

## I. RECOMMENDATIONS FOR A REFINED PETROLEUM SOLVENTS STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, Stoddard solvents and kerosene in the workplace be controlled by adherence to the following sections. The standards are designed to protect the health and provide for the safety of employees for up to a 10-hour work shift, 40-hour workweek, over a working life. Compliance with all sections of the standards should prevent adverse effects of these chemicals on the health of employees and provide for their safety. Techniques recommended are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standards. Although the environmental limits for the workplace are considered to be safe levels based on current information, the employer should regard these as the upper boundary of exposure and every effort should be made to keep the exposure as low as is technically feasible. The criteria and standards will be subject to review and revision as necessary.

Eye, nose, and throat irritation, dermatitis, and effects on the nervous system have been found in workers exposed to some refined petroleum solvents. Benzene, which has been shown to cause blood dyscrasias in humans, is present in small amounts in many refined petroleum solvents. NIOSH has concluded that benzene is leukemogenic. For further information on the hazards of benzene, refer to Appendix I. It is therefore recommended that, when benzene is found to be present in refined petroleum solvents, every effort be made to keep the benzene exposure as low as

possible. The refined petroleum solvents examined in this document are for the most part complex mixtures, and the possibility of synergistic or additive toxic effects of the components of these mixtures should not be overlooked.

These criteria and recommended standards apply to occupational exposure of workers to the following refined petroleum solvents: petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, Stoddard solvents, and kerosene, all included in the term "refined petroleum solvents."

The refined petroleum solvents considered in this document have a total aromatic content of less than 20%. Other hydrocarbon solvents such as thinners, whose total aromatic content may exceed 20%, are not discussed in this document. For the purposes of these recommended standards for refined petroleum solvents, the following definitions will apply to those solvents covered in this document:

"Petroleum ether" is a refined petroleum solvent that has a boiling range of 30-60 C and typically has a chemical composition of 80% pentane and 20% isohexane.

"Rubber solvent" is a refined petroleum solvent with a boiling range of 45-125 C and is composed of organic compounds whose carbon chain lengths range from C5 to C7. The chemical composition of a typical rubber solvent would be: 41.4% paraffins, 53.6% monocycloparaffins, 0.1% monoolefins, 1.5% benzene, and 3.4% alkyl benzene.

"Varnish makers' and painters' naphtha" is a refined petroleum solvent with a boiling range of 95-160 C and is composed of organic compounds whose carbon chain lengths range from C5 to C11. The chemical

composition of a typical varnish makers' and painters' naphtha would be: 55.4% paraffins, 30.3% monocycloparaffins, 2.4% dicycloparaffins, 0.1% benzene, 11.7% alkylbenzenes, 0.1% indans and tetralins.

"Mineral spirits" is a refined petroleum solvent with a boiling range of 150-200 C. A typical chemical composition for mineral spirits would be: 80-86% saturated hydrocarbons, 1% olefins, and 13-19% aromatics.

"Stoddard solvent" is a type of mineral spirits with a boiling range of 160-210 C and is composed of organic compounds whose carbon chain lengths range from C7 to C12. The chemical composition of a typical Stoddard solvent would be: 47.7% paraffins, 26% monocycloparaffins, 11.6% dicycloparaffins, 0.1% benzene, 14.1% alkylbenzenes, 0.5% indans and tetralins.

"140 Flash aliphatic solvent" is a type of Stoddard solvent with a boiling range of 185-207 C and is composed of organic compounds whose carbon chain lengths range from C5 to C12. A typical chemical composition for 140 flash aliphatic solvent would be: 60.8% paraffins, 24.5% monocycloparaffins, 11.2% dicycloparaffins, 0.07% benzene, 3.03% alkyl benzenes, and 0.3% indans and tetralins.

"Kerosene" is a refined petroleum solvent with a boiling range of 175-325 C. A typical chemical composition for kerosene would be: 25% normal paraffins, 11% branched paraffins, 30% monocycloparaffins, 12% dicycloparaffins, 1% tricycloparaffins, 16% mononuclear aromatics, and 5% dinuclear aromatics.

"Deodorized kerosene" is a refined petroleum solvent that has a boiling range of 209-274 C and a typical chemical composition of 55.2% paraffins, 40.9% naphthenes, and 3.9% aromatics.

If exposure to other chemicals also occurs, the employer shall comply also with applicable standards for the other chemicals. In particular, special attention shall be given to the benzene content of the refined petroleum solvents being used.

The "action level" for petroleum ether, rubber solvent, and varnish makers' and painters' naphtha is defined as an airborne time-weighted average (TWA) concentration of 200 milligrams per cubic meter (mg/cu m) of air for up to a 10-hour work shift in a 40-hour workweek. The "action level" for mineral spirits and Stoddard solvent is defined as a TWA concentration of 350 mg/cu m of air for up to a 10-hour work shift in a 40-hour workweek. The "action level" for kerosene is defined as a TWA concentration of 100 mg/cu m of air for up to a 10-hour work shift in a 40-hour workweek. "Occupational exposure" to refined petroleum solvents is defined as exposure above the action level. Exposure to refined petroleum solvents at lower concentrations will not require adherence to the following sections, except for Sections 2(a), 3, 4(a,b), 6(a,c-1), 7, and 8(a).

#### Section 1 - Environmental (Workplace Air)

##### (a) Concentration

(1) The employer shall control occupational exposure to airborne concentrations of petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, and Stoddard solvents so that no employee is exposed at a concentration greater than 350 mg/cu m of air, determined as a TWA concentration for up to a 10-hour work shift, 40-hour workweek. In addition, no employee shall be exposed to any of the above

refined petroleum solvents at a ceiling concentration greater than 1,800 mg/cu m as determined by a sampling time of 15 minutes.

(2) The employer shall control occupational exposure to kerosene so that no employee is exposed at a concentration greater than 100 mg/cu m of air determined as a TWA concentration for up to a 10-hour work shift, 40-hour workweek.

(b) Sampling and Analysis

Procedures for the collection and analysis of workroom air samples shall be as provided in Appendices II, III, and IV, or by any methods shown to be at least equivalent in precision and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance as described below shall be made available to all workers subject to occupational exposure to refined petroleum solvents.

(a) Preplacement examinations shall include at least:

(1) Comprehensive medical and work histories.

(2) Physical examination, giving particular attention to: the skin; appropriate liver function tests such as serum glutamic-oxaloacetic transaminase; complete blood count; urinalysis; and tests of nervous system function.

(3) A judgment of the ability of the worker to use negative or positive pressure respirators.

(b) Periodic examinations shall be made available at least on an annual basis and shall include at least:

(1) Interim medical and work histories.

(2) Physical examination as outlined in (a)(2) above.

(c) During examinations, applicants or employees having medical conditions which would be directly or indirectly aggravated by exposure to these substances, such as chronic dermatitis, shall be counseled on the increased risk of impairment of their health from working or continuing to work with these substances.

(d) Initial medical examinations shall be made available to all workers within 6 months after the promulgation of standards based on these recommendations.

(e) In an emergency involving these substances, all affected personnel shall be provided with immediate first aid, followed by prompt medical evaluation and care. In the event of eye or skin contact with refined petroleum solvents, contaminated clothing and shoes shall be removed immediately and eyes and skin shall be flushed with copious amounts of water. The medical attendants shall be informed of the possibility of central nervous depression.

(f) Pertinent medical records shall be kept by the employer for all employees occupationally exposed to refined petroleum solvents. Such records shall be kept for at least 30 years after employment has ended. These records shall be made available to 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.

Section 3 - Labeling and Posting

All labels and warning signs shall be printed both in English and in the predominant language of non-English-reading employees. Illiterate workers and workers reading languages other than those used on labels and posted signs shall receive information regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

The following warning label and sign shall be affixed in a readily visible location on petroleum ether, rubber solvent, varnish makers' and painters' naphtha, mineral spirits, Stoddard solvents, or kerosene storage tank containers:

NAME OF SOLVENT  
(synonym)

WARNING! FLAMMABLE! (or COMBUSTIBLE!)

CAN BE FATAL OR CAUSE SEVERE ILLNESS IF SWALLOWED

Keep away from heat, sparks, and open flame.  
No smoking permitted.  
Do not take internally.  
Keep container closed.  
Avoid prolonged or repeated breathing of vapor.  
Avoid contact with eyes and skin.  
Use with adequate ventilation.

In case of

Fire: Use appropriate foam-type, dry chemical (eg, sodium bicarbonate), or carbon dioxide extinguishers.

Spill: Flush area with adequate amounts of water.

First Aid: In case of eye or skin contact, flush with copious amounts of water while lifting the eyelids. Change clothing if contaminated. In case of accidental swallowing, call a physician. DO NOT INDUCE VOMITING!

Section 4 - Personal Protective Clothing and Equipment

(a) Protective Clothing

(1) Appropriate protective clothing, including gloves, aprons, suits, boots, and face shields (8-inch minimum) with goggles, made of a material resistant to refined petroleum solvents shall be provided for and worn by every employee to limit skin contact. In addition, the protective clothing shall also be fire-resistant. This type of clothing shall be worn by employees removing clothing from drycleaning machines or performing spotting operations. In addition to being solvent-resistant, the gloves used in these operations shall also be of sufficient length to protect the forearms of the employees. Employees performing these operations should keep solvent-saturated materials away from their breathing zones as much as possible.

(2) Unless protective clothing is being worn, the employer shall ensure that a change of clothing is immediately available to and used by any employee whose clothes become wetted with solvents.

(3) Where protective clothing is required, the employer shall provide the employee with separate storage facilities for work clothes and for street clothes, preferably separated by shower facilities.

(4) Safety showers and eyewash fountains shall be provided in appropriate areas. These showers and fountains shall be checked periodically to ensure their proper working condition.

(b) Eye Protection

Chemical safety goggles (splashproof) and face shields (8-inch minimum) meeting the requirements listed in 29 CFR 1910.133 and ANSI Z87.1-1968 shall be provided and worn in any operation in which there is a



reasonable probability of a solvent being splashed into the eyes.

(c) Respiratory Protection

(1) Sparkproof engineering controls, such as local exhaust hoods, fans, or other ventilation systems, shall be used if needed to keep solvent air concentrations below the TWA and ceiling environmental limits. Compliance with the environmental limits may not be achieved by the use of respirators except:

(A) During the time period necessary to install or test the required engineering controls.

(B) For nonroutine operations such as brief exposures at concentrations in excess of the environmental limits resulting from maintenance or repair activities.

(C) During emergencies when air concentrations of the solvent may exceed the environmental limits.

(2) When a respirator is permitted by paragraph (c)(1) of this section, it shall be selected and used pursuant to the following requirements:

(A) The employer shall establish and enforce a respiratory protection program meeting the requirements of 29 CFR 1910.134.

(B) The employer shall provide respirators in accordance with Tables I-1, I-2, and I-3 depending on the type of solvent used and shall ensure that the employee uses the appropriate respirator when needed. The respiratory protective devices provided in conformance with Tables I-1, I-2, and I-3 shall comply with the standards jointly approved by NIOSH and the Mining Enforcement and Safety Administration (formerly Bureau of Mines) as specified under the provisions of 30 CFR 11.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR PETROLEUM ETHER, RUBBER SOLVENT,  
AND VARNISH MAKERS' AND PAINTERS' NAPHTHA

Concentration	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 3,500 mg/cu m	(1) Chemical cartridge respirator with half-mask facepiece and organic vapor cartridge* (2) Supplied-air respirator with half-mask facepiece operated in demand (negative pressure) mode
Less than or equal to 17,500 mg/cu m	(1) Gas mask equipped with full facepiece and organic vapor canister (2) Supplied-air respirator equipped with full facepiece (3) Self-contained breathing apparatus with full facepiece operated in demand mode
Greater than 17,500 mg/cu m	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand mode, with auxiliary self-contained air supply
Emergency entry (into an area of unknown concentration)	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand mode, with auxiliary self-contained air supply

\*The service life of the organic vapor cartridge should be limited to 1 hour.

TABLE I-2

RESPIRATOR SELECTION GUIDE FOR STODDARD SOLVENTS AND MINERAL SPIRITS

Concentration	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 3,500 mg/cu m	(1) Chemical cartridge respirator with half-mask facepiece and organic vapor cartridge* (2) Supplied-air respirator with half-mask facepiece operated in demand (negative pressure) mode
Less than or equal to 17,500 mg/cu m	(1) Gas mask equipped with full facepiece and organic vapor canister (2) Supplied-air respirator equipped with full facepiece (3) Self-contained breathing apparatus with full facepiece operated in demand mode
Less than or equal to 30,000 mg/cu m	Supplied-air respirator equipped with full facepiece, hood, helmet, or suit in continuous-flow or other positive pressure mode
Greater than 30,000 mg/cu m	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand mode, with auxiliary self-contained air supply
Emergency entry (into an area of unknown concentration)	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand mode, with auxiliary self-contained air supply

\*The service life of the organic vapor cartridge should be limited to 1 hour.

TABLE I-3

## RESPIRATOR SELECTION GUIDE FOR KEROSENE

Concentration	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 1,000 mg/cu m	(1) Chemical cartridge respirator with half-mask facepiece and organic vapor cartridge* (2) Supplied-air respirator with half-mask facepiece operated in demand (negative pressure) mode
Less than or equal to 5,000 mg/cu m	(1) Gas mask equipped with full facepiece and organic canister (2) Supplied-air respirator equipped with full facepiece (3) Self-contained breathing apparatus with full facepiece operated in demand mode
Greater than 5,000 mg/cu m	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand mode, with auxiliary self-contained air supply
Emergency entry (into an area of unknown concentration)	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand mode, with auxiliary self-contained air supply

\*The service life of the organic vapor cartridge should be limited to 1 hour.

(C) Respirators specified for use in higher concentrations of solvent vapor may be used in atmospheres of lower concentrations.

(D) The employer shall ensure that no employee is being exposed to solvent air concentrations in excess of the environmental limits because of improper respirator selection, fit, use, or maintenance.

(E) The employer shall ensure that respirators are adequately cleaned and maintained and that employees are instructed in the proper use and in testing for leakage of respirators assigned to them.

(F) Respirators shall be easily accessible in work areas and employees shall be informed of their location.

Section 5 - Informing Employees of Hazards from Refined Petroleum Solvents

(a) The employer shall institute a continuing education program, conducted by persons qualified by experience or training, to ensure that employees have current knowledge of job hazards, of proper maintenance and cleanup methods, and of proper respirator use. The instructional program shall also include a description of the general nature of the medical surveillance procedures and of the advantages to the employee of undergoing these examinations. Educational programs for employees engaged in maintenance and repair shall include instruction on those work situations in which they may be occupationally exposed to refined petroleum solvents.

(b) Training program material in written or published form shall be kept on file at each establishment or department and shall be readily

accessible to all employees occupationally exposed to refined petroleum solvents.

The specific information required by the US Department of Labor form OSHA-20 "Material Safety Data Sheet," shown in Appendix V, or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor, shall also be kept on file, and be accessible to the employees. The employees shall be informed, and reformed at least annually, as to the availability and location of the above files.

#### Section 6 - Work Practices

##### (a) Emergency Procedures

For all work areas in which there is potential for emergencies involving refined petroleum solvents, the employer shall take necessary steps to ensure that employees are instructed in and follow the procedures specified below and any other appropriate procedures specific to the type of operation or process in a particular workplace.

(1) Procedures shall include prearranged plans for obtaining first-aid and emergency medical care and for transportation of injured workers.

(2) Firefighting procedures shall be established and implemented. The refined petroleum solvent sources shall be clearly marked, and workers and emergency personnel shall be instructed in proper shutoff procedures. The instructions shall include procedures for emergencies involving the release of solvent vapor. In case of fire, solvent sources shall be shut off or removed. Containers shall be removed or cooled with water. Chemical foam, carbon dioxide, or dry chemicals

shall be used for fighting solvent fires, and proper respiratory protection and protective clothing shall be worn.

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

(4) Nonessential employees shall be evacuated from exposure areas during emergencies. During an emergency, perimeters of hazardous areas shall be roped off, posted, and secured.

(5) Personnel who may be required to shut off sources of solvent, clean up spills, and repair leaks shall be properly trained in the appropriate procedures.

(6) Warning or alarm systems should be considered to alert workers to possible hazardous exposures to refined petroleum solvents during emergencies involving the release of refined petroleum solvent liquid or vapors.

(b) Exhaust Systems

Engineering control systems shall be used when needed to reduce exposure of employees to refined petroleum solvents to recommended limits. When a local exhaust ventilation system is used, it shall be designed and maintained to prevent the accumulation or recirculation of solvent vapor in the workroom. Drycleaning apparatus shall be operated under negative pressure so that, when the loading door is opened, air from the workroom will be drawn into the apparatus, thus preventing the escape of solvent vapors into the workroom. Exhaust systems discharging into outside air must conform with applicable local, state, and federal air pollution regulations. When mechanical ventilation is used to control exposure,

measurements which demonstrate system efficiency, eg, air velocity, static pressure, or air volume, shall be made at least every 3 months, or more frequently if required for the safe and efficient operation of a particular system. Measurements of system efficiency shall also be made as soon as possible but not later than 5 workdays after any change in production, process, or control that might result in an increase in air concentrations. When a fan is located in duct work and where a flammable solvent is likely to be present at concentrations at or above one-fourth the lower flammable limit, the fan rotating element shall be of nonsparking material or the casting shall be coated with or consist of a nonsparking material. The ventilation system shall contain devices along the length of the exhaust system intended to prevent the occurrence and propagation of flashbacks.

(c) Loading and Unloading

The handling and storage of refined petroleum solvents shall comply with NFPA Article 30 for flammable or combustible liquids.

(1) Fire extinguishers approved for Class IB fires, such as dry chemical extinguishers, shall be available in loading and unloading areas. Fire extinguishers shall be inspected annually and recharged or replaced if necessary.

(2) Safety showers and eyewash fountains shall be installed near loading and unloading areas and maintained in proper working order.

(3) The equipment required by paragraph (c)(1) and (c)(2) of this section shall be inspected regularly to ensure that it is in proper working order. The employer shall ensure that such inspection is performed by a qualified person.



(4) In case of a leak, loading or unloading operations should continue, as rapidly as possible (if safe) to drain the tank or make necessary repairs. Operations should cease in the event of a severe leak causing unsafe conditions, and emergency procedures should be instituted.

(5) Bonding facilities for protection against static sparks during the loading of tank vehicles shall be provided as required in 29 CFR 1910.106(f)(3)(iv).

(d) Solvent Carloading and Truckloading Procedures

(1) Smoking, matches, or lighters shall be strictly prohibited in car- and truckloading areas.

(2) Safety showers, eyewash fountains, and fire extinguishers containing chemicals approved for Class IB fires shall be installed and maintained in proper working order.

(3) A wheel chock, a car-loading sign, and a derail shall be placed in position and ground cables attached before any lines are connected to a tank car containing solvents.

(4) Wheel chocks, ground cables, and loading sign shall be in place before any lines are connected to a trailer containing solvents.

(5) Ground cables shall be removed only after loading or unloading lines have been removed and the dome covers have been secured.

(6) Rubber gloves and chemical safety goggles (splashproof) shall be used where the possibility of solvent splashes exists. Breathing of solvent vapor should be avoided.

(7) Any part of the body on which solvent has been spilled should be washed immediately with water and soap. Eyes should be flushed immediately with copious amounts of water while lifting the eyelids, and

the incident should be reported immediately to the appropriate health unit.

(e) Storage

Storage of bulk amounts shall meet the requirements for Class IB flammable liquid storage as specified in 29 CFR 1910.106(b).

(f) Waste Disposal

Spills of large amounts of solvents should be washed with water into an appropriate drainage system where it may be safely stored and either recovered or discarded. Discarding of waste shall be in compliance with applicable Environmental Protection Agency (EPA) standards. When it is not possible to wash a spill with water, the area should be cordoned off until cleanup operations have been completed. If a vacuum truck is used to remove the solvents, there should be no sources of ignition in the vicinity and sufficient flashback devices should be provided.

(g) Vessel Entry

Entry into confined spaces, such as tanks, pits, tank cars, and process vessels, which have contained refined petroleum solvents 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 the prescribed procedure will be followed.

(1) All lines shall be disconnected or blocked while the vessel is being cleaned. All valves or pumps leading to and from the vessel shall be locked out or tagged out.

(2) The vessel shall be washed with water and purged with air, or first with nitrogen and then with air.

(3) A calibrated combustible gas meter shall be used to check for explosion hazard. The test shall be performed by a person trained in the use of the combustible gas meter. Where it is possible that refined petroleum solvent vapors could increase in concentration within the confined space, this test shall be repeated every 30 minutes.

(4) The vessel shall then be checked for airborne solvent level, possible oxygen deficiency, and concentrations of other likely contaminants. A positive pressure respirator shall be used during this checking procedure.

(5) If a respirator is necessary, an appropriate type shall be provided to the employee. Section 4(c) of this chapter describes the types of respirators which are suitable under various conditions.

(6) Each employee entering the vessel shall be equipped with appropriate respiratory protection, a harness, and a lifeline. At least two other persons equipped with appropriate respiratory protection (one of which is a positive pressure type), harnesses, and lifelines shall watch at all times from the outside. At least one more person should be available to assist in an emergency.

(h) General Housekeeping

Employers shall ensure that proper maintenance of equipment is provided to minimize the accidental escape of refined petroleum liquid solvent or vapor. Cleanup of spills and repair of equipment and leaks shall be performed as soon as practical.

(i) Specific Operations

For specific information concerning operations such as spray finishing, dip tank procedures and the design of open surface tank ventilation, appropriate regulations, such as 29 CFR 1910.94(c)(d), 29 CFR 1910.107, and 29 CFR 1910.108, shall be followed.

Section 7 - Sanitation Practices

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

(b) Food or beverage preparation, storage, dispensing (including vending machines), and consumption shall be prohibited in work areas where any refined petroleum solvents are present.

(c) Smoking shall be prohibited in areas where refined petroleum solvents are used, transferred, stored, or manufactured.

(d) Adequate facilities with soap and water for handwashing shall be made available. If soap and water are inadequate, the employer shall provide appropriate substitutes. Skin cleansing with refined petroleum solvents shall be prohibited.

Section 8 - Monitoring and Recordkeeping

(a) Survey Requirements

Workers are not considered to have occupational exposure to refined petroleum solvents if environmental concentrations, as determined on the basis of an industrial hygiene survey, do not exceed the action level. Surveys shall be repeated at least once a year and within 30 days after any process change likely to result in increases of airborne refined petroleum

solvent concentrations. Records of these surveys, including the basis for concluding that concentrations of airborne refined petroleum solvents are at or below the action level, shall be maintained. If there is occupational exposure to refined petroleum solvents, then the following requirements shall apply:

(b) Personal Monitoring

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

(2) In all personal monitoring, samples of airborne refined petroleum solvents shall be collected that, when analyzed, will provide an accurate representation of the concentration of the refined petroleum solvent or solvents in the air breathed by the worker. Procedures for sampling and analysis of refined petroleum solvents shall be as provided in Appendices III and IV, or by any method shown to be at least equivalent in

precision and sensitivity to the methods specified.

(3) For each TWA determination, a sufficiently large number of samples shall be taken and analyzed to permit construction of valid estimates of TWA and ceiling concentration exposures of employees during each work shift. Variations in work and production schedules shall be considered in deciding when and how many samples are to be collected. The number of representative TWA and ceiling concentration determinations for an operation or process shall be based on such factors as variations in location and job functions of employees in that operation or process.

(c) Recordkeeping

Records of environmental monitoring shall be kept by the employer for at least 30 years. These records shall include the dates of measurements, job function and location of the employees at the worksite, sampling and analytical methods used, number, duration, and results of the samples taken, TWA and ceiling concentrations estimated from these samples, type of personal protective equipment used, and exposed employees' names. Each employee shall have access to information on his or her own environmental exposures. Environmental records shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare. Pertinent medical records shall be retained by the employer for 30 years after employment has ended. Records of environmental exposures applicable to an employee should be included in that employee's medical records. These medical records shall be made 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 or injury from workplace exposure to refined petroleum solvents. 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 and to provide for the safety of employees exposed to hazardous chemical and physical agents. The criteria and recommended standard should enable management and labor to develop better engineering controls and more healthful work practices and should not be used as a final goal.

These criteria for a standard for refined petroleum solvents are part of a continuing series of documents developed by NIOSH. The recommended standard applies to workplace exposure to petroleum solvents arising from the processing, manufacture, use, and handling of solvents 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 general

occupational exposures is not warranted. It is intended to (1) prevent injury from refined petroleum solvents, (2) be measurable by techniques that are valid, reproducible, and available to industry and official agencies, and (3) be attainable with existing technology.

Since petroleum ether, rubber solvent, and varnish makers' and painters' naphtha contain substantial amounts of C5-C8 alkanes, the possibility that exposure to these solvents could cause polyneuropathy must be recognized. Therefore, the recommended standards for these solvents reflect data and recommendations cited in the NIOSH document entitled Criteria for a Recommended Standard....Occupational Exposure to Alkanes.

The analytical method for refined petroleum solvents is recommended in Appendix IV. Additional suggestions have been made that may be helpful in adapting this method for specific analyses. It is nearly impossible, however, to prescribe gas-chromatographic conditions that will result in adequate analytical determinations in all cases. The success of the method will ultimately depend on how well the analyst adapts the chromatographic conditions to suit the analysis of the particular refined petroleum solvent that is being tested.

Although many reports were found and reviewed on "solvent" toxicity, many investigations failed to chemically describe the type of solvent used in their studies. In future experiments, it is important for the physical and chemical characteristics of a solvent, such as boiling range, flashpoint, and total aromatic as well as benzene content, to be given so that the solvent can be adequately defined. Additional toxicologic experiments are necessary for all the solvents examined in this document, and they should include studies on the effects of solvent vapor inhalation



on both animals and humans. Possible teratogenic, mutagenic, and carcinogenic potential of these solvents also need to be assessed. In addition, long-term epidemiologic studies should be undertaken to evaluate solvent toxicity and to correlate the observed effects with the data on the concentrations of the solvents to which workers are exposed during normal working conditions. More specific and efficient sampling devices should be designed and new and improved analytical procedures need to be developed for personal, automatic, and continuous monitoring systems.