VII. RESEARCH NEEDS

Information needed to develop a standard for occupational exposure to the diisocyanates is incomplete in many respects. It has been necessary to recommend a standard for the diisocyanates based on similarities to TDI and MDI, since adequate information is not available on other diisocyanates to demonstrate that they differ appreciably in their toxicity.

Detailed epidemiologic studies are needed to determine the long-term health effects of occupational exposure to diisocyanates and safe levels for such exposures. These studies should relate respiratory symptoms, pulmonary function data, and other health effects to actual individual exposures and should include long-term followup of persons leaving the workforce for health reasons.

Studies are required to ascertain whether all of the diisocyanates are sensitizing agents and whether they can produce cross-sensitizaton. Karol et al [62,110] have developed a test antigen by conjugating p-tolyl isocyanate with a protein carrier that has made it possible to demonstrate the existence of hapten-specific antibodies in workers exposed to TDI. Similar antigens would be useful for investigating the sensitizing properties of other diisocyanates, both in exposed workers and in animal studies.

Particularly needed are dose-response studies of sensitization to the diisocyanates to determine whether sensitization can result from long-term exposures at low concentrations and to investigate the relationship of length of exposure to the development of sensitization. These relationships could be studied in guinea pigs exposed to TDI, using the p-tolyl isocyanate antigen [110] to test for the induction of tolyl-specific antibodies. Sera from these animals should not be pooled, so that the standard deviation can be determined. Changes in respiratory response in exposed animals should also be evaluated to determine their correlation with the appearance of IgE or IgG antibodies. As a corollary experiment, animals should be exposed at the same total dose administered over varying time periods to simulate the effects of excursions while retaining the same 8-hour TWA exposure; eg, groups of animals might be exposed at 5 ppb for 8 hours, 160 ppb for 15 minutes, and 2,400 ppb for 1 minute.

To improve protection of exposed workers, it is particularly desirable to determine whether there are intrinsic, predictable differences between sensitizable and nonsensitizable individuals. The studies of Butcher et al [63,65], showing that persons sensitized to TDI tend to be hyperreactive to bronchoconstrictors such as mecholyl, appear to offer promise in this regard. It is necessary to determine whether this hyperreactivity is a result of exposure or a preexisting factor that may indicate a predisposition to become sensitized to diisocyanates. Methods of identifying sensitized individuals before overt chronic symptoms develop should also be explored. The value of measurements of eosinophilia and cyclic AMP and of

pulmonary function studies and immunologic testing as diagnostic tools should be carefully evaluated, since existing reports of their usefulness are contradictory. The p-tolyl isocyanate test antigen developed by Karol and her colleagues [62] appears to be a particularly useful diagnostic tool for TDI sensitization, and analogous antigens should be developed for investigating sensitization to other diisocyanates.

Because the diisocyanates may be highly reactive biologically, it is important that their potential to cause carcinogenic and mutagenic effects be investigated. Mutagenicity screening in microbial tests should be carried out, using a test protocol that will decrease the likelihood of hydrolysis to possibly mutagenic amine intermediates. Diisocyanates, especially those that are positive in mutagenicity tests, should also be tested for carcinogenicity in animal experiments. Studies of absorption, distribution, metabolism, and excretion of diisocyanates are also needed to elucidate the mechanism of their action.

The consequences of exposure to the aerosols produced in many diisocyanate applications, such as spraying, should also be investigated. It has been assumed that reactive diisocyanates in aerosol form produce the same biologic consequences as diisocyanate vapors at equivalent concentrations. This assumption should be experimentally verified. Similarily, most applications of diisocyanates involve simultaneous exposure to other toxic chemicals, and inadequate information is available on the role of these chemicals in producing observed health effects in diisocyanate workers and their possible additive or synergistic nature.

Reliable, sensitive continuous monitoring methods should be developed for all the diisocyanates. The paper-tape method developed by Reilly [136] is a valuable method for continuous monitoring of the aromatic diisocyanates, particularly TDI. Comparable methods are needed for other diisocyanates to protect workers from dangerous excursions and to provide better information relating health effects to actual exposures.

VIII. REFERENCES

1. Operating and Medical Codes of Practice for Safe Working with Isocyanates--A Report of the Isocyanate Sub-Committee of the British Rubber Manufacturers' Association Ltd Health Advisory Committee, rev. Birmingham, British Rubber Manufacturers' Association, Health Research Unit, 1977, 84 pp

2. Woolrich PF: Monoisocyanates, Diisocyanates and Polyisocyanates--Engineering, Medical Control and Toxicologic Considerations, Technical Bulletin No. 106. Kalamazoo, Mich, The Upjohn Co, 1973, 21 pp

3. Isocyanates (TDI and MDI). Natl Saf News 98:61-65, 1968

4. Sax NI: Dangerous Properties of Industrial Materials, ed 4. New York, Van Nostrand Reinhold Co, 1975, pp 493,549,552,593,920,926,1176

5. Lomonova GV, Frolova IN: [Comparative toxicity of hexamethylene diisocyanate and chlorohexyl isocyanate.] Gig Tr Prof Zabol 12:40-44, 1968 (Rus)

6. VEBA-IPDI--Unmatched for versatility, Data Sheet No. 22. Gelsenkirchen-Buer, West Germany, VEBA-CHEMIE AG, 1977, 79 pp

7. Information Concerning the Development of the Criteria Document and Recommended Health Standard for Organoisocyanates. Unpublished report submitted to NIOSH by Barnes JR, EI du Pont de Nemours and Co, Wilmington, Del, June 13, 1978, 1 p

8. Woolrich PF, Rye WA: Urethanes--Engineering, medical control and toxicologic considerations. J Occup Med 11:184-90, 1969

9. Chemical Safety Data Sheet SD-73--Properties and Essential Information for Safe Handling and Use of Toluene Diisocyanate, rev. Washington, DC, Manufacturing Chemists Association, 1971, 19 pp

10. Hawley GG (ed.): The Condensed Chemical Dictionary, ed 8. New York, Van Nostrand Reinhold Co, 1971, p 443

11. Lowe A: The chemistry of isocyanates. Proc R Soc Med 63:367-68, 1970

12. Arnold RG, Nelson JA, Verbanc JJ: Recent advances in isocyanate chemistry. Chem Rev 57:47-76, 1957

13. Dombrow BA: Reinhold Plastics Applications Series--Polyurethanes. New York, Reinhold Publishing Corp, 1957, 176 pp

14. Tubich GE: The potential health hazards of the new oil base no-bake binders. Trans Am Foundrymen's Soc 74:448-53, 1967

15. Diisocyanates and polyisocyanates, in Chemical Economics Handbook. Menlo Park, Calif, SRI International, 1976, pp 666.5021 B to 666.5021 D

16. Key MM, Henschel AF, Butler J, Ligo RN, Tabershaw IR (eds.): Occupational Diseases--A Guide to their Recognition, DHEW (NIOSH) Publication No. 77-181, rev. US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1977, pp 233-35

17. Williamson KS: Studies of diisocyanate workers (1). Trans Assoc Ind Med Off 14:81-88, 1964

18. Munn A: Hazards of isocyanates. Ann Occup Hyg 8:163-69, 1965

19. Friebel H, Luchtrath H: [The effect of toluene diisocyanate (Desmodur T) on the respiratory passages.] Arch Exp Pathol Pharmakol 227:93-110, 1955 (Ger)

20. Brugsch HG, Elkins HB: Toluene di-isocyanate (TDI) toxicity. N Engl J Med 268:353-57, 1963

21. Fuchs S, Valade P: [Clinical and experimental study of several cases of intoxication by Desmodur T (toluene diisocyanate 1-2-4 and 1-2-6).] Arch Mal Prof 12:191-96, 1951 (Fre)

22. Reinl W: [Diseases in the manufacture of polyurethane-based plastics.] Zentralbl Arbeitsmed Arbeitsschutz 3:103-07, 1953 (Ger)

23. Swensson A, Holmquist C, Lundgren K: Injury to the respiratory tract by isocyanates used in making lacquers. Br J Ind Med 12:50-53, 1955

24. Schur E: [Injury from Desmodur lacquers--Irritating gas or allergy?] Med Klin 54:168-70, 1959 (Ger)

25. Reinl W: [Occupational asthma and similar illnesses and their insurance coverage.] Zentralbl Arbeitsmed Arbeitsschutz 5:33-37, 1955 (Ger)

26. Ganz H, Mager E: [Injuries to health by Moltopren foam material.] Zentralbl Arbeitsmed Arbeitsschutz 4:42-44, 1954 (Ger)

27. Schuermann D: [Injuries to health caused by modern varnishes and foam materials.] Dtsch Med Wochenschr 80:1661-63, 1955 (Ger)

28. Woodbury JW: Asthmatic syndrome following exposure to tolylene diisocyanate. Ind Med Surg 25:540-43, 1956

29. Johnstone RT: Toluene-2,4-diisocyanate--Clinical features. Ind Med Surg 26:33-34, 1957

30. Sands FW, Boffardi G, James KE, Lundy W, Walsh WS: Toluene diisocyanate--Engineering and medical control of exposures in polyurethane foam manufacturing. Am Ind Hyg Assoc Q 18:331-34, 1957

31. Walworth HT, Virchow WE: Industrial hygiene experiences with toluene diisocyanate. Am Ind Hyg Assoc J 20:205-10, 1959

32. Elkins HB, McCarl GW, Brugsch HG, Fahy JP: Massachusetts experience with toluene di-isocyanate. Am Ind Hyg Assoc J 23:265-72, 1962

33. Goldblatt MW, Goldblatt J: Industrial carcinogenesis and toxicology, in Merewether ERA (ed.): Industrial Medicine and Hygiene. London, Butterworth and Co (Publishers) Ltd, 1956, vol 3, pp 421-30,557-62

34. Gerritsen WB: [Allergic asthma caused by isocyanates.] Chem Weekbl 51:269-70, 1955 (Dut)

35. Munn A: Experience with diisocyanates. Trans Assoc Ind Med Off 9:134-38, 1960

36. Zapp JA Jr: Hazards of isocyanates in polyurethane foam plastic production. AMA Arch Ind Health 15:324-30, 1957

37. Criteria for a Recommended Standard....Occupational Exposure to Toluene Diisocyanate, Publication No. HSM 73-11022. Rockville, Md, US Dept of Health, Education, and Welfare, Public Health Service, National Institute for Occupational Safety and Health, 1973, 97 pp

38. Henschler D, Assmann W, Meyer KO: [The toxicology of the toluene diisocyanates.] Arch Toxikol 19:364-87, 1962 (Ger)

39. Ehrlicher H, Pilz W: [Preventive measures in industrial hygienics and occupational medicine when using isocyanates (Desmodur) and analytical determination of some aromatic isocyanates--Part II.] Arbeitsschutz (Cologne), 1957, pp 7-10 (Ger)

40. Maxon FC Jr: Respiratory irritation from toluene diisocyanate. Arch Environ Health 8:755-58, 1964

41. Williamson KS: Studies of diisocyanate workers (2). Trans Assoc Ind Med Off 15:29-35, 1965

42. Charles J, Bernstein A, Jones B, Jones DJ, Edwards JH, Seal RME, Seaton A: Hypersensitivity pneumonitis after exposure to isocyanates. Thorax 31:127-36, 1976

43. Pepys J, Pickering CAC, Breslin ABX, Terry DJ: Asthma due to inhaled chemical agents--Tolylene di-isocyanate. Clin Allergy 2:225-36, 1972

44. Meddle DW, Radford DW, Wood R: A field method for the determination of organic aromatic isocyanates in air. Analyst (London) 94:369-76, 1969

45. Carroll KB, Secombe CJP, Pepys J: Asthma due to non-occupational exposure to toluene (tolylene) di-isocyanate. Clin Allergy 6:99-104, 1976

46. O'Brien IM, Newman-Taylor AJ, Burge PS, Harries MG, Fawcett IW, Pepys J: Toluene diisocyanate-induced asthma--Inhalation challenge tests and bronchial reactivity studies. Accepted for publication in Clin Allergy

47. O'Brien IM, Harries MG, Burge PS, Pepys J: Di-isocyanate induced asthma--Reactions to TDI, MDI, HDI and histamine. Accepted for publication in Clin Allergy

48. Longley EO: Methane diisocyanate--A respiratory hazard? Arch Environ Health 8:898, 1964

49. Lob M: [Fever caused by diphenylmethane-diisocyanate (MDI).] Schweiz Med Wochenschr 102:647-49, 1972 (Fre)

50. Lapp NL: Physiological changes as diagnostic aids in isocyanate expsoure. Am Ind Hyg Assoc J 32:378-82, 1971

51. Scheel LD, Killens R, Josephson A: Immunochemical aspects of toluene diisocyanate (TDI) toxicity. Am Ind Hyg Assoc J 25:179-84, 1964

52. Bruckner HC, Avery SB, Stetson DM, Dodson VN, Ronayne JJ: Clinical and immunologic appraisal of workers exposed to diisocyanates. Arch Environ Health 16:619-25, 1968

53. Nava C, Arbosti G, Briatico-Vangosa G, Cirla AM, Marchisio M, Zedda S: Pathology produced by isocyanates--Methods of immunological investigation. Ric Clin Lab 5:135-45, 1975

54. Butcher BT, Salvaggio JE, Weill H, Ziskind MM: Toluene diisocyanate (TDI) pulmonary disease--Immunologic and inhalation challenge studies. J Allergy Clin Immunol 58:89-100, 1976

55. Taylor G: Immune responses to tolylene diisocyanate (TDI) exposure in man. Proc R Soc Med 63:379-80, 1970

56. Porter CV, Higgins RL, Scheel LD: A retrospective study of clinical, physiologic and immunologic changes in workers exposed to toluene diisocyanate. Am Ind Hyg Assoc J 36:159-68, 1975

57. Weill H, Salvaggio J, Ziskind M, Jones RN, Diem J, Butcher B, Carr J, Glindmeyer H, Dharmarajan V: Respiratory and Immunologic Evaluation of Isocyanate Exposure in a New Manufacturing Plant. Unpublished report submitted to NIOSH by Tulane University School of Medicine, New Orleans, La, June 1977, 84 pp

58. Butcher BT, Jones RN, O'Neil CE, Glindmeyer HW, Diem JE, Dharmarajan V, Weill H, Salvaggio JE: Longitudinal study of workers employed in the manufacture of toluene-diisocyanate. Am Rev Respir Dis 116:411-21, 1977

59. Weill H, Salvaggio J, Ziskind M, Jones RN, Diem J, Butcher B, Carr J, Glindmeyer H, Dharmarajan V: Annual Report--Respiratory and Immunologic Evaluation of Isocyanate Exposure in a New Manufacturing Plant. Unpublished report submitted to NIOSH by Tulane University School of Medicine, New Orleans, La, Apr 1978, 27 pp

60. Konzen RB, Craft BF, Scheel LD, Gorski CH: Human response to low concentrations of p,p-diphenylmethane diisocyanate (MDI). Am Ind Hyg Assoc J 27:121-27, 1966

61. Vandervort R, Lucas JB: Owens-Corning Fiberglass Corporation--Huntingdon, Pennsylvania, Health Hazard Evaluation Determination Report No. 73-78-60. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1973, 10 pp

62. Karol MH, Ioset HH, Alarie YC: Tolyl-specific IgE antibodies in workers with hypersensitivity to toluene diisocyanate. Am Ind Hyg Assoc J 39:454-58, 1978

63. Butcher BT, Salvaggio JE, O'Neil CE, Weill H, Garg O: Toluene diisocyanate pulmonary disease--Immunopharmacologic and mecholyl challenge studies. J Allergy Clin Immunol 59:223-27, 1977

64. Van Ert M, Battigelli MC: Mechanism of respiratory injury by TDI (toluene diisocyanate). Ann Allergy 35:142-47, 1975

65. Butcher BT, Karr RM, O'Neil CE, Davies RJ, Salvaggio JE: Toluene diisocyanate (TDI) pulmonary disease--Studies of mediators and inhalation challenge testing in sensitized workers. J Allergy Clin Immunol 60:138, 1978 (Abst)

66. Butcher BT: Studies of sensitive workers manufacturing toluene diisocyanate. J Occup Med 20:290, 1978 (Abst)

67. Woolrich PF, Rye WA: Urethanes--Engineering, Medical Control and Toxicologic Considerations, Technical Bulletin No. 105. Kalamazoo, Mich, The Upjohn Co, Industrial Health Services, 1972, 25 pp

68. Precautions for the Proper Usage of Polyurethanes, Polyisocyanurates and Related Materials, Technical Bulletin No. 107. Kalamazoo, Mich, The Upjohn Co, Upjohn Chemical Division, 1973, 40 pp

69. Rothe A: [Occupational skin diseases caused by polyurethane chemicals.] Berufs-Dermatosen 24:7-24, 1976 (Ger)

70. Chizikov VA: [The biological action and hygienic characteristics of small concentrations of stilbene diisocyanate.] Tr Tsentr Inst Usoversh Vrachei 76:324-26, 1964 (Rus)

71. Mastromatteo E: Recent occupational health experiences in Ontario. J Occup Med 7:502-11, 1965

72. Burton D: Review of workmen's compensation disease claims from the plastics industry in Ontario, in Transactions of the 34th Annual Meeting of the American Conference of Governmental Industrial Hygienists, San Francisco, May 14-19, 1972, pp 147-55

73. Le Quesne PM, Axford AT, McKerrow CB, Jones AP: Neurological complications after a single severe exposure to toluene di-isocyanate. Br J Ind Med 33:72-78, 1976

74. Axford AT, McKerrow CB, Jones AP, Le Quesne PM: Accidental exposure to isocyanate fumes in a group of firemen. Br J Ind Med 3:65-71, 1976

75. Filatova VS, Babochkina MS, Kurando TB: [Problems of industrial hygiene and the state of health of workers in diisocyanate production plants.] Gig Tr Prof Zabol 6:25-31, 1962 (Rus)

76. Filatova VS, Kurando TB, Tubina AY: [Industrial hygiene and health status of workers engaged in production of hexamethylenediisocyanate.] Gig Tr Prof Zabol 12:3-7, 1968 (Rus)

77. Brodie BB, Reid WD, Cho AK, Sipes G, Krishna G, Gillette JR: Possible mechanism of liver necrosis caused by aromatic organic compounds. Proc Natl Acad Sci 68:160-64, 1971

78. Dilley JV: Final Report--Toxic Evaluation of Inhaled Chlorobenzene (Monochlorobenzene). Unpublished report submitted to NIOSH by SRI International, Menlo Park, Calif, 1977, 76 pp

79. Hama GM: Symptoms in workers exposed to isocyanates--Suggested exposure concentrations. AMA Arch Ind Health 16:232-33, 1957

80. Glass WI, Thom NG: Respiratory hazards associated with toluene di-isocyanate in polyurethane foam production. NZ Med J 63:642-47, 1964

81. Gandevia B: Studies of ventilatory capacity and histamine response during exposure to isocyanate vapour in polyurethane foam manufacture. Br J Ind Med 20:204-09, 1963

82. Adams WGF: Lung function of men engaged on the manufacture of tolylene diisocyanate (TDI). * Proc R Soc Med 63:378-79, 1970

83. Adams WGF: Long-term effects on the health of men engaged in the manufacture of tolylene di-isocyanate. Br J Ind Med 32:72-78, 1975

84. Peters JM, Murphy RLH, Pagnotto LD, Van Ganse WF: Acute respiratory effects in workers exposed to low levels of toluene diisocyanate (TDI). Arch Environ Health 16:642-47, 1968

85. Peters JM, Murphy RLH, Ferris BG Jr: Ventilatory function in workers exposed to low levels of toluene diisocyanate--A six-month follow-up. Br J Ind Med 26:115-20, 1969

86. Peters JM, Murphy RLH, Pagnotto LD, Whittenberger JL: Respiratory impairment in workers exposed to "safe" levels of toluene diisocyanate (TDI). Arch Environ Health 20:364-67, 1970

87. Peters JM: Cumulative pulmonary effects in workers exposed to tolylene diisocyanate. Proc R Soc Med 63:372-75, 1970

88. Musk AW, Peters JM, DiBerardinis L, Murphy RL: Acute and long term pulmonary function changes in subjects exposed to low concentrations of toluene di-isocyanate and diphenyl methane di-isocyanate. Am Rev Respir Dis 117:252, 1978 (Abst)

89. Wegman DH, Pagnotto LD, Fine LJ, Peters JM: A dose-response relationship in TDI workers. J Occup Med 16:258-60, 1974

90. Wegman DH, Peters JM, Pagnotto L, Fine LJ: Chronic pulmonary function loss from exposure to toluene diisocyanate. Br J Ind Med 34:196-200, 1977

91. Bunge W, Ehrlicher H, Kimmerle G: Medical aspects of work with surface coating systems using the spraying technique. Z Arbeitsmed Arbeitsschutz Prophylaxe 4 (Special Ed):1-46, 1977

92. Weill H, Salvaggio J, Neilson A, Butcher B, Ziskind M: Respiratory effects in toluene diisocyanate manufacture--A multidisciplinary approach. Environ Health Perspect 11:101-08, 1975

93. Vandervort R, Shama SK: King Seeley Thermos Company--Macomb, Illinois, Health Hazard Evaluation Determination Report No. 73-30-90. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1973, 18 pp

94. Grim KE, Linch AL: Recent isocyanate-in-air analysis studies. Am Ind Hyg Assoc J 25:285-90, 1964

95. Roper CP Jr, Cromer JW Jr: General Tire and Rubber Company--Marion, Indiana, Health Hazard Evaluation Determination Report No. 74-118-218. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1975, 18 pp

96. Bodner AH, Butler GJ, Okawa MT: American Standard Fiberglass--Stockton, California, Health Hazard Evaluation Determination Report No. 73-103-128. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1974, 10 pp

97. Tanser AR, Bourke MP, Blandford AG: Isocyanate asthma--Respiratory symptoms caused by diphenyl-methane di-isocyanate. Thorax 28:596-600, 1973

98. Saia B, Fabbri L, Mapp C, Marcer G, Mastrangelo G: Epidemiology of chronic non-specific lung disease in a population exposed to isocyanate--I. Analysis of symptoms. Med Lav 67:278-84, 1976

99. Fabbri L, Saia B, Mapp C, Marcer G, Mastrangelo G: Epidemiology of chronic non-specific lung disease in a population exposed to isocyanate--II. Analysis of respiratory impairment. Med Lav 67:305-14, 1976

100. Hervin RL, Thoburn TW: Trans World Airlines Main Overhaul Facility, Kansas City International Airport--Kansas City, Missouri, Health Hazard Evaluation Determination Report No. 72-96-237. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1975, 38 pp

101. Duncan B, Scheel LD, Fairchild EJ, Killens R, Graham S: Toluene diisocyanate inhalation toxicity--Pathology and mortality. Am Ind Hyg Assoc J 23:447-56, 1962

102. Information Concerning the Development of the Criteria Document and Recommended Health Standard for Organoisocyanates. Unpublished report submitted to NIOSH by Queener JS, EI du Pont de Nemours and Co, Wilmington, Del, 1972, 71 pp

103. Harton EE Jr, Rawl RR: Toxicological and Skin Corrosion Testing of Selected Hazardous Materials--April 1976, Final Report. Springfield, Va, US Dept of Commerce, National Technical Information Service, 1976, 28 pp (NTIS PB 264 975)

104. Information Concerning the Development of the Criteria Document and Recommended Health Standard for Organoisocyanates. Unpublished report submitted to NIOSH by VEBA-CHEMIE AG, Gelsenkirchen-Buer, West Germany, May 1978, 9 pp

105. Dernehl CU: Health hazards associated with polyurethane foams. J Occup Med 8:59-62, 1966

106. Niewenhuis R, Scheel L, Stemmer K, Killens R: Toxicity of chronic low level exposures to toluene diisocyanate in animals. Am Ind Hyg Assoc J 26:143-49, 1965

107. Kondratyev GG, Mustayev RK: [Study of the allergenic properties of hexamethylenediisocyanate in an experiment.] Springfield, Va, US Dept of Commerce, National Technical Information Service, 1974, 6 pp (AD/A 000 167) (Rus)

108. Thompson GE, Scheel LD: Alteration of lung pathology from diisocyanate by glycemic or sensitizing agents. Arch Environ Health 16:363-70, 1968

109. Stevens MA, Palmer R: The effect of tolylene diisocyanate on certain laboratory animals. Proc R Soc Med 63:380-82, 1970

110. Karol MH, Ioset HH, Riley EJ, Alarie YC: Hapten-specific respiratory hypersensitivity in guinea pigs. Am Ind Hyg Assoc J 39:546-56, 1978

111. Marcali K: Microdetermination of toluenediisocyanates in atmosphere. Anal Chem 29:552-58, 1957

112. Dharmarajan V, Weill H, Self CW: Environmental characterization of toluene diisocyanate (TDI) in a manufacturing plant. Am Ind Hyg Assoc J 39:414-18, 1978

113. Keller J, Dunlap KL, Sandridge RL: Determination of isocyanates in the working atmosphere by thin-layer chromatography. Anal Chem 46:1845-46, 1974

114. Butler GJ, Taylor JS: Uniroyal Incorporated--Mishawaka, Indiana, Health Hazard Evaluation Report No. 72-13-27. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1973, 21 pp

115. Fitzpatrick M, Craft R, Warren JW, Laird FH, Watson HA, Harris EJ, Beatty RL, Scheel LD: An industrial hygiene survey of polyurethane foam applications in an underground mine. Am Ind Hyg Assoc J 25:569-77, 1964

116. Dharmarajan V, Weill H: Physical state of airborne p,p'-diphenylmethane diisocyanate (MDI) and its measurement. Am Ind Hyg Assoc J 39:737-44, 1978

117. Guide for the Safe Handling and Use of Urethane Foam Systems. New York, Society of the Plastics Industry Inc, The Cellular Plastics Division, The Urethane Systems Manufacturers' Committee, 1971, 4 pp

118. Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971. New York, American National Standards Institute Inc, 1971, 63 pp

119. Hagopian JH, Bastress EK: Recommended Industrial Ventilation Guidelines, DHEW 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

120. Toxicity and Safe Handling of Isocyanates--A Review of the Literature (TDI) and Results of Toxicity Screening Studies on Additional Compounds. Pittsburgh, Pa, Mobay Chemical Co, 15 pp (undated)

121. Isocyanates--Hazards and Safe Handling Procedures, Technical Information Leaflet No. U93, ed 4. Manchester, England, Imperial Chemical Industries Ltd, Organics Division, Application Research and Technical Service Dept, 1976, 12 pp

122. Dyson WL, Hermann ER: Reduction of atmospheric toluene diisocyanate by water vapor. Am Ind Hyg Assoc J 32:741-44, 1971

123. Vogt CRH, Ko CY, Ryan TR: Modification of An Analytical Procedure for Isocyanates to High Speed Liquid Chromatography. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1976, 87 pp

124. Holland DG, Rooney TA: TDI vapor concentrations. J Occup Med (Lett) 19:239-40, 1977

125. Schanche GW, Hermann ER: Micrograms of TDI by chromatography. Am Ind Hyg Assoc J 35:47-52, 1974

126. Meddle DW, Wood R: A method for the determination of aromatic isocyanates in air in the presence of primary aromatic amines. Analyst (London) 95:402-07, 1970

127. Smith DB, Henderson R: TDI vapor concentrations. J Occup Med (Lett) 17:413-14, 1975

128. Pagnotto LD, Wegman DH: Exposure to triethylenediamine (TEDA) in urethane foam manufacture. J Occup Med (Lett) 18:523-24, 1976

129. Chemistry for Coatings. Pittsburgh, Pa, Mobay Chemical Corp, Plastics and Coatings Division, 1976, 16 pp

130. 2,4-Toluenediisocyanate (TDI) in Air--Physical and Chemical Analysis Branch Analytical Method No. 141, in NIOSH Manual of Analytical Methods, ed 2, DHEW (NIOSH) Publication No. 77-157-A. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1977, vol 1, pp 141-1 to 141-8

131. Skonieczny RF: A field and laboratory evaluation of the Ranta and Marcali methods for TDI. Am Ind Hyg Assoc J 24:17-22, 1963

132. Larkin RL, Kupel RE: Microdetermination of toluenediisocyanate using toluenediamine as the primary standard. Am Ind Hyg Assoc J 30:640-42, 1969

133. Belisle J: A portable field kit for the sampling and analysis of toluene diisocyanate in air. Am Ind Hyg Assoc J 30:41-45, 1969

134. Belisle JW: Air testing process. US Patent No. 3,533,750, Oct 13, 1970, 3 pp

135. Reilly DA: A field method for determining 4,4'-di-isocyanatodiphenylmethane in air. Analyst (London) 92:513-19, 1967

136. Reilly DA: A test-paper method for determination of tolylene di-isocyanate vapour in air. Analyst (London) 93:178-85, 1968

137. Miller JA, Mueller FX: Evaluation of a continuous instrumental method for determination of isocyanates. Am Ind Hyg Assoc J 36:477-83, 1975

138. Information Concerning the Development of the Criteria Document and Recommended Health Standard for Organoisocyanates. Unpublished report submitted to NIOSH by Moore G, MDA Scientific Inc, Park Ridge, Ill, Feb 22, 1978, 12 pp

139. Dunlap KL, Sandridge RL, Keller J: Determination of isocyanates in working atmospheres by high speed liquid chromatography. Anal Chem 48:497-99, 1976

140. 2,4-Toluenediisocyanate (TDI)--Standards Completion Program Failure Report No. S344. Cincinnati, US Dept of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, 1977, pp S344-1 to S344-4

141. Fisher AA: Contact Dermatitis. Philadelphia, Lea and Febiger, 1967, pp 134-35

142. Saunders JH, Frisch KC: Polyurethanes--Chemistry and Technology--Part I. Chemistry. New York, Interscience Publishers, 1962, pp 17-61

143. Rye WA: Human responses to isocyanate exposure. J Occup Med 15:306-07, 1973

144. Recommendations for the Handling of Aromatic Isocyanates, No. SC/EC-1. New York, International Isocyanate Institute Inc, 1976, 12 pp

145. Practices for Respiratory Protection, ANSI Z88.2-1969. New York, American National Standards Institute Inc, 1969, 29 pp

146. Peterson JE, Copeland RA, Hoyle HR: Health hazards of spraying polyurethane foam out-of-doors. Am Ind Hyg Assoc J 23:345-52, 1962

147. Powell CH, Rose VE: Engineering management of new applications of isocyanates. J Occup Med 11:132-35, 1969

148. Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1968, partial revision of ANSI Z2.1-1959. New York, American National Standards Institute Inc, 1968, 32 pp

149. Threshold Limit Values for 1959, Adopted at the 21st Annual Meeting, ACGIH, Chicago, Apr 25-28, 1959. Cincinnati, American Conference of Governmental Industrial Hygienists, 1959, p 268

150. Threshold Limit Values for 1962, Adopted at the 24th Annual Meeting, ACGIH, Washington, DC, May 13-15, 1962. Cincinnati, American Conference of Governmental Industrial Hygienists, 1962, p 9

151. Documentation of Threshold Limit Values. Cincinnati, American Conference of Governmental Industrial Hygienists, Committee on Threshold Limit Values, 1962, p 104

152. Threshold Limit Values for 1963, Adopted at the 25th Annual Meeting, ACGIH, Cincinnati, May 6-7, 1963. Cincinnati, American Conference of Governmental Industrial Hygienists, 1963, pp 9,11

153. Documentation of Threshold Limit Values, rev. Cincinnati, American Conference of Governmental Industrial Hygienists, Committee on Threshold Limit Values, 1966, pp 128,191-92

154. Documentation of the Threshold Limit Values for Substances in Workroom Air, ed 3, 1971. Cincinnati, American Conference of Governmental Industrial Hygienists, 2nd printing, 1974, pp 167,170-71,260-61

155. Threshold Limit Values for 1965, Adopted at the 27th Annual Meeting, ACGIH Houston, May 2-4, 1965. Cincinnati, American Conference of Governmental Industrial Hygienists, 1965, pp 12,15,18

156. Occupational Exposure Limits for Airborne Toxic Substances--A Tabular Compilation of Values from Selected Countries--Occupational Safety and Health Series No. 37. Geneva, International Labour Office, 1977, pp 58-59,72-73,92-93, 124-25,132-33,146-49,156-57,178-79,204-05,210-11