VI. WORK PRACTICES

Information concerning work practices for 1,1,1-trichloroethane can be found in the Manufacturing Chemists Association Safety Data Sheet SD-90. [15] Information on work practices for some specific uses is also available. [106,133]

(a) Transport, Handling, and Use

1,1,1-Trichloroethane may be stored in mild steel containers or, if there is excess moisture in the ambient air, in stainless steel or resin-lined containers. It can be decomposed to toxic and corrosive compounds including phosgene and hydrochloric acid by contact of liquid or vapor with open flame or red-hot surface, so it should be appropriately stored and handled to prevent such contact. [134,135] Damaged drums or other storage or transporting containers should not be welded until thoroughly purged with steam, flushed with water, and air dried. [136]

All piping and valves at the loading or unloading station should be of material resistant to 1,1,1-trichloroethane and should be carefully inspected prior to connection to the transport vehicle and periodically during the operation. Personal protective clothing must be provided during both inspection and connection. Information on imperviousness of some materials to 1,1,1-trichloroethane is available. [137] Eye wash and safety shower installations should be readily available in the immediate area. Signs indicating the location of safety showers and eye wash facilities should be prominently displayed throughout the work area. Unloading areas must be posted "DANGER: LOADING OR UNLOADING 1,1,1-TRICHLOROETHANE."

Due to the toxicity of 1,1,1-trichloroethane, processes in which it is used in large quantities should be carried out in closed systems. Well designed hoods and ventilation systems should be used to maintain exposures at or below concentrations specified by this recommended standard. Further protective measures include the use of personal protective equipment and clothing and purging of equipment prior to and during servicing and maintenance.

Safety showers are desirable and eye wash facilities are necessary in areas where 1,1,1-trichloroethane is handled. In locations where such facilities are not available, a container of water for emergency use must be kept with the first aid supplies.

(b) Equipment Maintenance

All equipment used for handling 1,1,1-trichloroethane must be emptied and purged prior to entry or disassembly. Steaming followed by washing with water is recommended for purging tanks and other containers which have held 1,1,1-trichloroethane. Pipe lines should be disconnected and capped. Under conditions where it is necessary to enter highly contaminated areas or otherwise work with 1,1,1-trichloroethane contaminated equipment, maintenance personnel must use either a self-contained breathing apparatus of the pressure demand mode, with an impervious protective suit, or a combination supplied air suit with auxiliary self-contained air supply. Ventilation should be continued during this time by blowing or drawing fresh air through the system. Safety precautions for emergency rescue require that all maintenance personnel be informed of the toxic properties of 1,1,1-trichloroethane and be instructed on the necessity of wearing personal protective equipment. Constant observation of anyone entering a

tank should be maintained in case rescue work is necessary.

(c) Emergencies

Spills must be anticipated. Storage tanks should be diked to contain the contents of the tank. Drum storage areas must also be diked to contain the volume of 1,1,1-trichloroethane present in the drums to prevent release to other areas. Areas where major spills are likely to occur should be constructed so that they may be closed until properly protected personnel can ventilate, enter, and clear the area. Warning signs must be posted so that unauthorized personnel will not enter the area. Normal work should not be continued until the concentration of 1,1,1-trichloroethane has been reduced to the recommended workplace environmental limit. Any combustion operations must be stopped until the spill is cleared. Disposal of 1,1,1-trichloroethane must be performed in compliance with local, state, and federal waste disposal regulations. Consideration should be given to pumping the diked spill to another tank. In addition, it is advisable to have facilities for transfer of the contents of a leaking tank to another suitable tank.

Areas in which small spills have occurred should be evacuated and well-ventilated. Small, portable fans may be used in confined areas where local exhaust ventilation is not feasible. Workers should not return to any work area if the odor of 1,1,1-trichloroethane is still perceptible without the concentration being determined first.

(d) Respiratory Protection

For adequate respiratory protection against the many conditions which may be encountered in individual operations, many types of respirators have been developed and approved. Each has a particular application and

limitations from the viewpoint of protection, as well as advantages and disadvantages from the viewpoint of operational procedures and maintenance. Detailed information on the selection and use of respirators can be obtained from the Respiratory Protection Devices Manual [138] published by the AIHA and the ACGIH in 1963. The American National Standards Practices for Resporatory Protection, ANSI Z88.2-1969, [139] also classifies, describes, and gives the limitations of respirators.

There are three categories of respirators: atmosphere-supplying respirators, air-purifying respirators, and combination atmosphere-supplying and air-purifying respirators.

One factor that affects the overall performance of demand-type (negative pressure) respirators is the variability of the face seal. Facepiece leakage is the major limitation of half-mask and quarter-mask facepieces operated with a negative pressure.

For uniform regulations covering the many face sizes and shapes of the US population, NIOSH recommends that the half-mask or quarter-mask facepieces operated with a negative pressure not be used for protection above 10 times the TWA environmental limit, although the majority of wearers can obtain protection in atmospheres of higher 1,1,1-trichloroethane concentrations. On the same basis, NIOSH recommends that the full facepiece, operated with negative pressure, may be used up to 50 times the TWA concentration limit. As eye irritation has been reported at concentrations of 500 ppm 1,1,1-trichloroethane, it is recommended that full facepiece respirators be used above this level. Due to the adequate warning nature of 1,1,1-trichloroethane, air-purifying respirators, such as the chemical cartridge type, may be used at concentrations less than 500

ppm. When significant and nonreversible health effects may occur, at 1,000 ppm and above, self-contained breathing apparatus or supplied-air respirators with a full facepiece must be used.

The maximum use concentration guides do not take into account the service life of the filters or absorbent canisters which also affect the performance of air-purifying respirators. The approval tests (under 30 CFR 11) for these two devices specify only carbon tetrachloride for the service life test. Based on recent tests by Nelson and Harder, [140] who tested standard respirator cartridges against many types of industrial organic solvents, it is now possible to estimate the service life of approved organic vapor canisters or cartridges against 1,1,1-trichloroethane. With a test concentration of 1,000 ppm of 1,1,1-trichloroethane, they reported that the standard organic vapor cartridge has a service life of 59 minutes before a breakthrough 100 ppm of 1,1,1-trichloroethane. Under the same test conditions, a service life of 90 minutes for carbon tetrachloride was obtained. The standard industrial size gas mask canister is tested against 20,000 ppm of carbon tetrachloride and it must have a service life of 12 minutes before a breakthrough of 5 ppm. Since it has been shown that charcoal can absorb 1.5 times as much carbon tetrachloride as 1,1,1-trichloroethane, it can be estimated that the service life for an industrial size canister is 150 minutes in an atmosphere of 1,000 ppm 1,1,1-trichloroethane.

NIOSH periodically issues a list of approved or certified respiratory protective devices. All devices approved by the Bureau of Mines are listed in Information Circular 8559 and supplements. All types of devices sertified by the Testing and Certification Laboratory of NIOSH are listed

in separate publications. These are available from the Testing and Certification Laboratory, NIOSH, Morgantown, West Virginia, 26505.

VII. RESEARCH NEEDS

Epidemiologic Studies

The evidence from epidemiologic studies is somewhat contradictory. Several studies [36,47,50,62,64] reported no adverse effects in man at concentrations of 100-800 ppm of 1,1,1-trichloroethane. Unfortunately, individual data is lacking in some, and experimental details are lacking in all of these studies.

Interpretation is further complicated by other studies [61,63] which report symptoms attributable to "substances used in the work environment," not necessarily 1,1,1-trichloroethane, at 10-250 ppm. These studies suffer from (1) exposure to vapors in addition to those of 1,1,1-trichloroethane (2) inadequate characterization of exposure concentrations and (3) intervening variables such as skin exposure and psychological effects. Therefore, carefully controlled, cross-sectional studies, which report individual data, adequately characterize the environment and control for exposure to airborne contaminants other than 1,1,1-trichloroethane, should be conducted.

Chronic Animal Studies

Although a number of animal studies have indicated chronic changes in the heart, [77] nervous reflex activity, [77] respiratory function, [77,85,88] and hepatic anatomy [41,77,88] resulting from "long term" exposure to 1,1,1-trichloroethane, most of these studies have used continuous exposures, which are not typical of the occupational setting.

Therefore, studies investigating the chronic effects of long term exposure to 1,1,1-trichloroethane should be conducted that utilize exposure schedules similar to those observed in industry, ie, an 8 to 10-hour day, 5 days per week.

Mutagenicity, Teratogenicity, Carcinogenicity

As only one study was available on teratogenicity [103], further studies are needed concerning the influence of 1,1,1-trichloroethane upon the mother and fetus. While it has not been determined if 1,1,1-trichloroethane is teratogenic, mutagenic, or carcinogenic in man, and it is not known what the tolerated dose of 1,1,1-trichloroethane is in the embryo or fetus, there is little doubt that many detrimental substances in the maternal bloodstream can readily reach the embryo or fetus via the placenta. As 1,1,1-trichloroethane concentrations in the occupational environment will lead to small but measurable concentrations of this substance in the bloodstream, additional information is needed.

A study by Dow Chemical Company in rats was inconclusive, as spontaneous neoplastic lesions occurred in both control and experimental groups. [90] A carcinogenesis study, as yet incomplete, by the National Cancer Institute may provide more data.

Synergistic Effects

From a review of the literature, it is evident that research must be initiated to answer important questions concerned with exposure to 1,1,1-trichloroethane and that a concerted effort must be directed toward

determining the possible additive, synergystic, or inhibitory effects of 1,1,1-trichloroethane, in combination with other hydrocarbons and organic solvents, on dose-response relationships.

VIII. REFERENCES

1. Christensen HE, Luginbyhl TT (eds): The Toxic Substances List 1974 Edition, HEW Publication No (NIOSH) 74-134. US Department Of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1974, p 333

2. Tauber E: [Concerning two new anesthetics.] Centralbl Med Wissenschaft 18:775-79, 1880 (Ger)

3. Lehmann KB, Flury F: [Toxicology and Hygiene of Industrial Solvents.] Berlin, Verlag von Julius Springer, 1938, pp 123-24 (Ger)

4. Van Arsdell PM: Health hazards of metal cleaning compounds -- Part IV. Organic Finishing 9:38-43, 1948

5. McNally WD: Industrial solvents -- Methyl alcohol; benzine; carbon tetrachloride; trichloroethylene; benzol; tetrachloroethane; tetrachloroethylene; carbon disulphide; tetraethyl-ortho-silicate; diethylphthalate. Ind Med 7:295-303, 1938

6. Henderson Y, Haggard HW: Noxious Gases and the Principles of Respiration Influencing Their Action, ed 2. New York, Reinhold Publishing, 1943, pp 102, 201-02, 207-08

7. Moeschlin S: Poisoning -- Diagnosis and Treatment, first American ed. New York, Grune and Stratton, 1965, p 313

8. American National Standard Acceptable Concentrations of Methyl Chloroform (1,1,1-Trichloroethane), Z37.26-1970. New York, American National Standards Institute, Inc, 1970, 8 pp

9. Stewart RD, Hake CL, Wu A, Graff SA, Forster HV, Lebrun AJ, Newton PE, Soto RJ: 1,1,1-Trichloroethane--Development of a Biologic Standard for the Industrial Worker by Breath Analysis, Report No. NIOSH-MCOW-ENVM-1,1,1-T-75-4. Milwaukee, Wis, The Medical College of Wisconsin, Department of Environmental Medicine, June 1975, 102 pp

10. May J: Odor thresholds of solvents for assessment of solvent odors in the air. Staub-Reinhalt Luft 26:34-38, 1966

11. Parameters Affecting the Determination of Odor Thresholds--Report to the Manufacturing Chemists Association Inc. Arthur A. Little Inc. C-68988, August 26, 1968

12. Hardie DWF: 1,1,1-trichloroethane, in Kirk RE, Othmer DT (eds): Encyclopedia of Chemical Technology, ed 2 rev. New York, Interscience Publishers, 1969, vol 5, pp 154-57

13. Weast RC (ed): Handbook of Chemistry and Physics -- A Ready Reference Book of Chemical and Physical Data, ed 50. Cleveland, The Chemical Rubber Publishing Co, 1969, p C-288

14. Irish DD: Halogenated Hydrocarbons--I. Aliphatic, in Patty FA (ed): Industrial Hygiene and Toxicology, ed 2 rev; Toxicology (Fassett DW, Irish DD, eds). New York, Interscience Publishers, 1963, vol 2, pp 1287-90

15. 1,1,1-Trichloroethane, Chemical Safety Data Sheet SD-90. Washington, DC, Manufacturing Chemists Association Inc, 1965, 14 pp

16. Technical Manual--Chlorothene VG Solvent. Midland, Mich, Dow Chemical Co, 1974, 28 pp

17. Industry and economic news--Competition sharpens in chlorinated solvents. Chem Eng 68:62,64,66, 1961

18. Synthetic Organic Chemicals, United States Production and Sales, 1966, TC Publication 248. US Tariff Commission, 1968, p 60

19. Synthetic Organic Chemicals, United States Production and Sales, 1968, TC Publication 327. US Tariff Commission, 1970, p 216

20. Synthetic Organic Chemicals, United States Production and Sales, 1969, TC Publication 412. US Tariff Commission, 1971, p 206

21. Synthetic Organic Chemicals, United States Production and Sales, 1970, TC Publication 479. US Tariff Commission, 1972, p 215

22. Synthetic Organic Chemicals, United States Production and Sales, 1971, TC Publication 614. US Tariff Commission, 1973, p 207

23. Synthetic Organic Chemicals, United States Production and Sales, 1972, TC Publication 681. US Tariff Commission, 1974, pp 206-07, 234, 238-40

24. Synthetic Organic Chemicals, US Production and Sales, 1973 ITC Publication 728, 1975, p 205

25. Dowclene WR--The Space Age Solvent. Midland, Mich, Dow Chemical Co, 1969, 41 pp

26. Chlorothene NU Solvent--The One With a Thousand and One Uses. Midland, Mich, Dow Chemical Co, 1973, 37 pp

27. Gleason MN, Gosselin RE, Hodge HC, Smith RP: Clinical Toxicology of Commercial Products--Acute Poisoning, ed 3. Baltimore, Williams & Wilkins Co, 1969, pp 61,101,103,108,118,180,197,207,212,226,233, 239,269,273,285,304,333,336,337,440,441,444,479,573,574,587,591, 607,639,652,653,681,706,725,761,771

28. Blondeau A: [Scholarly societies--Society of biology--Meeting of 17 November 1883.] Le Progres Medical 11:955-56, 1883 (Fre)

29. Rabuteau A: [An Elementary Essay on Therapeutics and on Pharmacology], ed 4. Paris, Place De L'Ecole-de-Medecine, 1884, p 1208 (Fre)

30. Dubois R, Roux L: [On the anesthetic action of methylchloroform.] CR Acad Sci 104:1549-51, 1887 (Fre)

31. Lazarew NW: [Concerning the strength of the narcotic effect of the vapors of the chlorine derivitives of methanes, ethanes and ethylenes.] Arch Exp Path Pharmakol 141:19-24, 1929 (Ger)

32. Krantz JC Jr, Park CS, Ling JSL: Anesthesia LX--The anesthetic properties of 1,1,1-trichloroethane. Anesthesiology 20:635-40, 1959

33. Dornette WHL, Jones JP: Clinical experiences with 1,1,1-trichloroethane --A preliminary report of 50 anesthetic administrations. Anesth Analg (Cleve) 39:249-53, 1960

34. Siebecker KL Jr, Bamforth BJ, Steinhaus JE, Orth OS: Clinical studies on new and old hydrocarbons. Anesth Analg (Cleve) 39:180-88, 1960

35. Stewart RD, Gay HH, Erley DS, Hake CL, Schaffer AW: Human exposure to 1,1,1-trichloroethane vapor--Relationship of expired air and blood concentrations to exposure and toxicity. Am Ind Hyg Assoc J 22: 252-62, 1961

36. Torkelson TR, Oyen F, McCollister DD, Rowe VK: Toxicity of 1,1,1-trichloroethane as determined on laboratory animals and human subjects. Am Ind Hyg Assoc J 19:353-62, 1958

37. Salvini M, Binaschi S, Riva M: Evaluation of the psychophysiological functions in humans exposed to the "Threshold Limit Value" of 1,1,1-trichloroethane. Br J Ind Med 28:286-92, 1971

38. Gamberale F, Hultengren M: [Methyl chloroform exposure--II Psycho-physiological function.] Arbete Och Halsa 1:29-50, 1972 (Swe)

39. Stewart RD, Gay HH, Schaffer AW, Erley DS, Rowe VK: Experimental human exposure to methylchloroform vapor. Arch Environ Health 19:467-72, 1969

40. Trochimowicz HJ, Reinhardt CF, Mullin LS, Azar A, Karrh BW: The effect of myocardial infarction on the cardiac sensitization potential of certain halocarbons. J Occup Med 18:26-30, 1976

41. McNutt NS, Amster RL, McConnell EE, Morris FM: Hepatic lesions in mice after continuous inhalation exposure to 1,1,1-trichloroethane. New York, Lab Invest 32:642-654, 1975

42. Stewart RD, Andrews JT: Acute intoxication with methylchloroform. JAMA 195:904-06, 1966

43. Litt IF, Cohen MI: "Danger...vapor harmful"--Spot-remover sniffing. N Engl J Med 281:543-44, 1969

44. Hall FB, Hine CH: Trichloroethane intoxication--A report of two cases. J Forensic Sci 11:404-13, 1966

45. Bass M: Sudden sniffing death. JAMA 212:2075-79, 1970

46. Griffiths WC, Lipsky M, Rosner A, Martin HF: Rapid identification of and assessment of damage by inhaled volatile substances in the clinical laboratory. Clin Biochem 5:222-31, 1972

47. Stewart RD: The toxicology of methyl chloroform. J Occup Med 5:259-62, 1963

48. Kleinfeld M, Feiner B: Health hazards associated with work in confined spaces. J Occup Med 8:358-64, 1966

49. Stahl CJ, Fatteh AV, Dominguez AM: Trichloroethane poisoning--Observations on the pathology and toxicology in six fatal cases. J Forensic Sci 14:393-97, 1969

50. Hatfield TR, Maykoski RT: A fatal methyl chloroform (trichloroethane) poisoning. Arch Environ Health 20:279-81, 1970

51. Stewart RD: Methyl chloroform intoxication--Diagnosis and treatment. JAMA 215:1789-92, 1971

52. Morgan A, Black A, Belcher DR: The excretion in breath of some aliphatic halogenated hydrocarbons following administration by inhalation. Ann Occup Hyg 13:219-33, 1970

53. Stewart RD, Dodd HC: Absorption of carbon tetrachloride, trichloroethylene, methylene chloride, and 1,1,1-trichloroethane through the human skin. Am Ind Hyg Assoc J 25:439-46, 1964

54. Astrand I, Kilbom H, Wahlberg I, Ovrum P: [Methyl chloroform exposure--I concentration in alveolar air and blood at rest and during exercise.] Arbete Och Halsa 1:1-28, 1972 (Swe)

55. Fukabori S: [The concentration of methyl chloroform in expired air of man after exposure.] J Sci Labor 46:535-43, 1970 (Jap)

56. Gazzaniga G, Binaschi S, Sportelli A, Riva M: [The elimination in the alveolar air in man of 1,1,1-trichloroethane following exposure to 600 ppm for three hours.] Boll Soc Ital Biol Sper 45:97-99, 1969 (Ita)

57. Stewart RD, Swank JD, Roberts CB, Dodd HC: Detection of halogenated hydrocarbons in the expired air of human beings using the electron-capture detector. Nature 198:696-97, 1963

58. Rowe VK, Wujkowski T, Wolf MA, Sadek SE, Stewart RD: Toxicity of a solvent mixture of 1,1,1-trichloroethane and tetrachloroethylene as determined by experiments on laboratory animals and human subjects. Am Ind Hyg Assoc J 24:541-54, 1963

59. Prost GH, Manillier D, Girard R: [Toxicologic analysis of expired air in subjects employing 1,1,1-trichloroethane.] Arch Mal Prof 33:197-98, 1972 (Fre)

60. Tada O: On the methods of evaluating the exposure to some chlorinated hydrocarbons (Pt 2). J Sci Labour 45:757-65, 1969

61. Weitbrecht U: [Tri and tri-substitutes in the metal industry.] Zentralbl Arbeitsmed 15:138-46, 1965 (Ger)

62. Stewart RD: The toxicology of 1,1,1-trichloroethane. Ann Occup Hyg 11:71-79, 1968

63. Binaschi S, Gazzaniga G, Rizzo S, Riva M: [Integration by means of infra-red spectography and gas chromatography in a case of intoxication by halogenated hydrocarbon derivatives.] Boll Soc Ital Biol Sper 45:94-96, 1969 (Ita)

64. Kramer CG, Ott GM, Fullerson JE, Hicks N, Imbus HR: Health of Workers Exposed to 1,1,1-Trichloroethane--A Matched Pair Study. Midland, Mich, The Dow Chemical Co, 1976, 20 pp.

65. Seki Y, Urashima Y, Aikawa H, Matsumura H, Ichikawa Y, Hiratsuka F, Yoshioka Y, Shimbo S, Ikeda M: Trichloro-compounds in the urine of humans exposed to methyl chloroform at sub-threshold levels. Int Arch Arbeitsmed 34: 39-49, 1975

66. Plaa GL, Evans EA, Hine CH: Relative hepatotoxicity of seven halogenated hydrocarbons. J Pharmacol Exp Ther 123:224-29, 1958

67. Klaassen CD, Plaa GL: Relative effects of various chlorinated hydrocarbons on liver and kidney function in mice. Toxicol Appl Pharmacol 9:139-51, 1966

68. Takeuchi Y: [Experimental studies on the toxicity of 1,1,1,2-tetrachloroethane compared with 1,1,2,2-tetrachloroethane and 1,1,1-trichloroethane.] Jap J Ind Health 8:371-75, 1966 (Jap)

69. Klaassen CD, Plaa GL: Relative effects of various chlorinated hydrocarbons on liver and kidney functions in dogs. Toxicol Appl Pharmacol 10:119-31, 1967

70. Gehring PJ: Hepatotoxic potency of various chlorinated hydrocarbon vapours relative to their narcotic and lethal potencies in mice. Toxicol Appl Pharmacol 13:287-98, 1968

71. Klaassen CD, Plaa GL: Comparison of the biochemical alterations elicited in livers from rats treated with carbon tetrachloride, chloroform, 1,1,2-trichloroethane and 1,1,1-trichloroethane. Biochem Pharmacol 18:2019-27, 1969

72. Horiguchi S, Horiuchi K: [Effect of environmental temperature on the toxicity of 1,1,1-trichloroethane in mice--(Supplementary report on the toxicity of 1,1,1-trichloroethane II).] Jap J Ind Health 13:290-91, 1971 (Jap)

73. Adams EM, Spencer HC, Rowe VK, Irish DD: Vapor toxicity of 1,1,1-trichloroethane (methyl chloroform) determined by experiments on laboratory animals. Arch Ind Hyg Occup Med 1:225-36, 1950

74. Horiguchi S, Horiuchi K: [An experiment of 1,1,1-trichloroethane vapor exposure to mice--(Supplementary report on the toxicity of 1,1,1-trichloroethane I).] Jap J Ind Health 13:226-27, 1971 (Jap)

75. Truhaut R, Boudene C, Jouany J-M, Bouant A: [Application of the physiogram to the study of acute toxicity of chlorinated solvents.] Eur J Toxicol 5:284-92, 1972 (Fre)

76. Truhaut R, Boudene C, Jouany J-M, Ducastel F: [First report concerning a method of acute intoxication through the pulmonary passageways of the animal and its graphic representation (physiogram).] Eur J Toxicol 2:200-06, 1969 (Fre)

77. Tsapko VG, Rappoport MB: [Effect of methyl chloroform vapor on the organism of animals.] Farmakol Toksikol 7:149-51, 1972 (Rus)

78. Rennick BR, Malton SD, Moe GK, Seevers MH: Induction of idioventricular rhythms by 1,1,1-trichloroethane and epinephrine. Fed Proc 8:327, 1949 (Abst.)

79. Belej MA, Smith DG, Aviado DM: Toxicity of aerosol propellants in the respiratory and circulatory systems--IV. Cardiotoxicity in the monkey. Toxicology 2:381-95, 1974

80. Herd PA, Lipsky M, Martin HF: Cardiovascular effects of 1,1,1-trichloroethane. Arch Environ Health 28:227-33, 1974

81. Reinhardt CF, Mullin LS, Maxfield ME: Epinephrine-induced cardiac arrhythmia potential of some common industrial solvents. J Occup Med 15:953-55, 1973

82. Aviado DM, Belej MA: Toxicity of aerosol propellants on the respiratory and circulatory systems--I. Cardiac arrhythmia in the mouse. Toxicology 2:31-42, 1974

83. Strosberg AM, Johnson LG, Miller LM: Methyl chloroform-induced fibrillation in the mouse. Fed Proc 32:3178, 1973 (Abst.)

84. Rice AJ, Roberts RJ, Plaa GL: The effect of carbon tetrachloride, administered in vivo, on the hemodynamics of the isolated perfused rat liver. Toxicol Appl Pharmacol 11:422-31, 1967

85. Prendergast JA, Jones RA, Jenkins LJ Jr, Siegel J: Effects on experimental animals of long-term inhalation of trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, dichlorodifluoromethane, and 1,1-dichloroethylene. Toxicol Appl Pharmacol 10:270-89, 1967

86. Plaa GL, Larson RE: Relative nephrotoxic properties of chlorinated methane, ethane, and ethylene derivatives in mice. Toxicol Appl Pharmacol 7:37-44, 1965

87. Platt DS, Cockrill BL: Biochemical changes in rat liver in response to treatment with drugs and other agents--II. Effects of halothane, DDT, other chlorinated hydrocarbons, thioacetamide, dimethylnitrosamine and ethionine. Biochem Pharmacol 18:445-57, 1969

88. MacEwen JD, Vernot EH: The biological effect of continuous inhalation exposure of 1,1,1-trichloroethane (methyl chloroform) on animals, Toxic Hazards Research Unit Annual Technical Report--1974, AMRL-TR-74-78. Wright Patterson Air Force Base, Ohio, Aerospace Medical Research Laboratory, National Institute for Occupational Safety and Health, National Aeronautics and Space Administration (joint study), 1974, pp 81-90

89. Eben A, Kimmerle G: Metabolism excretion and toxicology of methylchloroform in acute and subacute exposed rats. Arch Toxikol (Berl) 31:233-42, 1974

90. Quast JF, Leong BKJ, Rampy LW, Gehring PJ: Toxicologic and Carcinogenic Evaluation of a Methylchloroform (1,1,1-Trichloroethane) formulation by chronic inhalation in rats--Interim Report After 24 Months. Midland, Mich., The Dow Chemical Co, 1975, 14 pp.

91. Hake CL, Waggoner TB, Robertson DN, Rowe VK: The metabolism of 1,1,1-trichloroethane by the rat. Arch Environ Health 1:101-05, 1960

92. Boettner EA, Muranko HJ: Animal breath data for estimating the exposure of humans to chlorinated hydrocarbons. Am Ind Hyg Assoc J 30:437-42, 1969

93. Ikeda N, Ohtsuji H: A comparative study of the excretion of Fujiwara reaction-positive substances in urine of humans and rodents given trichloro- or tetrachloro-derivatives of ethane and ethylene. Br J Ind Med 29:99-104, 1972

94. Van Dyke RA, Wineman CG: Enzymatic dechlorination--Dechlorination of chloroethanes and propanes in vitro. Biochem Pharmacol 20:463-70, 1971

95. Herd PA, Martin HF: Effect of 1,1,1-trichloroethane on mitochondrial metabolism. Biochem Pharmacol 24: 1179-1185, 1975

96. Van Dyke RA, Rikans LE: Effect of the volatile anesthetics on aniline hydroxylase and aminopyrine demethylase. Biochem Pharmacol 19:1501-02, 1970

97. Fuller GC, Olshan A, Puri SK, Lal H: Induction of hepatic drug metabolism in rats by methylchloroform inhalation. J Pharmacol Exp Ther 175:311-17, 1970

98. Lal H, Shah HC: Effect of methylchloroform inhalation on barbituate hypnosis and hepatic drug metabolism in male mice. Toxicol Appl Pharmacol 17:625-33, 1970

99. Cornish HH, Ling BP, Barth ML: Phenobarbitol and organic solvent toxicity. Am Ind Hyg Assoc J 34:487-92, 1973

100. Carlson GP: Effect of phenobarbital and 3-methylcholanthrene pretreatment on the hepatotoxicity of 1,1,1-trichloroethane and 1,1,2-trichloroethane. Life Sci 13:67-73, 1973

101. Cornish HH, Adefuin J: Ethanol potentiation of halogenated aliphatic solvent toxicity. Am Ind Hyg Assoc J 27:57-61, 1966

102. Traiger GJ, Plaa GL: Chlorinated hydrocarbon toxicity-- potentiation by isopropyl alcohol and acetone. Arch Environ Health 28:276-78, 1974

103. Schwetz BA, Leong BKJ, Gehring PJ: The effect of maternally inhaled trichloroethylene, perchloroethylene, methyl chloroform and methylene chloride on embryonal and fetal development in mice and rats. Toxicol Appl Pharmacol 32:84-86, 1975

104. Burkatskaya EN, Tsapko VG, Khokholkova GA, Plisetsky IL, Krasnyuk EP, Boiko VG, Parlyuk AF: [Sanitary and hygienic characteristics of work conditions with the use of methyl chloroform in cleaning electrical equipment.] Gig Tr Prof Zabol 16(8): 41-42, 1973 (Rus)

105. Hervin RL, Reifschneider R: Health hazard evaluation/toxicity determination--Steel Tool and Engineering Co, Taylor, Mich, NIOSH-TR-076-74. Cincinnati, National Institute for Occupational Safety and Health, NTIS-PB-232 571, 1973, 13 pp

106. Kay RW: Survey of toxic hazards during vapour degreasing with trichloroethylene and 1,1,1-trichloroethane. Ann Occup Hyg 16:417-19,1973

107. Skory L, Fulkerson J, Ritzema D: Vapor degreasing solvents--When safe? Product Finishing, February 1974, pp 2-9

108. Pernell C: The collection and analysis of halogenated hydrocarbon vapors employing silica gel as an absorbing agent. J Ind Hyg Toxicol 26:331-33, 1944

109. Peterson JE, Hoyle HR, Schneider EJ: The analysis of air for halogenated hydrocarbon contaminants. Am Ind Hyg Assoc J 17: 429-33, 1956

110. Simmons JH, Moss IM: Measurement of personal exposure to 1,1,1-trichloroethane and trichloroethylene using an inexpensive sampling device and battery-operated pump. Ann Occup Hyg 16:47-49, 1973

111. Cropper FR, Kaminski S: Determination of toxic organic compounds in admixture in the atmosphere by gas chromatography. Anal Chem 35:735-43, 1963

112. White LD, Taylor DG, Mauer PA, Kupel RE: A convenient optimized method for the analysis of selected solvent vapors in the industrial atmosphere. Am Ind Hyg Assoc J 31:225-32, 1970

113. Williams FW, Umstead MB: Determination of trace contaminants in air by concentrating on porous polymer beads. Anal Chem 40:2232-34, 1968

114. Otterson EJ, Guy CU: A method of atmospheric solvent vapor sampling on activated charcoal in connection with gas chromatography, in Transactions of the 26th Annual Meeting, American Conference of Governmental Industrial Hygienists. Philadelphia, ACGIH, 1964, pp 37-43

115. Levadie B, Harwood JF: An application of gas chromatography to analysis of solvent vapors in industrial air. Am Ind Hyg Assoc J 21:20-24, 1960

116. Elkins Hgb: The Chemistry of Industrial Toxicology, ed 2. New York, John Wiley & Sons Inc, 1959, pp 141,317

117. Lugg GA: Fujiwara reaction and determination of carbon tetrachloride, chloroform, tetrachloroethane and trichloroethylene in air. Anal Chem 38:1532-36, 1966

118. Saltzman BE: Direct reading colorimetric indicators, in Air Sampling Instruments for Evaluation of Atmospheric Contaminants, ed 4. Cincinnati, American Conference of Governmental Industrial Hygienists, 1972, pp S22-23

119. Nelson GO, Shapiro EG: A field instrument for detecting airborne halogen compounds. Am Ind Hyg Assoc J 32:757-65, 1971

120. Baretta ED, Stewart RD, Mutchler JE: Monitoring exposures to vinyl chloride vapor--Breath analysis and continuous air sampling. Am Ind Hyg Assoc J 30:537-44, 1969

121. Rushing DE: Gas chromatography in industrial hygiene and air pollution problems. Am Ind Hyg Assoc J 19:238-45, 1958

122. Cooper CV, White LD, Kupel RE: Qualitative detection limits for specific compounds utilizing gas chromatographic fractions, activated charcoal and a mass spectrometer. Am Ind Hyg Assoc J 32:383-86, 1971

123. Report of the Committee on Threshold Limits, in Transactions of the 15th Annual Meeting of the American Conference of Governmental Industrial Hygienists, Los Angeles, April 18-21, 1953, pp 45-47

124. Methyl Chloroform (1,1,1-Trichloroethane), in Documentation of Threshold Limit Values. Cincinnati, American Conference of Governmental Industrial Hygienists, 1962, p 69

125. Report of the Committee on Threshold Limit Values, in Transactions of the 25th Annual Meeting of The American Conference of Governmental Industrial Hygienists, Cincinnati, May 6-10, 1963, p 77-79

126. Methyl Chloroform (1,1,1-Trichloroethane), in Documentation of Threshold Limit Values (rev ed). Cincinnati, American Conference of Governmental Industrial Hygienists, 1966, pp 124-25

127. American Industrial Hygiene Association, Toxicology Committee (John P Frawley, Chmn): 1,1,1-Trichloroethane -- Emergency Exposure Limits, in Emergency Exposure Limits. Am Ind Hyg Assoc J 25:585-86, 1964

128. Permissible Levels of Toxic Substances in the Working Environment -- Sixth Session of the Joint ILO/WHO Committee on Occupational Health, Geneva, June 4-10, 1968, Occupational Safety and Health Series No. 20. Geneva, International Labour Office, 1970, pp 182-87, 199, 202, 209-11, 217-19, 229, 236, 345, 350

129. Methyl Chloroform (1,1,1-Trichloroethane), in Documentation of Threshold Limit Values for Substances in Workroom Air, ed 3. Cincinnati, American Conference of Governmental Industrial Hygienists, 1971, pp 161-62

130. [1,1,1-Trichloroethane, special publication from Occupational Substances Injurious to Health -- Toxicological and Occupational-Medical Determinations of the MAK Standards. Commission to Test Occupational Substances Injurious to Health of the German Research Society], (D. Henschler Chmn, ed). Weinheim, Verlag Chemie GmbH, 1972, 5 pp (Ger)

131. American Conference of Governmental Industrial Hygienists: Threshold Limit Values of Air-borne Contaminents (sic) for 1968-- Recommended

and Intended Values. Adopted at the 30th Annual Meeting of ACGIH, St. Louis, Mo, May 13, 1968, pp 1-5, 10

132. Watanabe T, Macek CR, Ratcliffe HL, Aviado DM: Bronchopulmonary and hepatic effects of repeated inhalation of 1,1,1-trichloroethane in mice. Cleveland, Chemical Rubber Co, Solvents in the Environment series, accepted for publication.

133. Stoddard DL, Wells, WR: In-service solvent cleaning of electric motors. Am Ind Hyg Assoc J 23:62-66, 1962

134. Dyson P: Aerosol propellants. Journal of the Society of Cosmetic Chemists 14:402-15, 1963

135. Crummett WB, Stenger VA: Thermal stability of methyl chloroform and carbon tetrachloride. Ind Eng Chem 48:434-36, 1956

136. Dahlberg JA, Christiansen VO, Eriksson EA: On the formation of phosgene by photo-oxidation of methyl chloroform in welding. Ann Occup Hyg 16:41-46, 1973

137. Johnson TC, Merciez WD: Permeation of halogenated solvents through drybox gloves. Report No RFP-1608. Golden, Colorado, Dow Chemical Co, Rocky Flats Division, April 16, 1971, 5 pp

138. Respiratory Protective Devices Manual, American Industrial Hygiene Association and American Conference of Governmental Industrial Hygienists, 1963, 162 pp

139. American National Standard Practices for Respiratory Protection, Z88.2-1969. New York, American National Standards Institute, Inc, 1969, 31 pp

140. Nelson GO, Harder CA: Respirator cartridge efficiency studies--V. Effect of solvent vapor. Am Ind Hyg Assoc J 35:391-410, 1974

141. Hervin RL, Lucas J: Health Hazard Evaluation Report 72-35-34--Hazard Evaluation Services, Branch, Division of TEchnical Services, Budd Company, Clinton, Michigan. Cincinnati, US Dept Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, March 1973, 21 pp

142. Gunter BJ, Lucas JBL Health Hazard Evaluation Report 72-86--Hazard Evaluation Services Branch, Division of Technical Services, Gates Rubber Company, Denver, Colorado. Cincinnati, US Dept Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, April 1973, 11 pp

143. Gunter BJ, Bodner A: Health Hazard Evaluation report 73-180/183-159--Hazard Evaluation Services Branch, Division of Technical Services, Docutel Corporation, Irving, Texas. Cincinnati, US Dept

Health Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, November 1974, 8 pp

144. Apol AG: Health Hazard Evaluation Report 72-40-52--Hazard Evaluation Services Branch, Division of Technical Services, Ford Motor Company, Lorain, Ohio. Cincinnati, US Dept Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, June 1973, 13 pp

145. Rosensteel RE: Health Hazard Evaluation Report 73-176-163--Hazard Evaluation Services Branch, Division of Technical Services, Bristol Flowed Gasket Company, Waterbury, Connecticut. Cincinnati, US Dept Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, December 1974, 8 pp