# VI. WORK PRACTICES

Work practices and safety precautions for handling alkanes have been the subject of reports dealing mainly with the flammability and explosiveness of the alkanes [16,87]. No specific work practice guidelines designed for the prevention of alkane exposure are available. In general, engineering controls should be used to ensure that exposures remain below the recommended environmental limits, to minimize excursions and eye and skin contact, and to prevent fires.

Tables XII-2, XII-3, XII-4 [1-4] give the physical properties for pentane, hexane, heptane and octane. These alkanes are designated as flammable liquids of Class IA or IB based on the criteria in 29 CFR 1910.106 (19)(ii). The National Fire Protection Association's NFPA No. 30 Flammable and Combustible Liquids Code [55] and NFPA No. 70 Electrical Code [112] should be strictly adhered to; NFPA No. 36 Solvent Extraction Plants Code [16] should be complied with where applicable.

Special precautions are necessary when entering tanks, extractors, or vessels which may contain alkanes, when performing flame- or spark-generating operations such as welding and cutting, and when transferring alkanes. Before any employee enters a vessel, all pipelines leading into or out of the vessel must be blanked to prevent the entry of alkane liquids or vapors [87]. Vessels should be drained of all alkanes, cooled to a temperature below 110 F, and purged of all alkanes with steam or an inert gas [87]. A person should be designated to test the vessel atmosphere following purging by using a combustible gas meter or other suitable instrument [87]. No one should enter a tank, vessel, or extractor without

first being equipped with a lifebelt to which at least one lifeline, manned by a worker stationed outside the entrance, has been attached [87]. If hazards are such that a second coworker is needed outside the entrance, a second lifeline should be attached to the worker entering the enclosure. The use of portable lights to illuminate the interior of tanks, vessels, or extractors when they are undergoing cleaning or repairs should be prohibited. Such interiors should be illuminated by reflected light [87]. Only nonferrous tools should be used for scraping or chipping away clinging residues or accumulated deposits. Rags and other materials used to wipe up and absorb alkanes should be placed in standard safety containers. Cutting or welding must be performed only when an authorized representative of the employer signs a permit indicating that all necessary safety precautions have been taken [87].

The transfer of alkanes by means of gravity flow or compressed gas should be avoided [87]. When the use of these methods of transfer is unavoidable, positive automatic shutoffs are necessary. Transfer by compressed air is prohibited. Transfer from tank to process use should, where feasible, be through rigid pipe systems which are operated by remote control. When performed indoors, the transfer of liquids from portable containers should be by means of readily attached approved pumps and through continuous armored hose lines [87]. If safety cans are used, they should be of the approved kind, with a spring-closing lid and spout cover, and designed so that internal pressure is relieved when they are subjected to heat [113]. Alkanes must not be dispensed into metal containers unless the dispensing nozzle and containers are electrically interconnected.

Alkanes may generate high pressures in their storage containers if they are exposed to direct sunlight. Storage areas for alkanes should therefore be protected against the effects of direct sunlight. If tarpaulins and similar coverings are used, they should be positioned over containers to allow for air space [56]. Heating of an area, if required, should be by indirect means. Open-flame devices must be prohibited in any area where alkanes are used, stored, or handled [87].

Engineering controls should be designed and maintained to keep the levels of airborne alkanes below the recommended environmental limits. This will ensure that these levels remain well below their lower explosive limits. When a fan is located in duct work where the concentrations of alkanes may exceed 10% of a lower flammable limit, the rotating element should be of nonsparking material or the casting should be coated with, or consist of, nonsparking material. The ventilation system should contain devices along its length intended to prevent the propagation of flashbacks [87]. Additional information regarding ventilation systems can be found in Industrial Ventilation--A Manual of Recommended Practice [89], Fundamentals Governing the Design and Operation of Local Exhaust Systems Z9.2-1971 [90], and Recommended Industrial Ventilation Guidelines [114].

Evidence of skin irritation indicates that contact with liquid alkanes will probably cause eye injury. Therefore, the use of personal protective equipment, such as safety glasses or goggles, is required when contact of alkanes with the eyes is likely [115-117]. If eye contact or irritation occurs, the affected eye must be flushed immediately with gently flowing water for at least 10 minutes. A physician should be consulted to determine if additional treatment is necessary.

In alkane-manufacturing areas, routine checks should be made to ensure that leaks occurring in closed processes are detected. When leaks occur, they must be promptly repaired by trained maintenance workers wearing the appropriate protective clothing and respiratory protection as described in Section 4 of Chapter I; the repair operations should be properly supervised. If employees must withdraw samples from the process, and there is a possibility of significant exposure to the alkanes in liquid or vapor form, then a fire-resistant suit, which is impervious to alkanes and includes gloves, conductive boots, and a positive pressure supplied-air hood, should be worn. Protective clothing is normally not required for other operations involving the manufacture and use of alkanes; however, if it is worn, it should be fire-resistant. Fabrics that generate static electricity should be avoided. A change of clothing shall be made available to an employee whose regular work clothes become contaminated with alkanes. If the clothing becomes wet with liquid alkanes, the affected employee should avoid sources of ignition, quickly remove the clothing, and shower with soap and water. The clothing should then be air-dried and laundered before it is reworn. This procedure is recommended because liquid alkanes in contact with the skin have caused dermatitis and blistering [23,43]. The degree of irritation varies with the extent of exposure. Skin that has become chapped or cracked because of contact with alkanes may become infected; therefore, appropriate precautions should be taken.

Protective clothing and equipment, including respirators, should be kept clean and maintained in good condition. This can be ensured by regular cleaning after use and periodic inspection by trained personnel.

Worn equipment should be replaced when necessary. The employer must ensure that all equipment is in working order and that it is stored properly when not in use.

In emergency operations, fire and explosion may be the primary hazards. A program must be instituted for the quick evacuation of the work area. All personnel should be provided with respirators as designated for emergencies in Table I-1. All potentially exposed employees must be familiarized with escape procedures, and procedures for obtaining emergency medical care, for transporting injured employees, and for firefighting. Only personnel properly trained in emergency operations and properly equipped should be allowed into the work area for repair operations.

Safety showers, eyewash fountains, and fire extinguishers must be located in or near areas where alkane splashes are likely to occur and must be properly maintained. Washing facilities, soap, and water must be available to employees. As a good hygiene practice, it is recommended that employees wash their hands before eating, smoking, or using toilet facilities.

In summary, precautions must be taken to guard against exposure of personnel to toxic concentrations of alkanes and to the fire hazards associated with them. It is also important that employees be informed before job placement of the hazards associated with the use of alkanes, and whenever any changes are made in any process that may alter their exposure to alkanes. Appropriate emergency procedures should be stressed. Recommended labels and posters must be displayed. The US Department of Labor "Material Safety Data Sheet" shown in Appendix III or a similar approved form must be filled out and filed in a location readily accessible

to all workers who may be exposed to alkanes. If the recommended work practices are observed and good engineering controls are installed, employees working with alkanes should be adequately protected from the various hazards associated with alkanes, including overexposure, fire, and explosion.

# VII. RESEARCH NEEDS

One of the most pressing research needs for pentane, hexane, heptane, and octane is the acquisition of additional information concerning worker exposures and any corresponding health effects in the contemporary workplace environment. The present available information pertaining to these exposures is seriously inadequate. Most of the data deal with exposures to either hexane or mixtures of alkanes. The reports of exposures to mixtures of alkanes normally lack analyses of the mixtures and give insufficient information on the data necessary for the determination of dose-response relationships.

There is a need for additional information in the following areas to set better standards for pentane, hexane, heptane, and octane:

(a) Mechanism of Toxicity and Metabolism

The mechanism of toxicity and the metabolism of hexane have not yet been identified. Hexane seems to be metabolized in a manner similar to that of methyl n-butyl ketone. Research should be conducted to confirm or refute this theory. Although there is some evidence that pentane and heptane are neurotoxic, animal studies are needed to determine the relative neurotoxicity of pentane, heptane, and octane. Studies on animals other than rodents, especially primates, should be done to ascertain the systemic effects, if any, of long-term low-level exposures to hexane or other alkanes.

(b) Relationship Between the Toxicities of the Alkanes

Animal studies of the effects of exposures to mixtures containing alkanes and other carbon compounds, such as ketones, aldehydes, and

aromatics, are needed to determine if additive, potentiating, or synergistic effects result.

(c) Carcinogenicity, Mutagenicity, and Teratogenicity Studies

Studies are needed to determine if alkanes produce carcinogenic, mutagenic, or teratogenic effects in humans or animals.

(d) Sampling and Analytical Methods

Additional work is needed both to validate the recommended sampling and analytical methods and to develop improved procedures and equipment that will minimize interferences with the qualitative and quantitative analyses of the alkanes present in collected samples.

## VIII. REFERENCES


1. Gerarde HW: The aliphatic (open chain, acyclic) hydrocarbons, 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 1195-1201

2. Weast RC (ed): Handbook of Chemistry and Physics--A Ready-Reference Book of Chemical and Physical Data, ed 55. Cleveland, CRC Press Inc, 1974, pp C-212 to C-214,C-321 to C-322,C-327 to C-329,C-399,C-407,C-409,C-442

3. Dean JW (ed): Lange's Handbook of Chemistry, ed 11. New York, McGraw-Hill Book Co, 1973, pp 7-244 to 7-245,7-314 to 7-315

4. Hawley GG (ed): The Condensed Chemical Dictionary, ed 8. New York, Van Nostrand Reinhold Co, 1971, pp 311,437,443,484-85,575,580,610-11,666,897

5. Krane HG, Groh AB, Schulman BL, Sinfelt JH: Reactions in catalytic reforming of naphthas, in Proceedings of the Fifth World Petroleum Congress, Section III, Paper 4, New York, May 1959, pp 39-53

6. Craig RG, White EA, Henke AM, Kwolek SJ: H-G hydrocracking today. Hydrocarbon Process Pet Refiner 45:159-64, 1966

7. Phillips LB: How they control superfractionation. Hydrocarbon Process Pet Refiner 42:159-60, 1963

8. Hamilton WW, Eastwood SC, Potas AE, Schraishuhn EA: Catalytic cracking in airlift TCC units--Five schemes show how process can be applied to most refining processing situations. Pet Eng (Dallas) 24:C-5 to C-16, 1952

9. Crude Products from Petroleum and Natural Gas--For Chemical Conversion. United States International Trade Commission, 1974, 4 pp

10. Miller RD, Norrell GP: Analyses of natural gases of the United States, 1961. US Dept of the Interior, Bureau of Mines, Information Circular No. 8221, 1964, 148 pp

11. Chadwick JL, Green RL: Pentanes, in Kirk-Othmer Encyclopedia of Chemical Technology, ed 2 rev. New York, Interscience Publishers, 1967, vol 14, pp 707-16

12. Fuhner H: [The narcotic effect of gasoline and its components--Pentane, hexane, heptane, octane.] Biochem Z 115:235-61, 1921 (Ger)

13. Herskowitz A, Ishii N, Schaumburg H: N-hexane neuropathy--A syndrome occurring as a result of industrial exposure. N Engl J Med 285:82-85, 1971

14. Wilson RH, Hough GV, McCormick WE: Medical problems encountered in the manufacture of American-made rubber. Ind Med 17:199-207, 1948

15. Elkins HB: Organic compounds--Part I. Hydrocarbons, in The Chemistry of Industrial Toxicology. New York, John Wiley and Sons Inc, 1959, pp 99-111

16. National Fire Protection Association: National Fire Codes--A Compilation of NFPA Codes, Standards, Recommended Practices, and Manuals--Flammable Liquids, Boiler-Furnaces, Ovens, NFPA No. 36-1973. Boston, NFPA, vol 1, 1974, pp 36-1 to 36-54

17. Yamada S: [Polyneuritis in workers exposed to n-hexane, its cause and symptoms.] Jpn J Ind Health 9:651-59, 1972 (Jap)

18. Inoue T, Takeuchi Y, Takeuchi S, Yamada S, Suzuki H, Matsushita T, Miyagaki H, Maeda K, Matsumoto T: [Industrial health survey of high incidence of n-hexane intoxication among vinyl sandal manufacturers.] Jpn J Ind Health 12:73-84, 1970 (Jap)

19. Brignardello R, De Luca F, Spagnoli G: [Environmental pollution due to solvents in oil cake extraction industries.] Securitas 58:49-59, 1973 (Ita)

20. Truhaut R, Laget P, Piat G, Nguyen Phu-Lich, Dutertre-Catella H, Vu Ngoc Huyen: [Preliminary electrophysiologic results following experimental poisoning with technical hexane and heptane in white rats.] Arch Mal Prof Med Trav Secur Soc 34:417-26, 1973 (Fre)

21. Braier L: A comparative study of isocyclic hydrocarbons in animals and in man. Haematologica (Pavia) 58:491-500, 1973

22. Floret: [Industrial poisoning by hydrocarbons of the aromatic and aliphatic series (chlorinated hydrocarbons) and its prevention.] Zentralbl Gewerbehyg Unfallverhuet 14:257-61,369-72, 1927 (Ger)

23. Nomiyama I, Nomiyama G: [241. The effects of the cutaneous absorption of n-hexane on humans.] Jpn J Hyg 30:140, 1975 (Jap)

24. Yoshida T, Yanagisawa H, Muneyuki T, Shigiya R: [An electrophysiological study on n-hexane polyneuropathy.] Clin Neurol (Tokyo) 14:454-61, 1974 (Jap)

25. Ortega C: [Lung abscesses--Presentation of a case of unusual etiology--General considerations.] Rev Policlin Valencia 1:79-83, 1941 (Ita)

26. Takeuchi Y, Mabuchi C, Takagi S: Polyneuropathy caused by petroleum benzine. Int Arch Arbeitsmed 34:185-97, 1975

27. Battistini N, Lenzi GL: EEG observations in the polyneuropathy of boot-workers. Electroencephalogr Clin Neurophysiol (Amsterdam) 39:531-32, 1975

28. Gafafer WM: Occupational Diseases--A Guide to Their Recognition, PHS bulletin No. 1097. US Dept of Health, Education, and Welfare, Public Health Service, 1964, pp 182-83

29. Porter CA: Hexanes, in Kirk-Othmer Encyclopedia of Chemical Technology, ed 2 rev. New York, Interscience Publishers, 1966, vol 11, pp 1-5

30. Holcomb DE: Natural gas, in Kirk-Othmer Encyclopedia of Chemical Technology, ed 2 rev. New York, Interscience Publishers, 1966, vol 10, pp 459-63

31. Scheflan L, Jacobs MB: Handbook of Solvents. Huntington, NY, Robert E Krieger Publishing Co, 1953, pp 422-23,431-32,567-68,579-80

32. Drinker P, Yaglou CP, Warren MF: The threshold toxicity of gasoline vapor. J Ind Hyg Toxicol 25:225-32, 1943

33. Nelson KW, Ege JF Jr, Ross M, Woodman LE, Silverman L: Sensory response to certain industrial solvent vapors. J Ind Hyg Toxicol 25:282-85, 1943

34. Lazarew NW: [On the toxicity of various hydrocarbon vapors.] Arch Exp Pathol Pharmakol 143:223-33, 1929 (Ger)

35. Henderson VE, Smith AHR: Propylene impurities--Hexenes and hexanes. J Pharmacol Exp Ther 58:319-27, 1936

36. Gaultier M, Rancurel G, Piva C, Efthymioc ML: [Polyneuritis and aliphatic hydrocarbons.] J Eur Toxicol 6:294-96, 1973 (Fre)

37. Yamamura Y: N-hexane polyneuropathy. Folia Psychiatr Neurol Jpn 23:45-57, 1969

38. Iida M, Yamamoto H, Sobue I: [Prognosis of n-hexane polyneuropathy--Follow-up studies on mass outbreak in F district of Mie prefecture.] Igaku No Ayumi 84:199-201, 1973 (Jap)

39. Abbritti G, Siracusa A, Cianchetti C, Coli CA, Curradi F, Perticoni GF, De Rosa F: Shoe-makers' polyneuropathy in Italy--The aetiological problem. Br J Ind Med 33:92-99, 1976

40. Caccuri S: [Introduction to the problem of polyneuropathies from glues.] Acta Neurol (Napoli) 28:627-29, 1973 (Ita)

41. Patty FA, Yant WP: Report of Investigations--Odor Intensity and Symptoms Produced by Commercial Propane, Butane, Pentane, Hexane, and Heptane Vapor, No. 2979. US Dept of Commerce, Bureau of Mines, 1929, 10 pp

42. Fischer RB, Peters DG: Radiant energy measurements, in Basic Theory and Practice of Quantitative Chemical Analysis, ed 3. Philadelphia, WB Saunders Co, 1968, pp 669-70

43. Oettel H: [Effect of organic liquids on the skin.] Arch Exp Pathol Pharmakol 83:641-96, 1936 (Ger)

44. Swann HE, Kwon BK, Hogan GK, Snellings WM: Acute inhalation toxicology of volatile hydrocarbons. Am Ind Hyg Assoc J 35:511-18, 1974

45. Alarie Y: Irritating properties of airborne materials to the upper respiratory tract. Arch Environ Health 13:433-49, 1966

46. Miyagaki H: [Electrophysiological studies on the peripheral neurotoxicity of n-hexane.] Jpn J Ind Health 9:660-71, 1967 (Jap)

47. Kimura ET, Ebert DM, Dodge PW: Acute toxicity and limits of solvent residue for sixteen organic solvents. Toxicol Appl Pharmacol 19:699-704, 1971

48. Tsobkallo GI: [The influence of certain hydrocarbons included in the composition of gasoline on the respiration and blood pressure.] Farmakol Toksikol 10:23-30, 1947 (Rus)

49. Bohlen P, Schlunegger UP, Lauppi E: Uptake and distribution of hexane in rat tissues. Toxicol Appl Pharmacol 25:242-49, 1973

50. Robbins SL: Cell injury and cell death, in Pathologic Basis of Disease. Philadelphia, WB Saunders Co, 1974, pp 32-33

51. DiVincenzo GD, Kaplan CJ, Dedinas J: Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone, methyl ethyl ketone in guinea pig serum and their clearance. Toxicol Appl Pharmacol 36:511-22, 1976

52. Abdel-Rahman MS, Hetland LB, Couri D: Toxicity and metabolism of methyl n-butyl ketone. Am Ind Hyg Assoc J 37:95-102, 1976

53. Schaumburg HH, Spencer PS: Degeneration in central and peripheral nervous systems produced by pure n-hexane--An experimental study. Brain 99:183-92, 1976

54. Spencer PS, Schaumburg HH: Neurotoxic properties of certain aliphatic hexacarbons. Proc R Soc Med 70:7-9, 1977

55. National Fire Protection Association: National Fire Codes--A Compilation of NFPA Codes, Standards, Recommended Practices, and Manuals--Flammable Liquids, Boiler-Furnaces, Ovens, NFPA No. 30-1973. Boston, NFPA vol 1, 1974, pp 30-1 to 30-108

56. Highly Flammable Liquids and Liquified Petroleum Gases--Guide to the Regulations 1972. London, Her Majesty's Stationery Office, Department of Employment, 1973, 9 pp

57. Safe cleaning of oil tanks. Saf Maint 125:58-61,64, 1963

58. The hydrocarbon processing industry--Fire hazards and precautions. Fire Prot Assoc J 82:253-64, 1969

59. Flammable Liquids and Gases--Explosion Hazards, Fire Safety Data Sheets No. FS 6011. London, Fire Protection Association, Fire Prevention Information and Publication Centre, 1973, 5 pp

60. Westberg HH, Rasmussen RA, Holdren M: Gas chromatographic analysis of ambient air for light hydrocarbons using a chemically bonded stationary phase. Anal Chem 46:1852-54, 1974

61. Heptane (Method No. S89), Hexane (Method No. S90), Octane (Method No. S378), Pentane (Method No. S379), in NIOSH/OSHA Standards Completion Program. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1975, pp S89-1 to S89-9,S90-1 to S90-9,S378-1 to S378-9,S379-1 to S379-9

62. McTaggart NG, Luke LA: Hydrocarbon type analysis of petroleum distillates by gas solid chromatography. Energy Dig 1:46-50, 1972

63. Bryanskaya EK, Zakharenko VA, Petrov AA: [Calibration mixtures of C6-C8 alkanes for interpretation of gasoline fraction chromatograms.] Neftekhimiya 6:784-87, 1966 (Rus)

64. Kurtz SS Jr: The development of hydrocarbon analysis, 1922 to 1972, in Proceedings of the Symposium of Advances in Analysis of Petroleum and Its Products, New York, August 27-September 1, 1972, pp F4-F13

65. Mayer TJ, Camin DL, Raymond AJ: The development of instrumental methods for the analysis of gasoline components, in Proceedings of the Symposium of Advances in Analysis of Petroleum and Its Products, New York, August 27-September 1, 1972, pp F14-F37

66. Boulet R, Guichard-Loudet N, Henrion P, Poulet M, Raynal M, Roucache J, Cornu A, Ulrich J: [Detailed analysis of crude oil by gas chromatography, mass spectrometry and nuclear magnetic resonance--Application to geochemical problems.] Rev Inst Fr Pet Ann Combust Liq 23:315-39, 1968 (Fre)

67. Heaton WB, Wentworth JT: Exhaust gas analysis by gas chromatography combined with infrared detection. Anal Chem 31:349-57, 1959

68. Altshuller AP, Bellar TA: Gas chromatographic analysis of hydrocarbons in the Los Angeles atmosphere. J Air Pollut Control Assoc 13:81-87, 1963

69. Stephens ER, Burleson FR: Analysis of the atmosphere for light hydrocarbons. J Air Pollut Control Assoc 17:147-53, 1967

70. Barbul M, Beschea C, Pop A: [Determination of the C2-C5 hydrocarbons in air, hydrogen, and methane gas, at a level of parts per million.] Rev Chim 16:101-03, 1965 (Rom)

71. Burnham AK, Calder GV, Fritz JS, Junk GA, Svec HJ, Vick R: Trace organics in water--Their isolation and identification. J Am Water Works Assoc 65:722-25, 1973

72. Oord F: A simple method to collect air samples in a plastic bag. Am Ind Hyg Assoc J 31:532, 1970

73. Smith BS, Pierce JO: The use of plastic bags for industrial air sampling. Am Ind Hyg Assoc J 31:343-48, 1970

74. VanderKolk AL, VanFarowe DE: Use of Mylar bags for air sampling. Am Ind Hyg Assoc J 26:321-22, 1965

75. Conner WD, Nader JS: Air sampling with plastic bags. Am Ind Hyg Assoc J 25:291-97, 1964

76. Van Houten R, Lee G: A method for the collection of air samples for analysis by gas chromatography. Am Ind Hyg Assoc J 30:465-69, 1969

77. Feldstein M, Balestrieri S, Levaggi DA: The use of silica gel in source testing. Am Ind Hyg Assoc J 28:381-85, 1967

78. Campbell EE, Ide HM: Air sampling and analysis with microcolumns of silica gel. Am Ind Hyg Assoc J 27:323-31, 1966

79. Otterson EJ, Guy CU: A method of atmospheric solvent vapor sampling on activated charcoal in connection with gas chromatography. Transactions of the 26th Annual Meeting of the American Conference of Governmental Industrial Hygienists, 1964, pp 37-46

80. 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

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

82. Reid FH, Halpin WR: Determination of halogenated and aromatic hydrocarbons in air by charcoal tube and gas chromatography. Am Ind Hyg Assoc J 29:390-96, 1968

83. Louw CW, Richards JF: A simple directly combined gas chromatographic-infrared spectrometric system for identification of low molecular weight hydrocarbons. Appl Spectrosc 29:15-24, 1975

84. Leichnitz K (ed): Detector Tube Handbook--Air Investigations and Technical Gas Analysis with Drager Tubes, ed 2. Lubeck, Germany, Dragerwerk AG Lubeck, 1973, 164 pp

85. Jacobs MB: Detectors, in The Analytical Chemistry of Industrial Poisons, Hazards, and Solvents, ed 2 rev. New York, Interscience Publishers Inc, 1949, pp 478-512

86. Solvent Plant Safety. Phoenix, Anderson Clayton, Oil Mill Technical Dept, Industrial Div, 1971, 9 pp

87. Recommended Good Practice for Safeguarding the Solvent Extraction of Oils. Hartford, Conn, Factory Insurance Assoc, 1952, 97 pp

88. Summary plant observation report and evaluation. Menlo Park, Calif, Stanford Research Institute, October 1976 (Submitted to NIOSH under Contract No. CDC-99-74-31)

89. American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation: Industrial Ventilation--A Manual of Recommended Practices, ed 14. Lansing, Mich, ACGIH, 1976, pp 1-1 to 14-8

90. American National Standard--Fundamentals Governing the Design and Operation of Local Exhaust Systems, Z9.2. New York, American National Standards Institute Inc, 1971

91. Cook WA: Maximum allowable concentrations of industrial atmospheric contaminants. Ind Med 14:936-46, 1945

92. Report of the Sub Committee on Threshold Limits, in Proceedings of the Eighth Annual Meeting of the American Conference of Governmental Industrial Hygienists, Chicago, April 7-13, 1946, pp 54-55

93. American Conference of Governmental Industrial Hygienists: 1947 M.A.C. Values. Ind Hyg Newsletter, Division of Industrial Hygiene, US Public Health Service, August 1947, p 15

94. American Conference of Governmental Industrial Hygienists: Threshold Limit Values. Transactions of the 10th Annual Meeting. Boston, ACGIH, April 1948

95. American Conference of Governmental Industrial Hygienists: Threshold Limit Values of Airborne Contaminants and Intended Changes--Adopted by ACGIH for 1970. Cincinnati, ACGIH, 1970, 27 pp

96. American Conference of Governmental Industrial Hygienists: TLVs--Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1974. Cincinnati, ACGIH, 1974, 94 pp

97. American Conference of Governmental Industrial Hygienists: TLVs--Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1976. Cincinnati, ACGIH, 1976, pp 1-54

98. ACGIH Committee on Threshold Limit Values: Pentane. To be published in Documentation of Threshold Limit Values by American Conference of Governmental Industrial Hygienists

99. ACGIH Committee on Threshold Limit Values: Hexane. To be published in Documentation of Threshold Limit Values by American Conference of Governmental Industrial Hygienists

100. Inoue T, Yamada S, Miyagaki H, Takeuchi Y: Polyneuritis caused by n-hexane and the maximum allowable concentration, in Proceedings of 16th International Congress of Occupational Medicine, 1969, pp 522-24

101. Cavigneaux A: [Polyneuritis caused by n-hexane.] Cah Notes Document 67:199-202, 1972 (Fre)

102. ACGIH Committee on Threshold Limit Values: Heptane. To be published in Documentation of Threshold Limit Values by American Conference of Governmental Industrial Hygienists

103. ACGIH Committee on Threshold Limit Values: Octane. To be published in Documentation of Threshold Limit Values by American Conference of Governmental Industrial Hygienists

104. Flury F, Zernik F: [Mineral oil and mineral oil products, in Noxious Gases.] Berlin, J Springer, 1931, pp 258-61 (Ger)

105. Pennsylvania Dept of Environmental Resources: Title 25: Rules and Regulations; Pt 1: Dept of Environmental Resources; Subpart D: Environmental Health and Safety; Article IV: Occupational Health and Safety; Chapter 201: Places of Employment; Subchapter A: Threshold Limits. 201.1-201.121 Adopted Sept 28, 1971, effective Nov 1, 1971

106. Permissible Levels of Toxic Substances in the Working Environment--6th 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 201-03,209-11,218,225-26,234,237-38,249,351

107. Work Groups for Determination of MAK Values and Determination of Limit Values for Dusts: Work Substances Harmful to Health--

Toxicologic and Occupational-Medical Justifications of MAK Values (Maximum Work Place Concentrations). Wurzburg, Germany, Verlag Chemie, 1974, 6 pp

108. National Board of Occupational Safety and Health: Limit Values--Directions Concerning Limit Values for Air Contaminants at Places of Work, Directions No. 100. Translation issued by the National Board of Occupational Safety and Health, Stockholm, Sweden, October 1974, p 16

109. [Recommendation for permissible concentrations, etc.] Sangyo Igaku 13:475-84, 1971 (Jap)

110. American Conference of Governmental Industrial Hygienists: Threshold Limit Values of Air-borne Contaminents [sic] for 1968--Recommended and Intended Values. Cincinnati, ACGIH, 1968, 26 pp

111. Pritchard JA: A Guide to Industrial Respiratory Protection--NIOSH Technical Information. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1976, pp 137-45

112. National Fire Protection Association: National Fire Codes--A Compilation of NFPA Codes, Standards, Recommended Practices, and Manuals--Electrical, NFPA No. 70. Boston, NFPA, vol 5, 1974, pp 70-77 to 70-78,70-290 to 7-291

113. The use of safety cans and caution in handling and storing flammable liquids. Monitor 46:12, 1973

114. Hagopian JH, Bastress EK: Recommended Industrial Ventilation Guidelines, HEW Publication No. (NIOSH) 76-162. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Division of Physical Sciences and Engineering, 1976, 330 pp

115. Hygienic Guide Series--Heptane (n-Heptane). Akron, Ohio, American Industrial Hygiene Association, 1959, 2 pp

116. Hygienic Guide Series--Hexane (n-Hexane). Akron, Ohio, American Industrial Hygiene Association, 1959, 2 pp

117. Hygienic Guide Series--Pentane (n-Pentane). Akron, Ohio, American Industrial Hygiene Association, 1966, 2 pp

118. Sterner JH: Study of hazards in spray painting with gasoline as a diluent. J Ind Hyg Toxicol 23:437-48, 1941

119. McNair HM, Bonelli EJ: Basic Gas Chromatogarphy. Berkeley, Calif, 1969, pp 142-48