Technical Summary of Velsicol Corporation Workers' Chemical Exposure and Health Issues

Introduction – This fact sheet is intended to provide a review of the available information regarding workers at the Velsicol/Michigan Chemical Corporation plant and their occupational exposures to a variety of chemical agents. This fact sheet provides:

1. A list of chemicals that were in use at the plant site,
2. A list of chemicals that were measured in 1977 in the air at the plant site (increases the likeliness that workers were exposed to these chemicals),
3. Description of the possibility of worker exposure to multiple chemicals, and
4. A list of health effects observed in workers documented by the National Institute for Occupational Safety and Health (NIOSH) in 1977.

Additional information regarding the PBB Cohort, which studied health effects related to the consumption of polybrominated biphenyl (PBB) contaminated agricultural products, are available from the resources listed at the end of this document.

Background – The Michigan Chemical Corporation (MCC) began operations in 1936 and continued as a subsidiary of Velsicol Chemical Corporation from 1963 until 1978. The fifty-four acre site is located on the Pine River at 500 Bankson Street in St. Louis, Michigan. In 1977, at the time of the NIOSH health hazard evaluation, Velsicol employed approximately 240 hourly workers on 3 shifts. These 240 workers were identified as potentially exposed to the health hazards present at the facility. Out of these workers, 182 consented to participate in the NIOSH study and varying numbers participated in the research studies that followed.

Section I – Defining Chemical Exposure

For a chemical to harm a person's health, the chemical must enter a person's body and reach a quantity that will cause a particular type of harm. The type of harm that may be caused will depend on how the chemical enters the body (for example, inhale the chemical into one's lungs, ingest a chemical through one's mouth and into the digestive system, or contact with the skin), how much chemical enters the body, how long a person is exposed, and how often that exposure occurs. Larger quantities of chemical, longer exposure times, and more frequent exposure events are associated with a greater risk of negative health effects.

If a person is exposed to a large quantity of a chemical, health effects may occur immediately (acute effects) or many years later (chronic effects) or both. Acute effects are easier to link to a given chemical exposure event. Chronic health effects are very difficult if not impossible to link to a past chemical exposure. A negative health effect may be caused by a combination of factors such as a person's lifestyle, genetics, current health condition, as well as past chemical exposures.

Chemicals On-site – Records indicate that the following chemicals were in use at the Velsicol Chemical Corporation plant in the six on-site production areas. These materials and production processes produced between 30-40 chemicals at the St. Louis facility. Production periods for the chemicals varied depending on market need; specifically, PBBs were only manufactured from 1971-1974.

Table 1. *Listing of 27 NIOSH documented chemicals involved in production processes.*

- Benzene
- Bromine
- BTCM (Bromotrichloromethane)
- Carbon Tetrachloride
- DDT
- DEC (Di-Ethyl-Amino-Ethyl-Chloride)
- DIC (Di-isopropyl Amino-Ethyl Chloride Hydrochloride)
- DMC (Beta Dimethyl Amino Ethyl Chloride Hydrochloride)
- DMIC (Beta Dimethyl Amino Isopropyl Chloride)
- DMPC (Gamma-Dimethyl Amino Propyl-Chloride Hydrochloride)
- Ethylene Dichloride
- Firemaster BP 4A (Tetra-Bromo Bis Phenol)
- Firemaster 680, 100, 695 (PBB)
- HBCD (Hexabromocyclododecane)
- HCL (Hydrochloric Acid)
- Hydro-Bromic Acid or Hydrogen Bromide (H Br) Gas
- Iodine
- Lead
- Methenol or Methyl Alcohol
- Methyl Bromide
- PHT_4 (Tetrabromophthalic-Anhydride)
- Sulfuric Acid or Liquid SO_3
- TRIS (2, 3-Dichloropropyl) Phosphate
- Yttrium or other rare earths
- Magnesium Oxide
- Calcium Chloride
- Phenol

Section II – Workplace Air Monitoring

NIOSH investigators identified potential workplace exposures to raw materials, reaction intermediates and final products of production processes. These exposures occurred during the addition of raw materials to reaction processes, quality control sampling, product drying, filtration, and packaging processes, equipment maintenance, presence in ambient air, and through leaks or spills.

The NIOSH Health Hazard Evaluation Determination Report describes the worksite and workplace exposures determined via walkthrough environmental survey and air sampling studies conducted from May to June 1977. Samples were collected by devices worn by operators and through general environmental monitoring. Both membrane filtration and impinger sampling processes were utilized. Gravimetric determination was used to determine the amount of airborne dust collected on the filters and impinger solutions were analyzed by gas chromatography.

Table 2. *Summary of on-site testing conducted to determine worker exposures.*

Type of Test	Chemical(s) Analyzed For	Description
Atmospheric organic vapors	carbon tetrachloride, bromotrichloromethane, ethylene dichloride, benzene, 1-5-9 cyclododecatriene	Samples collected on activated charcoal filters using vacuum pumps at a rate of 50 or 200 milliliters per minute. Pumps were worn by employees and placed in the general area of production activities.
Atmospheric sulfuric acid	sulfuric acid	Samples collected on cellulose and mixed cellulose filters using gravimetric pumps at a flow rate of 1.5 liters per minute. Samples were taken in the employees' breathing zone.
Direct atmospheric measurement	carbon tetra chloride, ammonia, methyl bromide, sulfur dioxide	Samples drawn through stain indicator tubes placed near employees' breathing zone.

Atmospheric total particulates	total particulates (chemicals for which there were no laboratory analytical tests were treated and measured as total particulates)	Measurements were taken with a battery powered respirable dust monitor. Monitoring was conducted in the employees' breathing zone.

Workplace exposures that exceeded recommended standards included ethylene dichloride, carbon tetrachloride, and sulfur dioxide. Other high exposures of concern for which no exposure standards existed included: hexabromocyclododecane, trimethylene chlorobromide, bromotrichloromethane, and tetrabromophthalic anhydride.

A separate report was conducted on operator exposure to the PBB containing Firemaster BP-6. Results of sampling in the PBB production area and subsequent calculations determined that a worker in this area would have inhaled approximately 1 mg of Firemaster BP-6 per day. This exposure resulted in elevated blood levels of BP-6 in workers when compared to a control group (Keplinger, 1975).

Section III – Worker Exposure Information

The chemical exposures each worker experienced would vary depending on their work location(s), the production processes in which they were involved , and the length of time spent working at the plant. The use of the chemicals that exceeded recommended exposure standards would be limited to certain areas of the plant or to specific production processes. This would thereby limit the number of employees potentially exposed. However, employment records indicate that internal transfer between positions was quite common. This could result in many workers being exposed to multiple production processes and multiple chemicals. Additionally, 25% of the total workforce was employed in maintenance positions that serviced all areas of the plant. These workers could potentially have been exposed to all of the chemicals listed. Employment records indicate that of the 184 workers surveyed in 1977, 72% had worked at the plant at least 6 years and 38% had worked there longer than 10 years. These numbers demonstrate that occupational exposures could have occurred for significant periods of time resulting in an increased dose of any contaminant they were exposed to in the workplace. The information provided by the NIOSH study indicates that Velsicol workers were exposed to a variety of chemicals for extended periods of time and through multiple routes during manufacturing and maintenance processes.

Section IV – Health Effects

Exposure to the chemicals indicated does not mean that you will definitely experience adverse health effects. Only your physician can assess your current condition and answer questions regarding your current health status. This section will present health findings related to the NIOSH study and subsequent research studies that were published in the scientific literature.

NIOSH sampling and Velsicol records indicate the potential for significant worker exposures. Because of these findings, in 1977 NIOSH conducted employee medical examinations of all workers who agreed to participate. A variety of health effects that were related to the workplace exposures were identified. The health effects associated with these chronic exposures are often different than those observed from one time or brief exposure durations. The specific chemicals implicated as exceeding workplace standards (ethylene dichloride, carbon tetrachloride, and sulfur dioxide) are known to affect the liver, kidney, skin, neurological, eye, and adrenal glands. The results of NIOSH's employee medical examinations of these organs indicated several abnormalities among the workers examined. These abnormalities could be cause by years of occupational exposure to the chemicals identified or could be due to other factors known as

confounders. Potential confounders identified in this group were primarily related to alcohol consumption and tobacco use.

Table 3. *Health effects observed during NIOSH medical examinations.*

- 147 (81%) employees with acneform skin lesions
- Many employees showed signs of occupational liver disease: 152 (84%) with enlarged livers and 18 to 61 (10.1 to 33.9%) with abnormal liver enzymes
- 50 (27.6%) found to have obstructive pulmonary disease
- 48 (26%) with high blood pressure and 23 (22.5%) with elevated blood levels of low density lipoprotein (LDL)
- 24 (61.5%) of 39 employees tested had abnormal blastogenesis indicating suppressed immune system function
- Up to 52 (29.2%) individuals with abnormalities in their red blood cell indices
- 108 (60.7%) with band neutrophil white cells in peripheral blood
- Impaired performance on psychomotor dexterity test
- High incidence of psychological complaints

Note: percentages vary depending on the number of individuals tested.

Additional studies compared PBB levels of chemical workers to those of farmers on quarantined farms (due to high PBB levels in tested animals during the 1970s), members of the PBB Cohort, and the general population. Some studies simply compared PBB levels in the blood while other tried to link PBB levels to specific health effects. These studies do apply to Velsicol workers because of the PBB exposures that were investigated, however worker exposures to PBB and other chemicals were very different than the exposures encountered by the comparison populations.

- A study by Henry Anderson in 1978 compared chemical workers to exposed farmers. Chemical workers showed a significant increase in the prevalence of “chest” and “skin” symptoms when compared to the farmers. The 55 chemical workers also showed an increased prevalence of abnormal liver function when compared to the farmers although the result was not statistically significant.

- In 1979, J. George Bekesi looked for impaired immune function in a sample of 11 chemical workers. The four workers who worked directly in the PBB production area showed functional defects in their T-cell and marginal changes in B-lymphocyte function. Bekesi also found that PBB content in white cells was directly related to the severity of workplace exposure.

- A study by Joseph Chanda in 1981 explored the cutaneous effects of PBBs. He found a significant increase in prevalence of halogen acne in the chemical workers studied compared to the control population (Chanda, 1982).

These three studies echo the findings of the NIOSH Health Hazard Evaluation, which also found increased lung, liver and skin symptoms in chemical workers when compared to control groups. In response to their findings, NIOSH specifically recommended discontinuing exposures and long-term monitoring of the most affected individuals.

Section V – Additional Studies

The Michigan Chemical Corporation workers and their family members were enrolled as part of the Michigan Long-term PBB Study. The Michigan Long-term PBB Study was jointly commissioned by the US Public Health Service and the Michigan Department of Public Health to study the long-term health effects of those exposed to PBB as a result of the 1973 animal feed contamination incident. Participants were given health and exposure questionnaires and their blood sera were screened for PBB and other chemicals in the environment. Approximately 4,000 exposed persons, mostly local families living on contaminated farms, were enrolled by the late 1970's. A total of 494 participants were enrolled in the chemical worker and family member subset. Various resources have determined that among this group, 198 people were employed at MCC when the processing of PBB occurred and were likely exposed to this chemical in the workplace.

The cohort of the PBB Study that includes the chemical workers and family members was actively maintained in the study registry until about 1990 (i.e. they received periodic mailings from MDCH to update their status and contact information). During the 1990s, there was a reduction in funding to the PBB Study and one of the resulting changes was a discontinuation of follow-up for the cohort including the chemical workers. Resources have not been sufficient since then to allow further active maintenance of this subgroup. Current staff could find no documentation of any active decision to formally drop this group from the PBB Study.

NIOSH recommendations included a statement advising long term monitoring of the exposed Velsicol workers. However, the PBB Study was not designed in response to this recommendation. The PBB Study was designed as a research study to track the long-term health effects of the population exposed to PBBs. The data collected and the follow-up conducted do not address individual exposures and health effects. These health effects should be monitored by your individual physician.

Information Sources – The majority of the information summarized in this document comes from the National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluation conducted at the Velsicol plant in 1977. Other sources include Michigan Department of Community Health (MDCH) summaries of the PBB Cohort study, Environmental Protection Agency (EPA) documents, Agency for Toxic Substances and Disease Registry (ATSDR) publications and published research studies.

More Information

- PBB Fact Sheet:
  - MDCH DEOE: http://michigan.gov/documents/mdch_PBB_FAQ_92051_7.pdf
- ATSDR resources:
  - Public Health Statement: http://www.atsdr.cdc.gov/toxprofiles/phs68.html
  - Toxicological Profile: http://www.atsdr.cdc.gov/toxprofiles/tp68.html

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