrocarbons shall not be exposed to high temperatures or ultraviolet radiation.

Section 7 - Sanitation Practices

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

(b) Escape routes near phosgene control equipment shall be kept clear, reflecting general good housekeeping practices.

(c) Appropriate locker rooms shall be available for changing into required protective clothing in accordance with 29 CFR 1910.141(e). Clothing contaminated with liquid phosgene shall be immediately removed and

placed in a closed container in a well-ventilated area for later disposal or decontamination.

(d) Food should not be stored, prepared, dispensed, or eaten in phosgene work areas.

Section 8 - Monitoring and Recordkeeping Requirements

(a) Workroom areas where it has been determined, on the basis of an industrial hygiene survey or the judgment of a compliance officer, that environmental levels of phosgene are less than half of the TWA limit should not be considered to have phosgene exposure. Records of these surveys, including the basis for concluding that air levels of phosgene are below half of the TWA limit, shall be maintained until a new survey is conducted.

(b) Area Monitoring

Continuous automatic monitoring is recommended in any work area where an initial industrial hygiene survey indicates that a potential phosgene exposure exists. Such monitoring devices (see Appendix III) should have an audible or a visible alarm (light) which is triggered whenever the ceiling concentration limit is exceeded.

(c) Personal Monitoring

(1) Initial Monitoring

Within 6 months of the promulgation of this standard, each employer who has a place of employment in which phosgene is stored, handled, used, or formed shall design and implement a monitoring program which shall identify and measure or permit calculation of the exposure of all employees exposed to phosgene.

(2) Normal Monitoring

(A) Routine monitoring of employee exposure shall be conducted at 3-month intervals unless otherwise indicated by a professional industrial hygienist and whenever introduction of a production, process, or control change indicates a need for reevaluation.

(B) If an employee monitoring program measurement reveals that an employee is exposed in excess of the recommended environmental limits, the exposure of that employee shall be measured at least once every 2 weeks, control measures required by Section 6(b) shall be implemented, and the employee shall be notified. When two consecutive biweekly determinations reveal that employee exposure no longer exceeds either of the recommended environmental limits, routine monitoring may be resumed.

(3) Exposure Measurement

In all personal monitoring, samples representative of the exposure in the breathing zone of the employee shall be collected. Procedures for sampling, calibration of equipment, and analysis of phosgene 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.

An adequate number of samples shall be collected to permit construction of a TWA and peak exposure value for every operation or process. Variations in work and production schedules shall be considered in deciding when samples are to be collected. The minimum number of representative TWA determinations for an operation or process shall be based on the number of workers exposed as provided in Table I-2, or as otherwise indicated by a professional industrial hygienist.

TABLE I-2

SAMPLING SCHEDULE

| Number of Employees Exposed | Number of TWA Determinations |
|-----------------------------|--|
| 1 - 20 | 50% of the total number of workers |
| 21 - 100 | 10 plus 25% of the excess over 20 workers |
| Over 100 | 30 plus 5% of the excess over 100 workers |

(d) Recordkeeping

Employers shall maintain records of any accidental phosgene release requiring evacuation, and results of all exposure measurements, environmental surveys, and medical examinations performed as required by Section 2 of this chapter. Such records shall indicate the type of personal protective devices, if any, in use at the time of sampling. Records of environmental monitoring shall be maintained and shall be available to the authorized representatives of the Secretary of Health, Education, and Welfare, and of the Secretary of Labor. Each employee shall be able to obtain information on his own environmental exposure. Such

records shall be maintained for at least 5 years after the individual's employment is terminated.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational diseases arising from exposure to phosgene. 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 and recommended standard should enable management and labor to develop better engineering controls resulting in more healthful work environments. Simply complying with the recommended standard should not be the final goal.

These criteria for a standard for phosgene are part of a continuing series of criteria developed by NIOSH. The proposed standard applies to the processing, manufacture, use of, or other occupational exposure to phosgene 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 warranted. It is intended to (1) protect against injury from phosgene, (2) be measurable by techniques that are valid, reproducible, and available to industry and

official agencies, and (3) be attainable with existing technology.

The development of the recommended standard for occupational exposure to phosgene has revealed deficiencies in the data base in the following areas:

(1) epidemiologic studies of workers exposed to phosgene for extended periods;

(2) chronic animal exposure studies at low levels of phosgene;

(3) improvement of the sensitivity of sampling and analytical methods for personal monitoring;

(4) testing of automatic, continuous monitoring systems and associated alarms.

These gaps in our knowledge of phosgene should be filled.