Attachment "B"

VINYL CHLORIDE-POLYVINYL CHLORIDE TOXICOLOGY

1930 1. Patty, F. A., et al, "Acute Response of Guinea Pigs to Vapors of New Commercial Organic Compounds", Public Health Reports, 45, 1963.

1937 2. Union Carbide Corporation established a Chemical Hygiene Fellowship under Dr. H. F. Smyth at Mellon Institute of Research, Pittsburgh, Pennsylvania.

1940-1944 3. Mellon Institute of Research conducted sixteen studies of skin sensitization by vinyl chloride resins and compounds.

1947 4. Smyth, H. F., Jr. and Weil, C. S., "Chronic Oral Toxicity to Rats of Vinyl Chloride-Vinyl Acetate Copolymer", Toxicology and Applied Pharmacology, 9, 501-504, 1966.

The work started in 1944 involved feeding rats diets containing 1.5% and 12% of a vinyl chloride resin for two years and included two generations of reproductive studies. No effect attributable to the resin was found.

5. Animal Feeding Studies on Geon 202 by Harvard University for the B. F. Goodrich Company. (Geon 202 is a copolymer of vinyl chloride-vinylidene chloride.)

The feeding of a diet containing five percent by weight of resin to laboratory rats for two years produced no toxic effects or retardation of growth.

The feeding of a diet containing five percent by weight of resin to two dogs did not produce toxic effects or retardation of growth.

6. Oster, R. H., et al, "Narcosis with Vinyl Chloride", Anesthesiology, 8:359, 1947.

1949 7. Carr, J. et al, "Chemical Constitution of Hydrocarbons and Cardiac Automaticity", Journal of Pharmacology Exptl, Ther. 97, 1, (1949).

1949 8. Tribukh, S. L., et al, Gigenia Sanit., 10:38.

Quoted by Marsteller, et al, Splenomegalic Liver Disease, Toxicity of Vinyl Chloride-Polyvinyl Chloride, New York Academy of Sciences, Vol. 246, 1975.

1955 9. Von Oettingen, W. F., "The Halogenated Hydrocarbons, Toxicity and Potential Dangers", United States Public Health Service Publication Number 414, Government Printing Office, Washington, D. C. (1955).

10. Oppenheimer, B. S., et al, "Further Studies of Polymers as Carcinogenic Agents in Animals", Cancer Research, 15, pp. 335-340, 1950.

1956 11. Smyth, H. F., Jr., "Improved Communications-Hygiene Standards for Daily Inhalation", American Industrial Hygiene Association Journal, p. 129, 17, 1956.

1960 12. Mastromatteo, E., et al, "Acute Inhalation Toxicity of Vinyl Chloride to Laboratory Animals", American Industrial Hygiene Association Journal, p. 394, 5, 1960.

Bulletin Hygiene, 36:244.

1961 13. Torkelson, T. R., et al, "The Toxicity of Vinyl Chloride as Determined by Repeated Exposure of Laboratory Animals", American Industrial Hygiene Association Journal, p. 354, 22, Number 5, 1961.

14. Oppenheimer, E. T., et al., "Observations on the Effect of Powdered Polymer in the Carcinogenic Process", Cancer Research, p. 132, 21, 1961.

1962 15. The American Congress of Governmental Industrial Hygienists set the worker exposure to vinyl chloride at 500 ppm for eight-hour TWA weighted average.

16. Lester, D., et al, "Effects of Single and Repeated Exposures of Humans and Rats to Vinyl Chloride", American Industrial Hygiene Association Meeting, Washington, D.C., May, 1962.

1963 17. The American Congress of Governmental Industrial Hygienists set the worker exposure to vinyl chloride at 500 ppm threshold limit value.

1966 18. The Manufacturing Chemists Association Occupational Health Committee met to discuss reported acroosteolysis at B. F. Goodrich, Company plants in October 6, 1966.

1967 19. The Manufacturing Chemists Association sponsored a study of the epidemiology of acroosteolysis in the United States.

20. Wilson, R. H., et al, "Occupational Acroosteolysis", Journal of American Medical Association, Vol. 21, No. 8, 1967.

1968 21. Mutchler, J. E., et al, "Report on the Relation of Exposure to State of Health of Dow Chemical Workers", Gordon Conference, Tilton, New Hampshire, 8-1968.

1969 22. Popow, Jerzy, "Effect of Polyvinyl Chloride (PVC) Dust on the Respiratory System of the Rat", Roczniki Akademii Medcycznei im Juliana Marchlewskiego w Bialymstokur, Supplement 24, p. 5, Vol. 48, 1969.

(Rat exposure 92% of PVC dust particles less than five microns.)

23. Baretta, E. D., et al, "Monitoring Exposures to Vinyl Chloride Vapor: Breath Analysis and Continuous Air Sampling", American Industrial Hygiene Association Journal, p. 537, Vol. 30, 1969.

24. "Epidemiological Investigation of the Polyvinyl Chloride Industry in Reference to Occupational Acroosteolysis", The Institute of Industrial Health, The University of Michigan, February, 1969.

1970 25. Viola, P. L., "Cancerogenic Effect of Vinyl Chloride", Regina Elena Institute for Cancer Research, University of Perugia, Tenth International Cancer Congress, Houston, Texas, May 22, 1970.

1970 Viola, P. L. (continued)

26. "Pathology of Vinyl Chloride", Medicina del Lavoro, Vol. 61, pp. 174-179, March, 1970.

27. "The Vinyl Chloride Disease", Publication not identified, Summer, 1970.

28. "Oncogenic Response of Rat Skin, Lungs and Bones to Vinyl Chloride", Cancer Research, pp. 516-522, Vol. 31, 1971.

1971 29. Szende, C. K., et al, "Pneumoconiosis Developing After Inhalations of Polyvinyl Chloride", Orv. Hetil. 112:85-6, January 10, 1971.

(This is a study of one case of pneumoconiosis where the authors raise the assumption that aspiration of PVC dust may lead to pneumoconiosis. Individual particles were oval or polygonal in shape and 15-25 microns in diameter.)

30. The Manufacturing Chemists Association Occupational Health Committee met with Dr. Viola May 5 and 6, 1971 to discuss the work reported.

31. On October 27, 1971 the MCA Occupational Health Committee recommended that a study of chronic inhalation toxicology be undertaken by industry.

32. On November 16, 1971 an Ad Hoc Planning Group for Vinyl Chloride Research was formed with R. N. Wheeler, Jr. of Union Carbide Corporation Chairman.

33. On December 14, 1971 the Ad Hoc Planning Group met in Washington, D. C. and adopted a basic research plan of:

    1. Chronic Inhalation Toxicity Study at three levels with rats, mice and hamsters.

    2. Vinyl chloride metabolism study.

    3. An Epidemiological Study of PVC Industry Mortality

The program would cost approximately $350,000 for over a three- to four-year period.

(Maltoni at the end of 1970 planned a project to clarify the type and degree of carcinogenic risk from vinyl chloride sponsored by Montedison).

1972 34. Manufacturing Chemists Association requests for sponsorship of the vinyl chloride research project produced subscription of $165,000. The Ad Hoc Planning Group recommended starting the chronic inhalation toxicity study and delaying the remainder of the program until money was available. The Ad Hoc Group disbanded and was replaced by the MCA Technical Task Force for Vinyl Chloride Research under Dr. T. R. Torkelson of Dow.

35. Kramer, C. G., et al, "The Correlation of Clinical and Environmental Measurements for Workers Exposed to Vinyl Chloride", American Industrial Hygiene Journal, January, 1972.

36. The American Congress of Governmental Industrial Hygienists recommended that the TLV for vinyl chloride be reduced to 200 ppm for workers.

37. Chemical Safety Data Sheet SD-56 Vinyl Chloride Manufacturing Chemists Association revised, 1972.

1973 38. The Manufacturing Chemists Association contracted with Industrial Biotest Laboratory to carry out the long-term chronic inhalation study of vinyl chloride. The project was delayed due to relocation of the laboratory and due to unsatisfactory laboratory conditions.

39. The Manufacturing Chemists Association contracted with Tabershaw Cooper Associates, Berkeley, California to do a retrogressive epidemiology study of the workers in the VCM and PVC industry.

40. The MCA also contracted with Dow Chemical to study the metabolism of vinyl chloride in animals on a best efforts basis for one year.

41. Informal reports in confidence were received from Dr. C. Maltoni via Imperial Chemical Industries that rats exposed to 250 ppm of vinyl chloride were showing evidence of tumors. These results, as well as the Manufacturing Chemists Association research program, were discussed with Dr. Marcus Key and associates of NIOSH in mid year by representatives of MCA, Dow, Ethyl, Union Carbide Corporation and Imperial Chemical Industries.

42. Manufacturing Chemists Association reported to NIOSH, EPA and OSHA that mice exposed in the Industrial Biotest Laboratory study were showing evidence of angiosarcoma.

1974 43. The B. F. Goodrich Company reported on January 23, 1974 five workers at their Louisville, Kentucky plant had died of angiosarcoma.

44. NIOSH convened a group of labor, industry and governmental consultants to consider the problem. Union Carbide Corporation was represented by R. N. Wheeler, Jr. The group was unable to agree on a common program and was disbanded after two meetings.

45. Recommended Standard for Occupational Exposure to Vinyl Chloride, National Institute for Occupational Safety and Health, United States Department of Health, Education and Welfare, 1974.

46. OSHA promulgated an Emergency Temporary Standard for Exposure to Vinyl Chloride. Worker exposure was to be limited to 50 ppm ceiling vinyl chloride.

47. Richardson, H. L., "Angiosarcoma of the Human Liver", United States Environmental Protection Agency, April 17, 1974.

48. Occupational Safety and Health Administration Exposure to Vinyl Chloride, United States Department of Labor, (29 CFR 1910.1017) October 21, 1974.

49. Proposed Regulation Vinyl Chloride Final Environmental Impact Statement, Occupational Safety and Health Administration, United States Department of Labor, 1974.

1975 50. OSHA promulgated a Permanent Standard for Vinyl Chloride Exposure with permissible exposure limited to one ppm eight-hour TWA and five ppm ceiling value.

51. "Biological Reactivity of PVC Dust", Nature, Vol. 56, August 21, 1975.

52. "PVC Dust Fells Factory Mice Suggesting New Work Hazard", New Scientist, June, 1975.

53. "Epidemiological Study of Vinyl Chloride Workers", Tabershaw/Cooper Associates, Inc., 2180 Milvia Street, Berkeley, California 94704, May 3, 1974.

1975 54."Vinyl Chloride, Code of Practice for Health Precautions", Health and Safety Executive, London, 1975.

55."VC/PVC: Berspiel einer Prooblemlosung, Heransgeber: Verban Kunststofferzengende Industrie e.v. Frankfurt, Main, 1975.

56.Scientific and Technical Assessment Report on Vinyl Chloride and Polyvinyl Chloride, United States Environmental Protection Agency, 1975.

57.Standard Support and Environmental Impact Statement, Promulgated Emission Standard for Vinyl Chloride, United States Environmental Protection Agency, 1975.

58.Adams, W.G.F. and Purchase I.F.H., "Is PVC Dust A Hazard?", Unpublished Communication, Imperial Chemical Industries, Ltd. Welwyn Garden City, Hertfordshire, England, July 23, 1975.

59.Linch, A. L., "Evaluation of Ambient Air Quality by Personnel Monitoring", pp. 141-145, C.R.C. Press, Inc., 1975.

60.Kuzmack, A. and McGaughy, R., "Quantitative Risk Assessment for Community Exposure to Vinyl Chloride", United States Environmental Protection Agency, 1975.

61.Proposed Standard for Vinyl Chloride, United States Environmental Protection Agency, Society of the Plastics Industry Comments, New York, 1975.

1976 62.Standard Support and Environmental Impact Statement, Emission Standard for Vinyl Chloride, Volume II, United States Environmental Protection Agency, 1976.

63.Report on a Mortality Study Covering Employees of PVC Fabricators, Organization Resources Counselors, Inc., 1625 I Street, N. W., Washington, D. C. 20006, February, 1976.

64.Pigott, G. H., "In Vitro, Studies of a Range of Formulations of PVC", American Chemical Society, New York, New York Meeting, April 4, 1976.

1976 65. Infante, P. F., et al, "Carcinogenic, Mutagenic and Teratogenic Risks Associated with Vinyl Chloride", Mutation Research, pp. 131-142, Vol. 41, 1976.

66. Wheeler, R. N., Jr., "Specialty Vinyl Chloride Resin Processes, Effects of Governmental Regulations", American Chemical Society, San Francisco, California Meeting, September, 1976.

67. Epidemiologic Study of Vinyl Chloride Workers Employed by Union Carbide Corporation, South Charleston, Plant, Equitable Environmental Health, Inc., 2180 Milvia Street, Berkeley, California 94704, December, 1976.

1977 68. Fox, A. J., et al, "Mortality Experience of Workers Exposed to Vinyl Chloride Monomer in the Manufacture of Polyvinyl Chloride in Great Britain", British Journal of Industrial Medicine, pp. 1-10, Vol. 34, 1977.

69. Baxter, P. J., et al, "Angiosarcoma of the Liver in Great Britain 1963-1973", British Medical Journal, pp. 919-921, Vol. 2, 1977.

70. Falk, Henry, et al, "A Cross-Sectional Epidemiologic Survey of Vinyl Chloride Workers", United States Department of Health, Education and Welfare, National Institute for Occupational Safety and Health, Cincinnati, Ohio, April, 1977.

71. Gehring, P. J., et al, "Resolution of Dose-Response Toxicity Data for Chemicals Requiring Metabolic Activation: Example-Vinyl Chloride", Dow Chemical U.S.A., Midland, Michigan 48640, July 12, 1977.

72. MacMahon, Brian, M.D., "Vinyl Chloride and Human Reproduction" The Society of the Plastics Industry, Vinyl Chloride-Polyvinyl Chloride Safety Group, August 15, 1977.

73. Downs, T. D., et al, "Vinyl Chloride, Birth Defects and Fetal Wastage, A Critical Review", The Society of the Plastics Industry, September 16, 1977.

74. Scamehorn, J. F. and Yang, Kang, "Diffusion of Vinyl Chloride in Polyvinyl Chloride Below the Glass Transition Temperature", American Institute of Chemical Engineers, New York, New York Meeting, November, 1977.

1978 75. Epidemiological Study of Vinyl Chloride Workers, Final Report, Manufacturing Chemists Association, Washington, D. C., February, 1978.

76. Chemical Safety Data Sheet SD-56 Vinyl Chloride, Manufacturing Chemists Association Revised, February, 1978.