NIOSH/OSHA STANDARDS COMPLETION PROGRAM

DRAFT TECHNICAL STANDARD AND

SUPPORTING DOCUMENTATION FOR

*** TETRACHLOROETHYLENE ***

NIOSH/OSHA Draft Technical Standard and Supporting Documentation for TETRACHLOROETHYLENE

The basic text of this document contains the draft technical standard approved by the Joint Review Committee of the NIOSH/OSHA Standards Completion Program and the supporting documentation for the substance TETRACHLOROETHYLENE.

The SCP draft technical standards are recommendations to the Department of Labor for its consideration in rulemaking and have no legal status until final rules have been promulgated by that agency. This draft standard is provided for your information only.

The References and Sources, Respirator Table Documentation and Use/Exposure and Control Documentation are the working documents used by the various SCP working groups during the development of the draft technical standard and serve as the technical foundation for the standard. The classification for each substance and the regulatory statements were derived following a decision logic established for the various sections of the standard.

(a) Definitions. (1) "Permissible exposure" means exposure of employees to airborne concentrations of tetrachloroethylene not in excess of 100 parts per million (ppm) averaged over an eight-hour work shift (time weighted average) and not in excess of 200 parts per million (ppm) at any time during an eight-hour work shift except that an exposure not in excess of 300 parts per million (ppm) at any aggregate of 5 minutes in any 3 hours shall be permitted as stated in § 1910.1000, Table Z-2.

(2) "Action level" means one half of the permissible exposure for tetrachloroethylene for an eight-hour work shift.

(b) Exposure determination and measurement. (1) Each employer who has a place of employment in which tetrachloroethylene is released into the workplace air shall determine if any employee may be exposed to airborne concentrations of tetrachloroethylene at or above the action level. The determination shall be made each time there is a change in production, process, or control measures which could result in an increase in airborne concentrations of tetrachloroethylene.

(2) A written record of the determination shall be made and it shall contain at least the following information:

(i) Any information, observations, or calculations which may indicate employee exposure to tetrachloroethylene;

(ii) Any measurements of tetrachloroethylene taken;

(iii) Any employee complaints of symptoms which may be attributable to exposure to tetrachloroethylene; and

(iv) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered.

(3) If the employer determines that any employee may be exposed to tetrachloroethylene at or above the action level, the exposure of the employee in each work operation who is believed to have the greatest exposure shall be measured. The exposure measurement shall be representative of the maximum eight-hour time weighted average exposure of the employee.

(4) If the exposure measurement taken pursuant to paragraph (b)(3) of this section reveals employee exposure to tetrachloroethylene at or above the action level, the employer shall:

(i) Identify all employees who may be exposed at or above the action level; and

(ii) Measure the exposure of the employees so identified.

(5) If an employee exposure measurement reveals that an employee is exposed to tetrachloroethylene at or above the action level, but not above the permissible exposure, the exposure of that employee shall be measured at least every two months.

(6) If an employee exposure measurement reveals that an employee is exposed to tetrachloroethylene above the permissible exposure, the employer shall:

(i) Measure the exposure monthly of the employee so exposed; and

(ii) Institute control measures as required by paragraph (d) of this section.

(iii) Individually notify, in writing, within five days, every employee who is found to be exposed to tetrachloroethylene above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce the exposure to at or below the permissible exposure.

(7) If two consecutive employee exposure measurements taken at least one week apart reveal that the employee is exposed to tetrachloroethylene below the action level, the employer may terminate measurement for the employee.

(8) For purposes of this paragraph, employee exposure is that which would occur if the employee were not using a respirator.

(c) Methods of measurement. (1) An employee's exposure shall be obtained by any combination of long term or short term samples which represents the employee's actual exposure averaged over the time periods appropriate to the permissible exposure (See Appendix B (iv) of this section).

(2) The method of measurement shall have an accuracy, to a confidence level of 95 percent, of not less than that given in Table 1.

Table 1

Concentration	Required Accuracy
Above permissible exposure	± 25%
At or below permissible exposure and above the action level	± 35%
At or below the action level	± 50%

(d) Compliance. (1) No employee shall be exposed to tetrachloroethylene above the permissible exposure as defined in paragraph (a)(1) of this section.

(2) Employee exposures to airborne concentrations of tetrachloroethylene shall be controlled to at or below the permissible exposure by engineering and work practice controls:

(i) Engineering and work practice controls shall be instituted to reduce exposures to at or below the permissible exposure, except to the extent that such controls are not technically feasible.

(ii) Wherever engineering and work practice controls are not sufficient to reduce exposures to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators in accordance with paragraph (d)(4) of this section.

(3) Engineering controls. (i) When mechanical ventilation is used to control exposure, measurements which demonstrate system effectiveness, for example, air velocity, static pressure, or air volume, shall be made at least every three months. Measurements of system effectiveness shall also be made within five days of any change in production, process, or control which might result in an increase in airborne concentrations of tetrachloroethylene.

(ii) In the design of open surface tank ventilation for the purposes of § 1910.94(d), operations involving tetrachloroethylene shall be classified as B-1 at 70 degrees F.

(4) Compliance with the permissible exposure shall not be achieved by the use of respirators except:

(i) During the time period necessary to install or implement engineering or work practice controls; or

(ii) In work situations in which engineering and work practice controls are technically not feasible; or

(iii) To supplement engineering and work practice controls when such controls fail to reduce airborne concentrations of tetrachloroethylene to at or below the permissible exposure; or

(iv) For operations which require entry into tanks or closed vessels; or

(v) In emergencies.

(5) Where respirators are needed and permitted under this paragraph to reduce employee exposure, the employer shall select and provide the appropriate respirator from Table 2 and shall ensure that the employee uses the respirator provided.

TABLE 2 RESPIRATORY PROTECTION FOR TETRACHLOROETHYLENE

CONDITION	PERMISSIBLE RESPIRATORY PROTECTION
Vapor Concentration	
500 ppm or less	Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s).
	A gas mask with a chin-style or a front- or back-mounted organic vapor canister.
	Any supplied-air respirator with a full facepiece, helmet or hood.
	Any self-contained breathing apparatus with a full facepiece.
Greater than 500 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
	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.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure - demand or other positive pressure mode.

Escape	Any gas mask providing protection against organic vapors.
	Any escape self-contained breathing apparatus.

(6) Respirators shall be approved by the Mining Enforcement and Safety Administration (formerly Bureau of Mines) or by the National Institute for Occupational Safety and Health under the provisions of 30 CFR Part 11.

(7) The employer shall institute a respiratory protection program in accordance with § 1910.134(b), (d), (e), and (f).

(e) Fire and safety. (1) The employer shall familiarize himself with the information contained in the Substance Technical Guidelines (Appendix B of this section) for tetrachloroethylene.

(2) Tetrachloroethylene shall be stored so as not to come in contact with strong oxidizers or chemically active metals.

(f) Personal protective equipment. (1) Employers shall provide and ensure that employees use impervious clothing, gloves, face shields (eight-inch minimum) and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with liquid tetrachloroethylene. Face shields shall comply with § 1910.133(a)(2),(a)(4), (a)(5), and (a)(6).

(2) Employers shall ensure that clothing wet with liquid tetrachloroethylene is placed in closed containers for storage until it can be discarded or until the employer provides for the removal of tetrachloroethylene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the tetrachloroethylene, the employer shall inform the person performing the operation of the hazardous properties of tetrachloroethylene.

(3) Employers shall ensure that non-impervious clothing which becomes contaminated with liquid tetrachloroethylene be removed promptly and not reworn until the tetrachloroethylene is removed from the clothing.

(4) Employers shall provide and ensure that employees use splash-proof safety goggles (cup-cover type dust and splash safety goggles) which comply with § 1910.133 (a)(2)-(a)(6) where liquid tetrachloroethylene may contact the eyes.

(g) Spills and disposal. In the event that liquid tetrachloroethylene is spilled the employer shall immediately provide available ventilation and then clean up the spill.

(h) Sanitation. (1) Employers shall ensure that employees whose skin becomes contaminated with liquid tetrachloroethylene promptly wash or shower with soap and mild detergent and water to remove any tetrachloroethylene from the skin.

(2) Employers shall ensure that employees who handle liquid tetrachloroethylene wash their hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.

(i) Training and information. (1) Each employer who has a workplace in which tetrachloroethylene is present shall keep a copy of this regulation with Appendixes A, B and C at the workplace. This material shall be made readily available to affected employees.

(2) Each employer who has employees exposed to tetrachloroethylene above the action level or employees who may have skin or eye contact with liquid

tetrachloroethylene, or employees who work where a spill of tetrachloroethylene may occur, shall annually:

(i) Inform affected employees of the information contained in the Substance Safety Data Sheet for tetrachloroethylene (Appendix A of this section);

(ii) Advise affected employees as to the signs and symptoms of exposure to tetrachloroethylene.

(iii) Instruct affected employees to advise the employer of the development of signs and symptoms of exposure to tetrachloroethylene which are listed in Appendix A of the section; and

(iv) Provide training to ensure that employees understand the precautions of safe use, emergency procedures, and the correct use of protective equipment relative to tetrachloroethylene.

(j) Medical Surveillance. (1) The employer shall provide medical procedures as required by this paragraph. All medical procedures shall be performed by or under the supervision of a physician at no cost to the employee.

(2) The employer shall make available to each employee who is to be exposed to liquid tetrachloroethylene or airborne concentrations of tetrachlorpethylene at or above the action level, without regard to the use of respirators, a medical examination which shall include the following:

(i) A medical history and physical examination with emphasis on the liver and skin.

(ii) A profile of liver function.

(iii) Urinalysis to include specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

(3) The employer shall obtain from the physician, as a record of the examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) A record of the results of liver function tests.

(iii) A record of the results of urinalysis.

(4) The employer shall make available to each employee, exposed to tetrachloroethylene in excess of the action level at 12 months from the date of the employee's first exposure, and at every 12 months of exposure in acces of the action level thereafter, a medical examination which must include the following:

(i) A medical history and physical examination (see paragraph (j)(2)(i) of this section).

(ii) A profile of liver function.

(iii) Urinalysis (see paragraph (j)(2)(iii) of this section.

(5) The employer shall obtain from the physician, as a record of the periodic examination, the following information:

(i) A written opinion which conforms with paragraph (j)(7) of this section.

(ii) A record of the results of liver function tests.

(iii) A record of the results of urinalysis.

(6) The employer shall provide to the examining physician the following information:

(i) A copy of this regulation with its Appendixes A, B, and C for tetrachloroethylene;

(ii) A description of the employee's duties as they relate to his exposure to tetrachloroethylene;

(iii) A description of any personal protective equipment and respirators required to be used;

(iv) The results of any measurement which may indicate the affected employee's exposure;

(v) The affected employee's anticipated exposure; and

(vi) Upon request of the physician, any available information from previous medical examination of the affected employee.

(7)(i) The physician's written opinion shall be a signed statement by the examining physician specifically stating: (A) Whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to tetrachloroethylene or would directly or indirectly aggravate any detected medical condition;

(B) Any recommended limitations upon the employee's exposure to tetrachloroethylene, including limitations upon the use of personal protective equipment and respirators;

(C) That the employee has been informed by the physician of any detected medical conditions which require further medical examination or treatment.

(ii) The physician's written opinion shall not reveal specific medical findings or diagnoses unrelated to exposure to tetrachloroethylene.

(iii) The employer shall provide the employee with a copy of the physician's written opinion.

(8) No employee shall be exposed to liquid tetrachloroethylene or airborne concentrations of tetrachloroethylene in such a way as would put the employee at increased risk of material impairment of his health from such exposure. This determination may be based on the physician's written opinion.

(9) The employer shall provide emergency and follow-up medical examinations and treatment for any employee injured through exposure to tetrachloroethylene.

(10) If the examining physician chooses to use alternative medical examinations to those specified in paragraphs (j)(2) and (4) of this section, the employer may accept such alternative medical surveillance examinations as meeting the requirements of this part provided that the employer:

(i) Obtains a statement from the examining physician setting forth the alternative medical examinations and the rationale for substitution and evidence that they will be equally effective.

(ii) Informs each exposed employee of the fact that alternative medical examinations to those required in paragraphs (j)(2) or (4) of this section are to be made available.

(11) If an employee refuses any required medical examination, the employer shall inform the employee of the possible health consequences of such refusal and obtain a signed statement from the employee indicating that the employee understands the risks involved by refusing to be examined.

(12) No medical procedure which would be performed pursuant to this section need be performed if records of a previous such procedure performed within the past six months are acceptable to the examining physician.

(k) Recordkeeping. (1) Exposure determination. (i) The employer shall keep an accurate record of all determinations required to be made pursuant to paragraph (b)(1) of this section.

(ii) The record shall include the written determination required in paragraph (b)(2) of this section.

(iii) This record shall be maintained until replaced by a more recent record.

(2) Exposure measurements. (i) The employer shall keep an accurate record of all measurements taken to determine employee exposure to tetrachloroethylene.

(ii) This record shall include:

(A) The date of measurement;

(B) Operations involving exposure to tetrachloroethylene which are being monitored;

(C) Sampling and analytical methods used and evidence of their accuracy, including the method, results and date of calibration of sampling equipment;

(D) Number, duration, and results of samples taken; and

(E) Name, social security number and exposure of the employee monitored.

(iii) This record shall be maintained until replaced by a more recent record but in no event for less than one year.

(3) Mechanical ventilation. (i) When mechanical ventilation is used as an engineering control, the employer shall maintain an accurate record of the measurements demonstrating the effectiveness of such ventilation required by paragraph (d)(3) of this section.

(ii) This record shall include:

(A) Date of measurement;

(B) Type of measurement taken;

(C) Result of measurement.

(iii) These records shall be maintained for at least one year.

(4) Employee training and information. (i) The employer shall keep an accurate record of all employee training and information required by paragraph (i) of this section.

(ii) This record shall include:

(A) Date of training;

(B) Name and social security number of employee trained;

(C) Content or scope of training provided.

(iii) This record shall be maintained until replaced by a more recent record.

(5) Medical surveillance. (i) The employer shall keep an accurate record of employee medical surveillance required by paragraph (j) of this section.

(ii) The record shall include:

(A) Results of tests required by paragraph (j)(2) and (j)(5) of this section;

(B) Any employee medical complaints relative to exposure to tetrachloroethylene;

(C) A copy of information provided to the physician pursuant to paragraph (j)(6)(ii), (iii), (iv), (v), and (vi) of this section.

(D) Physician's written opinion; and

(E) A signed statement of any refusal to be examined.

(iii) This record shall be maintained for the duration of the employment of the affected employee.

(6) Access to records. (i) All records required to be maintained by this section shall be made available upon request to authorized representatives of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health.

(ii) Employee exposure determination and exposure measurement records required to be maintained by this section shall be made available to employees and former employees and their designated representatives.

(iii) Employee medical records required to be maintained by this section shall be made available upon written request to a physician designated by the employee or former employee.

(l) Employee observation of measurement. (1) The employer shall give affected employees or their representatives an opportunity to observe any measurement of employee exposure to tetrachloroethylene which is conducted pursuant to this section.

(2) When observation of measurement of employee exposure to tetrachloroethylene requires entry into an area where the use of personal protective devices, including respirators, is required, the observer shall be provided with and required to use such equipment and comply with all other applicable safety procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) Receive an explanation of the measurement procedure.

(ii) Visually observe all steps related to the measurement of the airborne concentration of tetrachloroethylene that are being performed at the place of exposure; and

(iii) Record the results obtained.

NOTE: The information contained in the following appendixes is advisory in nature and is not intended, by itself, to create any additional obligations not otherwise imposed or detract from any existing obligation.

APPENDIX A

SUBSTANCE SAFETY DATA SHEET FOR TETRACHLOROETHYLENE

I. SUBSTANCE IDENTIFICATION

A. Substance: Tetrachloroethylene

B. Permissible Exposure: 100 parts of tetrachloroethylene per million parts of air (ppm) averaged over an eight-hour work shift. Also, 200 ppm shall not be exceeded during an eight-hour work shift except that a peak of 300 ppm is permitted for 5 minutes in any 3 hours during the work shift.

C. Appearance and Odor: Colorless liquid with an odor like chloroform or ether.

II. HEALTH HAZARD DATA

A. Ways in Which the Chemical Affects Your Body: Tetrachloroethylene can affect your body if you inhale it or if it comes in contact with your eyes or skin. It may also affect your body if you swallow it.

B. Effects of Overexposure:

1. Short-Term Exposure: Tetrachloroethylene may cause headache, nausea, drowsiness, dizziness, incoordination and unconsciousness. It may also cause irritation of the eyes, nose and throat and flushing of the face and neck. In addition, it might cause liver damage with such findings as yellow jaundice and dark urine. The liver damage may become evident several weeks after the exposure.

2. Long-Term Exposure: Prolonged or repeated overexposure to liquid tetrachloroethylene may cause irritation of the skin. It might also cause damage to the liver and kidneys.

3. Reporting Signs and Symptoms: You should inform your employer if you develop any signs or symptoms and suspect that they are caused by exposure to tetrachloroethylene.

III. EMERGENCY FIRST AID PROCEDURES

A. Eye Exposure: If tetrachloroethylene gets into your eyes, wash the eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation persists after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

B. Skin Exposure: If tetrachloroethylene gets on your skin, promptly wash the contaminated skin using soap or mild detergent. If tetrachloroethylene soaks through your clothing, remove the clothing promptly and wash the skin using soap or mild detergent. If irritation persists after washing, get medical attention.

C. Breathing: If you or any other person breathes in large amounts of tetrachloroethylene move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

D. Swallowing: When tetrachloroethylene has been swallowed, get medical attention immediately. If medical attention is not immediately available, get the person to vomit by having him touch the back of the throat with his finger or by giving him large amounts (one pint or more) of warm salt water (two tablespoons of salt per pint of water). Do not make an unconscious person vomit.

E. Rescue: Move affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the locations of the equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

A. Respirators: Respirators are not the best way to control exposure to tetrachloroethylene. You can only be required to wear them for routine use if your employer is in the process of installing controls or control measures prove inadequate. You may be required to wear respirators for non-routine activities or in emergencies. If respirators are worn, they must have a Mining Enforcement and Safety Administration (MESA) or National Institute for Occupational Safety and Health (NIOSH) approval label. (Older respirators may have a Bureau of Mines approval label.) For effective protection, respirators must fit your face and head snugly. Respirators should not be loosened or removed in work situations where there use is required. If you can smell tetrachloroethylene while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

B. Protective Clothing: You must wear impervious clothing, gloves, face shield or other appropriate protective clothing to prevent repeated or prolonged skin contact with liquid tetrachloroethylene. Replace or repair impervious protective clothing that has developed leaks.

C. Eye Protection: You must wear splash-proof safety goggles (cup-cover type dust and splash safety goggles) where eye contact to liquid tetrachloroethylene may occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING AND STORAGE

A. Tetrachloroethylene must be stored in tightly closed containers in a well-ventilated area away from strong oxidizers and chemically active metals.

B. You must promptly remove any non-impervious clothing that becomes contaminated with liquid tetrachloroethylene and this clothing must not be reworn until the tetrachloroethylene is removed from the clothing.

C. If your skin becomes contaminated with liquid tetrachloroethylene, you must promptly wash or shower with soap or mild detergent to remove the tetrachloroethylene from your skin.

D. If you handle liquid tetrachloroethylene, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking or using toilet facilities.

E. Ask your supervisor where tetrachloroethylene is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

A. Each year your employer is required to inform you of the information contained in this Substance Safety Data Sheet for tetrachloroethylene. In addition, your employer must instruct you in the safe use of tetrachloroethylene, emergency procedures, and the correct use of protective equipment.

B. Your employer is required to determine whether you are being exposed to tetrachloroethylene. You or your representative have the right to observe employee exposure measurements and to record the results obtained. If your employer determines that you are being overexposed, he is required to inform you of the exposure and of the actions which are being taken to reduce your exposure.

C. Your employer is required to keep records of exposure determinations, exposure measurements, and medical surveillance. Your employer is required to make records of exposure determinations and your exposure measurements available to you or your representative upon your request. Your employer is required to release your medical records to your physician upon your written request.

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APPENDIX B

SUBSTANCE TECHNICAL GUIDELINES
FOR TETRACHLOROETHYLENE

I. PHYSICAL AND CHEMICAL DATA

A. Substance Identification

1. Synonyms: Perchloroethylene; perchlorethylene; tetrachlorethylene; perk
2. Formula: $CCl_2 = CCl_2$
3. Molecular weight: 165.85

B. Physical Data

1. Boiling point (760 mm Hg): 121.2 C (250 F)
2. Specific gravity (water = 1): 1.62
3. Vapor density (air = 1 at boiling point of tetrachloroethylene): 5.83
4. Melting point: -22.4 C (-8 F)
5. Vapor pressure at 20 C (68 F): 14 mm Hg
6. Solubility in water, % by weight at 20 C (68 F): 0.015
7. Evaporation rate (butyl acetate = 1): 2.8
8. Appearance and odor: Colorless liquid with an odor like chloroform or ether

II. FIRE, EXPLOSION AND REACTIVITY HAZARD DATA

A. Fire

1. Not combustible

B. Reactivity

1. Conditions contributing to instability: Heat.
2. Incompatibilities: Reacts with strong oxidizers and chemically active metals such as barium, lithium and beryllium.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, phosgene and carbon monoxide) may be released when tetrachloroethylene decomposes.
4. Special precautions: Liquid tetrachloroethylene will attack some forms of plastics, rubber and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

A. If tetrachloroethylene is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth or a similar material.

B. Persons not wearing protective equipment should be restricted from areas of spills or leaks until cleanup has been completed.

C. Waste disposal methods: Tetrachloroethylene may be disposed of by absorbing in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure Above the Action Level:

1. Eight hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken such that the average eight-hour exposure may be determined from a single sample or two (2) four-hour samples. Short term samples (up to 30 minutes) may also be used to determine average exposure level if a minimum of five (5) measurements are taken in a random manner over the eight-hour work shift. Random sampling means that any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all such random equal duration samples taken on one (1) work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).
2. Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of tetrachloroethylene in the employee's breathing zone. A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.
3. Peak Above Ceiling Evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentration of tetrachloroethylene. Each measurement should consist of a 5-minute sample or series of consecutive samples totaling five (5) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.
4. Monitoring Techniques: The sampling and analyses under this section may be performed by instruments such as: detector tubes certified by NIOSH under 42 CFR Part 84, portable direct-reading instruments, dosimeters, or gas and vapor adsorption tubes with subsequent chemical analyses. The method of measurement must determine the concentration of tetrachloroetylene to plus or minus 35%.

B. Exposure Above the Permissible Exposure: The monitoring and measurements under this section should be essentially the same described under paragraph (IV)(A). When sampling for peak exposure evaluations, more than three (3) measurements should be taken during the work shift so that increased confidence may be placed in the judgement that the employee has or has not, in fact, been exposed in excess of the permissible limit. Laboratories performing chemical analyses

should be accredited in Industrial Hygiene Chemistry by the American Industrial Hygiene Association. The method of measurement must determine the concentration of tetrachloroethylene to plus or minus 25%.

C. Methods: Methods meeting the above accuracy requirements are available from NIOSH.

D. Qualified Persons: Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. MISCELLANEOUS PRECAUTIONS

A. Store tetrachloroethylene in tightly closed containers in a well ventilated area.

B. High exposures to tetrachloroethylene can occur when transferring the liquid from one container to another.

C. Employers should advise employees of all areas and operations where exposure to tetrachloroethylene could occur.

VI. COMMON OPERATIONS

Common operations in which exposure to tetrachloroethylene is likely to occur are: during its production and its use as solvent for dry cleaning, vapor degreasing, cold cleaning, paint removers, adhesives, detergents and inks; for the extraction of oils from pharmaceuticals and in the processing and finishing of textiles; and as an intermediate in the manufacture of fluorocarbons.

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APPENDIX C - MEDICAL SURVEILLANCE GUIDELINES

I. ROUTE OF ENTRY

Inhalation.

II. TOXICOLOGY

Tetrachloroethylene vapor is a narcotic. Rats did not survive when exposed for longer than 12-18 minutes to 12,000 ppm; when exposed repeatedly to 470 ppm they showed liver and kidney injury. Cardiac arrhythmias attributed to sensitization of the myocardium to epinephrine have been observed with certain other chlorinated hydrocarbons, but exposure of dogs to concentrations of 5000 and 10,000 ppm of tetrachloroethylene did not produce this phenomenon. Four human subjects were unable to tolerate 5000 ppm in a chamber for 6 minutes. They experienced vertigo, nausea, and mental confusion during the ten minutes following cessation of exposure. In an industrial exposure to an average concentration of 275 ppm for 3 hours, followed by 1100 ppm for 30 minutes, a worker lost consciousness; there was apparent clinical recovery one hour after exposure but the monitored concentration of tetrachloroethylene in the patient's expired air diminished slowly over a 2 week period. During the second and third post-exposure weeks, the results of liver function tests became abnormal, suggesting that acute exposure had had a significant effect upon the liver. Other instances of liver injury following industrial exposure have been reported. Other effects on humans of inhalation of various concentrations are as follows: 2000 ppm, mild narcosis within 5 minutes; 600 ppm, sensation of numbness around the mouth, dizziness and some incoordination after 10 minutes. In human experiments, 7 hour exposures at 100 ppm resulted in mild irritation of the eyes, nose, and throat; flushing of the face and neck; headache; somnolence; and slurring speech. Exposure of the skin to the liquid for 40 minutes resulted in a progressively severe burning sensation beginning within 5 to 10 minutes and this produced marked erythema, which subsided after 1 to 2 hours. The liquid sprayed into rabbits' eyes produced immediate pain and blepharospasm; patches of epithelium were lost but the eyes recovered completely within 2 days.

III. SIGNS AND SYMPTOMS

Irritation of eyes, nose, throat; nausea; flushing of the face and neck; vertigo, dizziness, incoordination, headache, somnolence; erythema of skin from repeated or prolonged contact with liquid. Signs and symptoms of liver involvement may occur.

IV. SPECIAL TESTS

Breath analysis for tetrachloroethylene.

V. TREATMENT

Remove from exposure. Flush eyes with water and wash skin with soap and water. If swallowed and the person is conscious, induce vomiting. Give artificial resuscitation if indicated. Recovery is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. GENERAL

Most reported effects of tetrachloroethylene are caused by its narcotic properties. Liver function abnormalities after exposure have been reported. It is important that the physician become familiar with plant operating conditions in which exposure to tetrachloroethylene occurs. Those with skin disease may not tolerate the wearing of protective clothing and those with chronic respiratory disease may not tolerate the wearing of negative pressure respirators.

B. PREPLACEMENT

The following medical procedures must be made available to each employee who is exposed to tetrachloroethylene:

1. A complete history and physical examination -- The purpose is to detect preexisting conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of liver should be stressed. The skin should be examined for evidence of chronic disorders.

2. Liver function tests -- Tetrachloroethylene may cause liver damage. A profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

3. Urinalysis -- Since kidney damage has also been observed from exposure, a urinalysis shall be obtained to include specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

C. PERIODIC EXAMINATIONS

The above medical examinations are to be repeated on an annual basis.

References

1. American Conference of Governmental Industrial Hygienists: "Perchloroethylene (Tetrachloroethylene)," Documentation of the Threshold Limit Values for Substances in Workroom Air (3d ed., 2d printing), Cincinnati, 1974, p. 201.

2. Hygienic Guide Series: "Tetrachloroethylene (Perchlorethylene)," American Industrial Hygiene Association Journal, 26:640-643, 1965.

3. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II - Toxicology (2d ed. revised), Interscience Publishing Company, New York, 1963, pp. 1314-1317.

4. von Oettingen, W. F.: The Halogenated Aliphatic, Olefinic, Cyclic, Aromatic, and Aliphatic-Aromatic Hydrocarbons Including the Halogenated Insecticides, Their Toxicity and Potential Dangers, U.S. Public Health Service Publication No. 414, U.S. Government Printing Office, Washington, D.C., 1955, pp. 227-235.

5. Reinhardt, C. F., et al: "Epinephrine-Induced Cardiac Arrhythmia Potential of Some Common Industrial Solvents," Journal of Occupational Medicine, 15:953-955, 1973.

6. Browning, Ethel: Toxicity and Metabolism of Industrial Solvents, Elsevier Publishing Company, Amsterdam, 1965, pp. 213-219.

7. Stewart, R. D.: "Acute Tetrachloroethylene Intoxication," Journal of the American Medical Association, 208:1490-1492, May 26, 1969.

REFERENCES AND SOURCES
TETRACHLOROETHYLENE
1910.93

(d) Compliance - Open surface tank classification based on relative evaporation rate of 2.5 hours (from Doolittle)

(f) Personal Protective Equipment, and, (h) Sanitation

Eye: Grant, "Toxicology of the Eye;" "Tetrachloroethylene," Chemical Safety Data Sheet

Skin: Patty, "Industrial Hygiene and Toxicology;" Sax, "Dangerous Properties of Industrial Materials;" "Tetrachloroethylene," Commonwealth of Pennsylvania; Stewart et al., "Absorption of Carbon Tetrachloride, Trichloroethylene, Tetrachloroethylene, Methylene Chloride and 1,1,1-Trichloroethane Through the Human Skin," AIHA Journal, Sept. - Oct. 1964, p. 439

Ingestion: Browning, "Toxicity and Metabolism of Industrial Solvents;" Sax, "Dangerous Properties of Industrial Materials;" Gleason, "Clinical Toxicology of Commercial Products;" Stecher, "Merck Index"

COMMENTS

Eye - Classification: 2
Output statement numbers: 10
Exceptions: None

Grant reports "experimental momentary spraying of rabbit eyes with tetrachloroethylene from a pressurized fire extinguisher from a distance of one foot caused immediate pain and blepharospasm. The corneal epithelium became granular and optically irregular and patches of epithelium were lost, but the eyes recovered completely within two days." By analogy with trichloroethylene, it is concluded that a classification of 2 is appropriate.

Skin - Classification: 2
Output statement numbers: 2, 7b, 17g, 17i, 20a
Exceptions: None

Patty reports "incidental contact on open skin does not cause serious injury.". According to Sax, repeated or prolonged contact results in "dermatitis preceded by a reddening and burning and more rarely a blistering of the skin." Skin becomes dry and cracked due to removal of oils and is susceptible to infection. The Commonwealth of Pennsylvania reports "tetrachloroethylene is absorbed in appreciable amounts through unbroken skin" and may have serious consequences. Work by Stewart et al determined that human subjects experienced pain within 5 - 10 minutes of immersion of the thumbs in the solvent; the maximum pain (described as mild to moderate burning) was experienced within 15 - 20 minutes. Ten minutes after the 30 minute exposure, the pain persisted without decreased intensity; it gradually subsided one hour following exposure. One to two hours after exposure, the marked erythema subsided in all cases. An analysis of alveolar air concentration showed skin absorption. Stewart's data show a maximum, approximately constant range of concentrations at 20, 30

and 60 minutes post exposure (0.26 - 0.36, 0.26 - 0.35, 0.23 - 0.39 ppm respectively); a concentration of 0.16 - 0.26 ppm was measured 5 hours post exposure. A classification of 2 is concluded to be sufficient to prevent harmful exposures. The vapor pressure of the substance is 14 mm Hg at 20 C. It does not have a flashpoint. Analogy to trichloroethylene and its additional chlorine atom leads to the conclusion that flammability is not a problem. Statement 7b is utilized to prevent the taking home of clothing contaminated to the extent that a harmful exposure might occur.

Ingestion - Classification: 2
Output statement numbers: 20a
Exceptions: None

An oral LD50 for rabbits of 8120 mg/kg was reported by Browning. She continues, "vertigo, somnolence and disturbance of equilibrium appeared in cats at a level of 1 mg/kg." No toxic effects were found in dogs after dosages of 18 - 39 g/kg given as an emulsion. Merck lists an oral mouse LD50 of 8.85 g/kg. Gleason reports "tetrachloroethylene is given therapeutically for hookworms to adults by mouth in dosages of 1 - 4 ml." Some fatty degeneration of the liver and kidney damage has been noted. Because of its relatively low vapor pressure, it is concluded that a classification of 2 is appropriate.

SUBSTANCE TECHNICAL GUIDELINES

The references cited for this document include:

Manufacturing Chemists Association, Chemical Safety Data Sheet SD-24 (MCA)
Stauffer Chemical Co., "Stauffer Chlorinated Hydrocarbons" (Stauffer)
Ethyl Corporation, "Ethyl Chlorinated Solvents" (Ethyl)
Dow Chemical USA, Material Safety Data Sheet (Dow)

Sources of data items used:

I. A. 1. Synonyms: MCA; Stauffer
2. Formula: MCA
3. Molecular weight: Stauffer
B. 1. Boiling point: MCA; Stauffer
2. Specific gravity: MCA
3. Vapor density: Stauffer
4. Melting point: MCA; Stauffer
5. Vapor pressure: MCA; Stauffer
6. Solubility in water: Stauffer
7. Evaporation rate: Stauffer
8. Appearance and odor: MCA

II. B. 1. Conditions contributing to instability: ADL
2. Incompatibilities: none
3. Hazardous decomposition products: MCA
4. Special precautions: ADL

III. A. Steps if released or spilled: MCA
C. Waste disposal method: MCA; Dow

V. Miscellaneous precautions: MCA; Stauffer

USE/EXPOSURE AND CONTROL DOCUMENT

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for TETRACHLOROETHYLENE

References used in the preparation of this document include:

Browning, E., "Toxicity and Metabolism of Industrial Solvents," Elsevier Publishing Co., 1965 (Browning)

"Chemical Abstracts," American Chemical Society, Vol. 66 - 77, 1967 - 1972 (CA)

Chemical Engineering, "Perchloroethylene," 6/24/74 (Chem Eng)

"Chlorinated Solvents," Ethyl Corporation, Industrial Solvents Division (Ethyl)

Considine, D. M., "Chemical and Process Technology Encyclopedia," McGraw Hill, 1974 (Considine)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 1954 (Chem Tech)

Kirk, R. and Othmer, D., "Encyclopedia of Chemical Technology," Interscience Publishers, 1972 (K-O)

Mellan, I., "Source Book of Industrial Solvents," Vol. II, Reinhold Publishing Corp., 1957 (Mellan)

"Perchloroethylene," Chemical Data Sheet No. 27, Mass. Department of Labor and Industries, Feb. 1974 (Perchloroethylene)

"Perchloroethylene," Chemical Safety Data Sheet, Manufacturing Chemists Assoc. (CSDS)

Stanford Research Institute, "Chemical Economics Handbook" (SRI)

"Tetrachloroethylene," Hazard Process Index, Hazard Entry #182, NIOSH HSM-99-73-62 (HPI)

"Tetrachloroethylene," American Conference of Government Industrial Hygienists, Hygienic Guide Series, June 1960 (Hygienic Guide)

References for Specific Use/Exposure

1. Considine, K-O, SRI
2. Chem Tech, Considine, Ethyl
3. Considine, HPI, SRI
4. Browning, CA, SRI
5. Considine, HPI, SRI
6. Chem Tech, Considine, K-O
7. CA, Chem Eng., Chem Tech, HPI, SRI
8. Mellan, SRI
9. Considine, Ethyl, Hygienic Guide
10. Perchloroethylene
11. Chem Tech, SRI

References for Specific Control Methods

1. CSDS, Ethyl
2. CSDS, Ethyl
3. ADL estimate, Ethyl
4. CSDS, Ethyl
5. Ethyl, HPI
6. CSDS, Ethyl
7. CSDS, Ethyl
8. Ethyl
9. CSDS, Ethyl
10. Perchloroethylene, CSDS
11. CSDS

NIOSH/OSHA Draft Technical Standard
and Supporting Documentation for TETRACHLOROETHYLENE

RESPIRATOR TABLE DOCUMENTATION

Substance: Tetrachloroethylene

D. O. L. Standard: 100 ppm, where 200 ppm shall not be exceeded except that a peak is permitted of 300 ppm for 5 minutes during any 3 hours.

WARNING PROPERTIES:

Odor Threshold: Both Staub and Stern state that 50 ppm is the odor threshold for tetrachloroethylene.

Eye Irritation Level: Grant reports that "exposure to high concentrations of (tetrachloroethylene) vapor causes mild sensation of irritation to the eyes, but serious injury is not likely." The exact concentrations producing irritation are not mentioned by Grant.

Spector, however, reports that after a 20 - 30 minute exposure to 206 - 235 ppm, eye irritation occurs in humans.

Patty reports "very slight irritation of the eyes" among humans at 106 ppm.

Other Information: Spector reports that a 10-minute exposure to 513 - 690 ppm produces nose and throat irritation.

Evaluation of Warning Properties: Since the odor threshold of tetrachloroethylene is below the permissible exposure limit, and since eye irritation occurs at a concentration only 2 times greater than the permissible exposure limit, the warning properties of tetrachloroethylene are considered to be adequate. Gas sorbent respiratory equipment is permitted.

IDLH: 500 ppm

Basis for IDLH Value: This IDLH is based upon the report by Spector that a 95-minute exposure to 1000 ppm produces "slight drunkenness, (but) no narcosis. Spector also states that a 20 to 30 minute exposure to 206-235 ppm tetrachloroethylene causes dizziness in humans. An IDLH of 500 ppm is used to prevent disorientation during escape.

Other Toxicological Information: Patty reports that the principal physiological response to an exposure to a high concentration of tetrachloroethylene is CNS depression. Gastrointestinal disturbances may be observed also. Chronic exposures to tetrachloroethylene may result in liver and kidney damage.

Patty states that "dizziness, inebriation and incoordination have been observed in industrial exposure." Patty mentions an investigation in which 7 cases of exposure to tetrachloroethylene were reported. The concentrations ranged between 232 and 385 ppm. Six men had "symptoms of headache, nausea, lightheadedness, dizziness, tiredness, hang-over, and a feeling of intoxication," and liver disfunction was observed in 3 of these 6 men. The seventh man "had a severe gastric hemorrhage and cirrhosis of the liver."

Spector, in summarizing the inhalation toxicity data of humans, reports that a 20- to 30-minute exposure to 206 - 235 ppm tetrachloroethylene causes "eye irritation, sinus congestion, nasal discharge, sleepiness (and) dizziness;" a 2-hour exposure to 206 - 356 ppm causes "headache, eye burning, sinus congestion, tongue thick, impaired coordination, (and) nausea;" a 10-minute exposure to 513 - 690 ppm causes "eye, throat, nose irritation, dizziness, oral numbness, loss (of) inhibition, (and)

some incoordination;" a 95-minute exposure to 1000 ppm produces "slight drunkeness, (but) no narcosis;" a 2-minute exposure to 930 - 1185 ppm causes "irritation of eyes, throat, (and) marked dizziness;" a 5-minute exposure to 2000 ppm produces slight narcosis.

In a study using experimental animals, one investigator mentioned by Patty noted that "2000 ppm were tolerated for up to 14 hours, 3000 ppm were tolerated for 4 hours." Several minutes of exposure to 6000 ppm and several hours at 2000 ppm produced unconsciousness in the animals.

Browning reports that Carpenter determined that a 4-hour exposure to 4000 ppm killed 2 - 4 out of 6 rats. A lethal dose for the rat for a 6 - hour exposure was determined to be 6000 ppm, and for 1.2 hours was determined to 20,000 ppm. 3700 ppm was lethal for the mouse, and "for the cat a 2 1/2 hour exposure to 16,200 ppm was not fatal, though it was fatal for one animal at 4100 ppm." Browning points out that some of the inhalation data are inconsistent.

USE/EXPOSURE AND CONTROL DOCUMENT
TETRACHLOROETHYLENE

	Use/Exposure	Principal Route of Entry	Currently Used Control Methods
1.	Inhalation of vapor and skin contact with liquid during use as a dry cleaning agent. (Professional shops, coin - operated dry cleaning establishments, industrial dry cleaning, double knit dry cleaning).	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves - when removing garments from machines)
2.	Inhalation of vapor and skin contact with liquid or vapor during use as a degreaser and cleaner of metal. Vapor degreasing - it is used where a high boiling point is advantageous (high melting pitches and waxes) and where moisture may be trapped in recesses (porous metals and pieces with deep recesses or blind holes - water vapor azeotropes off with the tetrachloroethylene vapors). Liquid degreasing - cold cleaning, electric portable degreasers, immersion degreasers, spray degreasers (electronic components, electroplating equipment)	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles)
3.	Inhalation of vapor during use as a chemical intermediate. Production of fluorocarbons, (dichlorotetrafluoroethane, trichlorotrifluoroethane, tetrachlorodifluoroethane) trichloroacetic acid, and intermediate for pesticides.	A	Process enclosure; local exhaust ventilation; general dilution ventilation
4.	Inhalation of vapor and skin contact with liquid during use in the processing and finishing of textiles	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves)

	(scouring, sizing, desizing, solvent for dyes, grease removal from furs, carrier for fabric finishes, resin solvent for fabric impregnations		
5.	Inhalation of vapor during manufacture and processing of tetrachloroethylene (majority is made by oxyhydrochlorination, chlorination or dehydrochlorination of other hydrocarbons or chlorinated hydrocarbons)	A	Process enclosure; local exhaust ventilation; general dilution ventilation
6.	Inhalation of vapor and skin contact with liquid during use as an extraction of oils from wet corn germ, extraction of pharmaceuticals during manufacture, extraction of fat from wet meat scraps, extraction of vegetable and mineral oils, sulfur extraction)	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves)
7.	Inhalation of vapor and skin contact with liquid during use as an industrial solvent (rubber industry - rubber solutions, manufacture of insulated wire; textile industry - cleaning operations; printing industry - printing ink blending; soap industry compounding detergents; soot removal; carrier solvent in paint removers, adhesives, rubber based cements)	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles)
8.	Inhalation of vapor and skin contact with liquid during manufacture and of equipment using tetrachloroethylene as a heat exchange fluid (high tension switches and transformers)	A,B	Local exhaust ventilation; general dilution ventilation

9.	Inhalation of vapor and skin contact with liquid during compounding and use of proprietary and safety solvents (mixture and azeotropes with other solvents to achieve specific properties - raise or eliminate flash points of fast evaporating solvents)	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, protective clothing, goggles)
10.	Inhalation of vapor and skin contact with liquid during cleaning and maintenance of storage vessels and during clean up of accidental spills	A,B	Local exhaust ventilation; general dilution ventilation; personal protective equipment (gloves, boots, respiratory protective devices)
11.	Inhalation of vapor and skin contact with liquid during miscellaneous applications (anthelmintic and vermifuge for humans and animals, aerosol spray for laundry treatment as a competitor of enzyme presoaks, drying medium for metal and wood in a process similar to degreasing)	A,B	Local exhaust ventilation; general dilution ventilation

A -- Inhalation
B -- Skin and eye contact resulting in localized irritation
C -- Ingestion
D -- Skin contact resulting in absorption and subsequent systemic poisoning

------ JES2 JOB STATISTICS ------

1,382 CARDS READ

0 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.00 MINUTES EXECUTION TIME

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