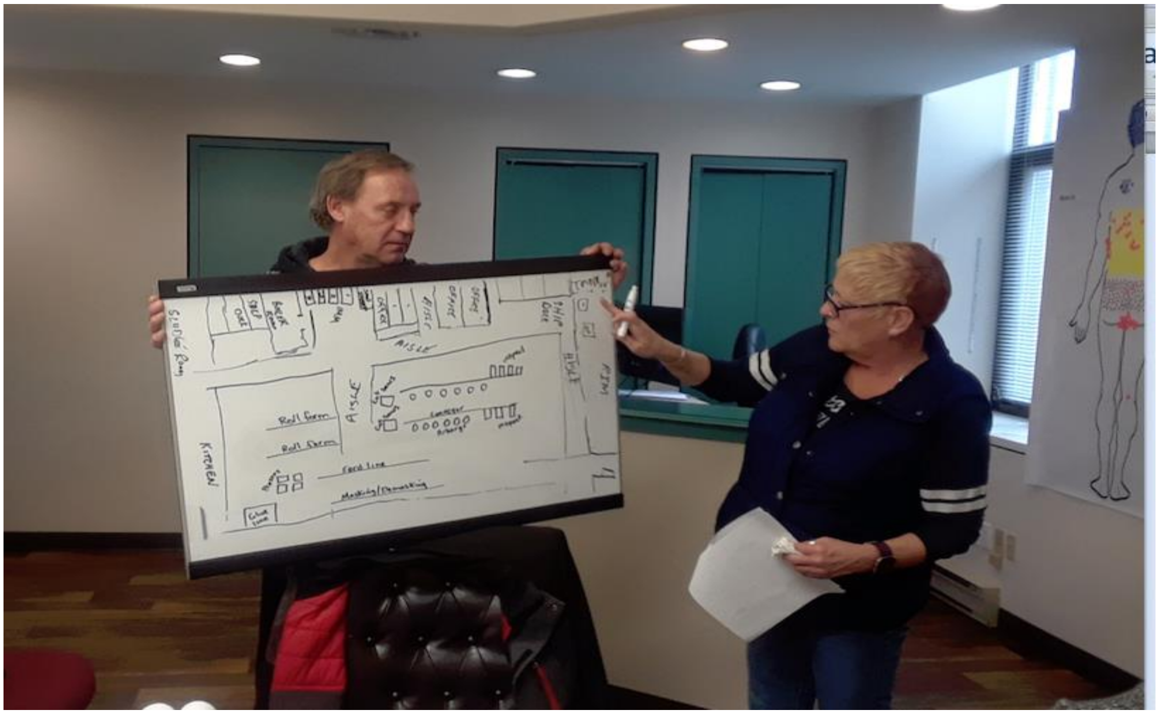

Advisory Committee members during risk mapping session

"WE CAN'T BREATHE"

A RETROSPECTIVE EXPOSURE PROFILE OF THE PEBRA INC. PLASTICS PLANT IN PETERBOROUGH, ONTARIO (1986-1996)

PREPARED BY

Dale DeMatteo, BA, MHSc and Robert DeMatteo, BA, MA, DOHS

AND

Unifor Local 1987 including: Local President, Mark Clapper, Past President, Rose Wickman, Dave Gooley, Jackie Dufty, Cecil Firlott, Karen Quesnel, and Rick McDougal

FOR

The Occupational Health Clinics for Ontario Workers (June 2020)

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PREFACE

"We can't breathe. We have to get out of here!"[1] A worker's urgent cry to co-workers, documented in a Union Health and Safety Committee log book, is a more dire reflection of thousands of individual and collective work refusals that took place during the "Pebra era" (1986-1996) at the now Ventra Plastics plant in Peterborough, Ontario. A Ministry of Labour (MOL) official admitted that work refusals during that first turbulent decade "filled two entire filing cabinets" as he called on both parties to meet on neutral ground and agree to find a solution – or he threatened, "We are putting an (MOL, Health and Safety) *officer in the building".[2] Interestingly, the first Pebra facility that opened in Kitchener, Ontario in 1981, was acknowledged as having a much less turbulent history.[3] Ten years later, in 1996, Pebra declared bankruptcy and over the next five years, the company was sold three times, each time under bankruptcy orders. It has been a long and, as one MOL inspector described, "rocky road"[4] to compliance with Ontario's Occupational Health & Safety Act at the plant. Evidence of this "rocky road" is abundant -- from a WSIB Auditor's report awarding Pebra's Health and Safety Program an embarrassing "7% out of 100%"[5] to many examples of recalcitrance, indifference, and outright disregard for workers on the part of management, and workers themselves ignoring one of the few openly stated "safety rules" by smoking in washrooms.*

Importantly, what is exposed in this report is evidence of the contradictory nature of 'scientific evidence' as practiced by the MOL that pits warning information of over-exposure provided in chemical manufacturers' MSDS sheets and worker self-reports of such exposures, against questionable air sampling techniques –- the later given priority in MOL decisions as to what is acceptable evidence of health 'risks' to workers, or constitutes a 'harmful level' of chemical exposures. From the time Pebra Inc. opened the plant in Peterborough, MOL reports document a pattern of worker health concerns and problematic work areas in the facility -- beginning years before Pebra workers knew such a thing as a "MSDS" existed or that the chemicals (other than Isocyanates) they were exposed to daily, and in large amounts, could be dangerous to their health.

INTRODUCTION

The purpose of this research project was to develop retrospective exposure profiles of the work processes at Pebra Inc., now Ventra plastics facility, in Peterborough, Ontario between 1986 and 1996. This involved a systematic effort with the participation of UNIFOR Local 1987 Workers' Advisory Exposure Committee to collect, document and analyze empirical information about how production was carried out in this complex plastics production operation. The committee was led by past and present local presidents, Rose Wickman and Mark Clapper, and included Jackie Dufty, Dave Gooley, Karen Quesnel, Cecil Firlotte, and Rick McDougal. This work was undertaken to document the extent and nature of chemical and physical exposures that are possibly linked with the various cancers and other diseases that many employees and their families suffered over the years. Given the complexity of chemical exposures in plastics production processes, and evidence of considerable by-stander exposures, the researchers relied upon qualitative research methods to profile exposures, retrospectively.

HISTORY OF THE PEBRA (NOW VENTRA) PLASTICS PRODUCTION FACILITY[6,2]

In 1981, a German plastic auto parts firm came to Canada and first located in a 22,000 square foot facility in Kitchener, Ontario. Initially, automobile parts were made in Germany, then shipped to Kitchener for completion, and finally routed to GM in the United States. In 1984, a new production line was developed using a process called "post-lamination" for making auto side molding with coated stainless steel sheet metal.

By 1986, parts were manufactured at the Kitchener plant using an innovative process, "reaction injection molding," brought from Germany and called "R-RIM". With production expanding, the company set up a second facility in Peterborough, purchasing a 200,000 sq. ft. metal clad structure, which was expanded in the late 1990s to accommodate its larger thermoplastic injection molding machines and production operations. The current plant is well over 350,000 square feet.

Between 1987 and 1989, production in Peterborough focused on post-laminating side molding and thermoplastic injection molding for auto trim parts. From 1993 to the present, a multi-million-dollar, state of the art, robotic paint line was added. By 1992, the Peterborough plant employed over 400 people with the capacity to carry out R-RIM molding (introduced in 1989), punching and notching, parts assembly, injection molding, and a semi-automated paint facility, in addition to a North American-wide distribution system for their completed products.

Over a decade (1986 to 1996), the Peterborough workforce grew from seventy-five to five hundred and seventy-five women and men, with production increasing from one product to thirty different products, importantly, with no change or substantive improvement to the ventilation and air intake systems. Initially when most jobs involved close "hand work", the workforce included more women than men (60:40), becoming closer to 50:50 as operations became more automated. Advisory Committee members identified that for every 50 people hired, approximately 30 became long-term employees -– a pattern that continues to this day.

By 1992, Pebra Inc. employed 3000 workers worldwide, with corporate offices in Toronto and an engineering/design office in Detroit. Yet by 1996, Pebra Inc. went into bankruptcy and since then the Peterborough plant has gone through a number of corporate ownership turnovers: first JPE Inc., and then Ventra Plastics, which in turn was taken over by Flex-N-Gate (its current owner) but still operating under the Ventra name. Ownership transitions were as follows: Pebra Inc. 1986-1996; JPE 1996-1998; Ventra 1998-2001; Flex-N-Gate/Ventra 2001-Present.

Along with these corporate transitions, there were a number of historical stages in plastics production at the plant including:

1986-1988: The initial production processes (transferred from Germany) consisted of 4 small injection machines; in the next two years post laminate, roll forming, and manual paint line operations were added.

1986-1992: Manual paint line; from 1993-1996: partially automated paint line introduced and later expanded; by 2004, the paint line was fully automated (robotics).

1988-2000: Tank Farm and R-Rim Department brought from Germany, allowing larger molded parts such as rocker panels and fascias to be made on site. During that period the number of large clamps increased from 4 to 8 prior to R-RIM department's closure.

1998-2010: Second building was added ("warehouse") located on Monaghan Avenue used for storage, assembly, and shipping.

2004-present: Fully automated injection-molding clamps with use of robotics (now consisting of 17 very large machines); a modern, fully automated, paint line with newer robots added in 2008.

METHODS

A Risk-Based Approach to identifying workplace chemical exposures:

To address the challenges of identifying, retrospectively, employees' chemical exposures at the Peterborough Pebra plant during the decade 1986-1996, a Risk-Based Approach was used for the purpose of relating work-acquired diseases to chemical exposures in the workplace environment. Basic concepts and tenets of industrial hygiene were applied to identify exposure risk factors during the production processes that workers were either engaged in directly, or exposed to as bystanders. The risk factors, or variables, that have an influence on the extent and nature of exposures are well established, scientifically derived, concepts in industrial hygiene.

This approach aligns with the work of Sonia Lal, industrial hygienist with the Occupational Health Clinics for Ontario Workers (OHCOW), who undertook a detailed retrospective exposure assessment of the production processes at the Ventra plant in 2004-2005.[7] Similar to Lal's work, this current retrospective assessment relies upon a number of "qualitative" risk factors, similar to that used by Marano et al. in the aircraft industry.[8] In this regard, we assessed the production processes and working conditions with regard to their potential to have significantly exposed workers to chemical risks. The risk factors framework included:

- The physical state(s) of the chemicals (liquid, mist, gas, vapour, solid, dust) and route(s) of entry (inhalation, absorption, ingestion),
- The quantity of the chemical used, e.g., volume of chemicals, solvents, resins, etc.,
- Size of the materials and surface areas being worked upon or fabricated,
- Proximity to the source of exposure,
- Direct/indirect handling of chemicals,
- Duration of exposure (including use of overtime and/or multiple shifts),
- State of ventilation systems, e.g., effectiveness of general, natural, and local exhaust ventilation,
- Provision of make-up (fresh air circulation) air,
- Provision of personal protective equipment (PPE) i.e., respiratory protection, clothing (e.g. gloves, coveralls), eye protection,
- Safe work practices/procedures,
- State of housekeeping practices,
- Eating and drinking at workstations,
- Work organization factors, e.g., piece-rate system, physical effort, and impact on safe work practices,
- Workers knowledge of and training re: chemicals used, including access to, and understanding of, MSDS technical data.

Qualitative and participatory research methods:

This study applied a "mixed" qualitative/quantitative approach to gathering and assessing information necessary to develop rich, detailed exposure profiles of the industrial processes undertaken at the plastics facility.[9-13]

Qualitative and "mixed" research methods in industrial hygiene and epidemiology have been successfully used in similar industrial circumstances where there are: diverse groups of workers holding multiple jobs; numerous, complex industrial processes; and, exposures that have changed over the years[8,14-18] Rather than rating individual exposures, this research focuses on profiling the production processes and their exposure points, along with workplace factors that put workers at greater/less risk of being exposed. This approach is best able to address the challenges presented by the nature of the plastics production processes carried out at the Pebra plant, and the limitations in the availability and reliability of "hard' exposure data from industrial hygiene monitoring. As well, detailed descriptions of worker exposures in many of these industries are limited at best. Published research seldom contains data reflecting the typical, day-to-day conditions experienced by workers.

Information sources and research process:

This project relied upon ***four*** basic sources of information on industrial processes, working conditions, and the nature and extent of exposures including:

1)Focus group sessions—Advisory Committee: The mainstay of this research effort was the Advisory Committee, made up of worker members of the joint health and safety committee as well as retirees and workers with long experience with the plant's operation. Their collective experience spanned an era from the plants' opening in 1986 to the present. The authors/researchers served as facilitators in what might be called a detailed 'risk mapping' exercise. The committee became a permanent "focus group" formed by consensus between participants' and Unifor Local 1987 executive committee members. Other workers, with in-depth experience in particular processes, participated in the focus group's fact gathering sessions.

The committee consisted of seven regular members, who met once to twice a week for four to five hours from January to the end of April, 2019. Meetings were organized with reference to the industrial processes and working conditions for each department with attention to details on: chemicals, equipment used, materials being fabricated, the volume of production, the work tasks and how materials were handled, descriptions of work conditions, exposure controls, access to information, work practices, housekeeping, sensory experience, and adverse health symptoms. The meetings often included other Pebra employees, or retirees, invited for their special knowledge of the work processes being discussed. Between meetings, Committee members researched issues where no confirmation was achieved through phone contact with other workers or by seeking further documentation. Additional information was generated by members through phone calls, informal discussions, and sharing of primary/historical documents within the group.

The dynamic associated with focus group methods (the ability to both enrich and challenge the accuracy of information collected) and consideration of particular processes or issues lent itself to rich discussion and in-depth understanding of the complex work environment during the Pebra era. Throughout, the "constant comparative" method associated with qualitative research was applied, where information collected is continually contrasted and compared with previous information for its consistency and truth-value (i.e., reliability). In addition, we sought agreement and group/individual confirmation to achieve accuracy of information i.e., validity and reliability. In the course of this research, more than 20 individuals contributed, in some way, to the group sessions. The sessions (other than actual map drawing sessions) were taped and notes typed and distributed to Committee Members for their review and corrections. With intensive mapping sessions where participants created risk maps of various departments, these diagrams were photographed for the record. These various types of data collection were reviewed and checked for accuracy then reworked into the resource template that forms the body of this work.

2) Risk Mapping: The Advisory Committee relied heavily upon hazard/risk mapping sessions with key informants/groups of informants, similar to that described in other research efforts to gather qualitative data on chemical exposures in the plastics industry and foundries[18-23]

Risk mapping is a participatory method where workers collectively draw a graphic representation of their workplace and the health hazards that affect them. This technique is used to describe the production methods, tasks and materials in order to generate data concerning the risks of exposure(s) using the risk factors listed above. These physical drawings of the workplace allow workers to more easily pinpoint and identify hazards and the particular form such hazards take. Importantly, it assists participants in situating a work process in the context of the broader production process(es) around them as to identify "by-stander" exposures that are often significant, yet easily missed, when assessing exposure risks. It is a concrete approach to describing and identifying the day-to-day reality of the workplace and a method of identifying how workers perceive and face the hazards that work presents. It also allows workers and technicians to mesh "science" and worker experience in an effort to validate worker experiences. Because this exercise in risk mapping is a collective activity, with the entire group contributing to the view of the workplace, it leads to a more accurate picture of work processes and degree of risk exposures.[24]

3) Documentation: In addition to these qualitative findings, an effort was made to include historical "quantitative" data. Documentation of exposure conditions during the Pebra era was obtained from: 1) the Ontario Ministry of Labour Inspectorate reports/investigations; 2) Joint Health and Safety Committee minutes/reports/logs; 3) union and employee/employer correspondence, 4) Consultant reports generated by the employer; 5) relevant Ministry of the Environment (MOE) documents as evidence of chemical fumes/exposures experienced and reported by the surrounding community -- all of which substantiated, as well as provided a cross check on, the reliability and accuracy of focus group generated information.

In addition to supporting/reinforcing focus group generated data, these various sources of documentation exposed a pattern of recalcitrance on the part of Pebra to adhere to the law, up to and including outright disregard, verging on contempt, for its workers as reflected in numerous incidents. Several of such incidents included workers disciplined for "complaining" about poor air quality or symptoms they experienced, or when requesting to have the air tested because strong fumes were present and told by a manager: "There are 3 million chemicals. What do you want me to test for? You tell me and I'll do it!"

(Discussions are currently taking place with OHCOW for the creation of an exposure profile data base for the storage and retrieval of documents referenced in this report, including Ministry of Labour (MOL) reports, Joint Health and Safety Committee (JHSC) minutes, union Health and Safety (H&S) logs, consultant reports, internal memorandum, and MSDSs.)

4) Industrial hygiene, occupational health, and related literature reviews: Additional information was obtained through reviews of the scientific literature documenting industrial processes and observed exposures from published studies of similar work environments, as well as general information identifying and describing various industrial processes. Such information can be found in a literature review of plastics production in Appendix A

By including these multiple sources of information we were able to corroborate the description of work processes and exposure conditions through the method called "triangulation".[12,13,25]

GENERAL FINDINGS

This research is meant to address employees' concerns that the extent and nature of their exposures and working conditions were adversely affecting their health, and were responsible for the large number of cancers and other diseases (including reproductive problems) experienced by the women and men who worked there. Given the large number of carcinogenic and endocrine disrupting chemicals (EDC) used at the plant, their perception of a connection cannot be dismissed. It was also their view that the company and the government inspectorate misrepresented their exposure conditions which undermined their efforts to make improvements, and pursue compensation disease claims at the Workplace Safety and Insurance Board (WSIB). These issues were similarly addressed by Lal and Wong in 2000 and 2005[7,26].

Indeed, workers were routinely exposed to: benzene, silica, resin dust containing isocyanate residues, asbestos, vinyl chloride, phthalates, acrylonitrile, styrene, 1,3 butadiene, cadmium, lead, trichloroethylene, toluene, methyl ethyl ketone, xylene, epichlorohydrin, Bisphenol-A, welding fumes, metal working fluids, and isocyanates to mention but a few. Many chemicals used in plastics production are classified as mammary carcinogens and hormone disrupters. Many of these are associated with hormone related cancers such as breast, ovarian, prostate and testicular cancer. These classes of endocrine disrupters include phthalates, phenols and bisphenols known to pose a significant risk to health. Our review of biological monitoring studies demonstrated that workers in the plastics industry have higher body burdens of endocrine disrupting substances than found in the general populations, already at levels shown to harm animals. Second, these substances have a longer half-life than originally believed and bio-accumulate. These observations were found for a number of endocrine disrupting substances such as bisphenol A, styrene, acrylonitrile and phthalates. Levels found in workers were above those demonstrated to cause changes in the function of human tissue. (see Literature Review pp. 110-167).

Studies also indicated that air monitoring can underestimate the true body burden of these substances. While air monitoring levels were below current exposure limits, body burdens were significantly higher than levels found in 'unexposed' populations.

As well, endocrine disrupters have disruptive effects at infinitesimal levels. At times, low doses may have more powerful effects than higher doses. Consequently, these substances may not exhibit the traditional linear dose-response curve. And since workers are exposed to a complex mix of compounds, the combined effect may exert additive or even synergistic effects.

Health impact of toxic exposures and patterns of illnesses among workers:

During focus group discussions, participants identified an extensive list of workplace diseases they believe are related to the large variety of toxic chemicals used in their work producing plastic automotive parts. These included: cancers of the lung, breast, colon, brain, pancreas, salivary gland, thyroid, liver, prostrate, lymphoma, leukemia, Non-Hodgkin's Lymphoma, kidney, skin; adverse reproductive effects including frequent miscarriages, children born with birth defects/developmental deficits and difficulty conceiving; as well as other diseases including: chronic obstructive pulmonary disease (COPD), cardiovascular diseases, muscular sclerosis, Parkinson's disease, aneurisms, dermatitis, chronic bronchitis, neurological disorders, and sensitization to Isocyanates and solvent exposures. To date, a total of 133 workers have registered (or been registered by surviving family members) with the Occupational Health Clinics for Ontario Workers (OHCOW) for assessments of possible occupational illnesses. These include 33 workers with cancer diagnoses -- two with more than one confirmed primary cancer diagnosis. [27]

However, the Advisory Committee was able to identify a much larger group requiring investigation, using the union seniority list for the period in question, cross-referenced with: OHCOW's "Ventra Master List" of clinic registrants, the local union's compensation records, and logs documenting worker illnesses compiled by union officers. In addition, committee members conducted telephone follow-ups with affected workers and/or surviving family members. The table that follows exhibits significantly larger incidence of several cancers than would be expected in such a small group over less than 35 years, as well as other illnesses reported in the scientific literature. (See Appendix A and C for a review of the toxic effects.) Assessing the extent of the occupational burden of disease in this group would require a rigorous epidemiological study able to more exhaustively identify and confirm relevant diagnoses, to accurately distinguish between metastatic and primary site cancers, and to account for other relevant factors such as age at diagnosis, length of exposure and so on. The Advisory Committee strongly recommends that such a study be urgently undertaken in light of these initial findings.

TABLE 1

POTENTIAL OCCUPATIONAL DISEASE AMONG WORKERS

1986-1996*

OCCUPATIONAL CANCERS *	**OCCUPATIONAL ILLNESSES (non cancer)**
32 Lung Cancers	Cardiovascular diseases (58 reports) including: Heart attacks/ disease 27; blood pressure issues 5; aneurysms 5; strokes 4.
22 Breast Cancers	Reproductive Abnormalities (36 reports) including: Hysterectomies 11; miscarriages 10 (some multiple); “women’s’ issues” 8; birth defects/died in birth 3; breast cysts 3.
10 Cancers with no site identified	Neurological conditions (67 reports) including: Chronic: headaches 19; mental health issues 11; depression 10; memory loss 9; Alzheimer’s Disease 3; vertigo 3; ALS; psychosocial problems.
8 Kidney cancers	Respiratory conditions (97 reports) including: Chronic: sinusitis 20; difficulty breathing 17; cough 12; COPD 10; sensitization 7; lung disease 5; nose/throat issues 3.
7 Gastrointestinal cancers	Gastro-Intestinal conditions (29 reports) including: Chronic stomach pain 11; twisted/herniated bowel 4; IBS 4; perforated/ruptured colon 2; Crohn’s Disease 2; perforated appendix 1
37 Other cancers (<4 per cancer) including: thyroid, liver, brain, skin, bone, nasal, lymphoma, Non-Hodgkin’s lymphoma, salivary gland, bladder, cervical, prostate, mesothelioma, Jaw, and pancreatic. *TOTAL CANCERS…116	Musculoskeletal Conditions (137 reports) including: Back 20; bilateral shoulders 19; bilateral carpel tunnel 16; shoulder 18; knee 10; bilateral tendonitis 8; tendonitis 8; neck 6; single carpel tunnel 7; wrist 6; knee 6.

- This table constitutes a review of the union seniority list 1986-1996 N=521) based on committee members’ collective knowledge and a review of OHCOW claims on record with the union (including 59 reported deaths).

Evidence of often chronic, long-term illnesses among employees was accompanied by frequent incidents where large numbers of workers were overcome by toxic fumes and vapors from production processes they may have been performing, or bystander exposures due to fugitive emission from neighbouring departments. These incidents were manifested in reports of: difficulty breathing, tightness in the chest, irritation of the upper respiratory tract, nose bleeds, dizziness, light headedness, confusion, memory lapses, "wobbly" legs, loss of consciousness, nausea, skin rashes, and dermatitis. As one MOL inspector noted: "These workers believe that the air in the plant is not fit to breathe."[4] The range of symptoms noted above is well documented in Ministry of Labour inspection reports as well as when workers were sent to hospital for assessment and treatment. The many exposure/adverse effects incidents, especially in the 1990's, led to frequent work refusals under the Occupational Health and Safety Act (OHSA) that were investigated by MOL inspectors.

These anecdotal reports are confirmed by the large number of occupational injury claims filed with the WSIB by Pebra workers. For example, in 1990, a particularly bad year for plant wide over exposures, 54 injury claims were filed for adverse respiratory and neurological effects as a result of chemical exposures at the plant. [7]

As well, evidence of frequent chemical exposures is supported by the very large number of work refusals that occurred under the OHSA. Between September 4, 1990 and November 15, 1990 there were 20 work refusals associated with adverse health effects usually involving irritation of the eyes and upper respiratory tract and neurological effects including: dizziness, headache, disorientation, loss of consciousness, nausea and GI tract irritation. In the majority of cases, refusals involved a significant number of workers. In some cases, refusals involved mass evacuation of the plant due to spills and releases, or ventilation system malfunctions. On May 7, 1990, more than 120 workers were involved in a work refusal/evacuation incident. Between August 1990 and November 1990 there were 20 recorded chemical spills or releases, usually involving isocyanate chemicals -- either in the paint line or R-RIM Department. This pattern was duplicated over many years. For example, on April 27, 1993, three women began vomiting as a result of a release of solvent fumes. This led to further refusals by 51 workers, also affected by fumes. During the month of January 1994, fourteen work refusals were carried out. In most cases, a number of workers were transported to hospital for assessment and treatment.[7] (For detailed information on work refusal investigations and spills see **APPENDIX B**).

According to a Ministry of Labour report dated April 18, 1989 by Connie Demb, "The Industrial Health and Safety Branch (IHSB) file for the (Pebra) Kitchener plant shows a general history of substantial compliance…The Peterborough plant, however, has been the subject of many orders and investigations since 1986." During a single "cyclical" plant inspection in 1989 (Report # 250328) 38 orders and 14 recommendations were issued for compliance.[3]

Ms. Demb further documents a 1988 critical injury investigation where a worker fell unconscious from exposure to glues being mixed in an area without appropriate exhaust ventilation, resulting in an order that glues **<u>must</u>** be mixed in a room with appropriate ventilation.[3]

In 1989, the Ministry of Labour issued two orders for the company to comply fully with the provision of the Designated Substance Regulation (DSR) for Isocyanates, requiring" continuous ventilation" to prevent possible exposures to Isocyanates and "inclusion" of all R-Rim workers in an Isocyanate control program. The company appealed the orders arguing that: its control program was working well; continuous ventilation was impractical; and levels of Isocyanates were below the exposure limit. The company further argued that the cost of installing a continuous ventilation system was prohibitive while making not so vague threats that it might have to drop expansion plans and move to the United States. In response, the Ministry challenged management's assertion that the control program was "working well". Under examination, the MOL inspector reported that during his visit, the paint spraying operation was closed down because fumes were escaping into the general environment. There was also report of an Isocyanate spill leading to evacuation of the plant. A MOL physician, Dr. Leon Genesove, identified in his investigation, that four workers, already in the ISO control program, had not received pre-placement medicals or training, and were using Isocyanate containing putty – without the workers' knowledge and awareness that it contained the chemical. At the end of the appeal process, the Ministry's orders were upheld.[28] (Note: During the appeal process, four new work refusals were under investigation).

These incidents, chronicling frequent daily occurrences of adverse effects, are signs of chronic "over exposure" to the multitude of toxic and carcinogenic chemicals used in the production of plastic automobile parts and products during the Pebra era. In conducting this research, the committee ascertained that production at the plant was rife with exposure risk factors that could be linked to: the character of production methods; unsafe work practices; inadequate PPE and insufficient exhaust ventilation; lack of training and information on the hazardous chemicals being used (for both workers and managers); and limited -- to no -- worker participation in health and safety decisions. It wasn't until 1992 that the company finally provided (and made accessible) the legally required MSDSs for the chemicals used in the plant. It took a mass work refusal of 250 workers that year, in response to the employer's continued refusal to provide MSDSs and full-scale hazard-specific training, to prompt the MOL to finally order the employer to provide MSDSs and train workers on how to understand and use the information in them. Reflecting the company's cavalier attitude towards health and safety, workers were told in these company training sessions that the chemicals they used, other than ISO, were no more toxic than "goop" or "silly putty" that children played with. [2] The company initially challenged the order, which was later upheld, and workers were bussed to a near-by hotel for "retraining" by Canadian Auto Workers' Union, Health & Safety, and worker educators.

It is important to note that the company finally complied with this order only after MOL manager, Martin Donat, threatened to assign an inspector to work full-time in the plant **-- at the company's expense.** According to a committee member, Mr. Donat admitted to union health and safety reps that the MOL had "two file cabinets filled with documents on problems at the plant."[2]

It would be an understatement to say that this plant lacked a pro-active health and safety culture. The manufacturers' MSDSs for literally hundreds of chemicals used throughout the plant cite the symptoms workers regularly reported to management as evidence of worker over-exposure to various chemicals. As indicated previously, evidence of daily over-exposure is documented in MOL investigations of work refusals under the occupational health and safety act, which were made worse by the fact that, in most cases, employees were not provided with personal protective equipment and/or local exhaust ventilation required as stated on MSDSs for individual chemicals. Importantly, workers' symptom complaints give testimony to chronic over-exposure based on the information chemical manufactures are legally required to provide in their MSDSs, including the extensive list of chemicals used at the plant. (See **MOL reports in APPENDIX B**).

Large Number of Toxic Chemicals Used in Production:

Later in this report, when documenting the various work processes at the plant, a more directed list of literally hundreds of chemicals used in the various processes is identified, **including hazardous ingredients and by-products.** As example, note the following complex of chemicals used in the various operations associated with the paint line alone. A total of 98 chemical trade named products were used directly by workers. These products were used in very large quantities during the different paint processes including: 11 primers (adhesion promoters), 8 catalysts, 25 thinners/solvents, 8 di-ionization process chemicals (washes with acids and caustics), 28 paint kitchen chemical mixes, 12 sludge room chemicals, 6 paint cart maintenance chemicals along with intensive welding and grinding to remove the build-up of Isocyanate paints. Importantly, each product contained its own impressive list of "hazardous ingredients" identified in the MSDSs. For example, the MSDSs for the 11 primer coats indicate the presence of 35 additional "hazardous ingredients" including: toluene, xylene, ethyl benzene, propylene oxide, carbon black, titanium dioxide, methyl Isobutyl ketone, and MEK, to mention a few. (**These commercial products are listed in APPENDIX C along with the hazardous ingredients, decomposition products and health effects noted in the MSDSs**).

Review of Chemical MSDSs:

During this investigation, several hundred product MSDSs were reviewed. Each product was documented and its "hazardous ingredients," decomposition products, and health effects noted along with recommended control measures. In addition to identifying a large number of seriously toxic, carcinogenic, and/or hormone disrupting chemicals, we discovered in reviewing the MSDSs that: information was often incomplete; the symptoms reported by workers were documented signs of over-exposure; and that Pebra was not abiding by the required control measures stated in the MSDSs.

Such in-plant chemical exposures did not stop at the plant gate. There were frequent complaints from the surrounding community and nearby school, concerning strong chemical odours and particulate emanating from the plant resulting in adverse health effects and damage to property from particulate and fumes spewing from the plant stacks. Such complaints prompted investigations by the Ontario Ministry of the Environment on a number of occasions, and are a matter of public record.

In 1994/1995, in response to a number of community complaints (including the local school) of chemical odours and particulate coming from the plant, the Ontario Ministry of the Environment and Energy ordered Pebra to hire a consultant to conduct an environmental emissions assessment of chemicals being released into the community**. That investigation revealed that Pebra used 267,936 USG of paint annually, resulting in emissions of 1,389,251 lbs. of volatile organic compounds (VOC) just from its paint line activity – which was also a major source of indoor air contamination and worker complaints.**

Total VOC emissions were composed of the following organic compounds: Isobutyl acetate, primary amyl acetate, 1-methoxy-2-propanol acetate, toluene, ethyl benzene, methyl ethyl ketone, methyl N-amyl ketone, aluminum, copper, mineral spirits, petroleum distillate, N-butyl acetate, aliphatic polyisocyanate (HDI), aromatic polyisocyanate (TDI), carbon black, titanium dioxide, xylene, dimethyl glutarate, 2-propanone, iron oxide, aromatic hydrocarbon blend, and others. [29]

This provides added empirical evidence to support the contention that exposure controls at the Pebra plant were ineffective, or non-existent, both inside and outside the facility, and that these exposures constituted a threat to the health of **both workers and members of the community.**

More importantly, when taken together with such risk factors as inadequate personal protective equipment and local exhaust ventilation; poor health and safety training and general lack of information; extensive overtime and multiple shifts; poor work practices and safety culture, and large quantities of toxic chemicals directly handled by the employees -- the risk of worker over-exposure(s) was extremely high. Again, this is reflected in the extremely high incidence of adverse health effects experienced by employees, and the frequency with which workers exercised their right to refuse when under assault by mixtures of many chemicals.

BACKGROUND TO THE GENERAL PROCESS OF PRODUCING (POLYMERS) PLASTICS

Plastics consist of polymers composed of a long chain of repeating monomers. They are produced through multiple steps in different occupational settings and workers are exposed to chemicals of concern at various stages of processing.

There are three basic stages of production and several different types of plastics manufacturing processes as described in the ***Concise Encyclopaedia of Plastics***. [30] A comprehensive, description of the toxic properties of monomers, additives and solvents is provided in Sheftel's ***Handbook of Toxic Properties of Monomers and Additives***. [31]

In the first stage of plastics production, petroleum oil and gas go through a process called catalytic cracking in which the oil and gas is broken down, through chemical reactions, into distinct chemicals called monomers. Monomers are the basic building blocks of all plastics.

Some include such chemicals as vinyl chloride, styrene, bisphenol-A (BPA), acrylonitrile, butadiene, ethylene, and urethane to mention a few. Chains of monomers are referred to as ***pre-polymers or oligomers;*** or if several polymers are combined, they are known as ***co-polymers.*** These different monomers are highly reactive constituting a seriously hazardous class of chemicals.

In the second stage, the resulting monomers are sent to a resin producer to undergo a process called polymerization. This involves chemical reactions in which the molecules of the monomer combine to form a long chain of molecules that are much heavier than the original monomer. In doing so, resin producers convert monomers into polymer products. For example, in the case of the monomer vinyl chloride, it is transformed into polymerized polyvinyl chloride, and with styrene, transformed into polystyrene. Other kinds of polymerizations include: nylon, acrylonitrile-butadiene-styrene (ABS) and polyurethane to mention a few.

In the third stage, these newly formed polymers are shaped into pellets, powders or liquids and shipped to plastics products manufacturers (such as Pebra/Ventra) who, in the third stage, make these polymers into paints, adhesives and plastics products including pipes, fabrics, packaging and auto parts to name a few. While polymers are often viewed as "inert", they are capable of harm when unbound traces of reactive monomers are released when heated during the molding or grinding process and with the addition of numerous additives including: heavy metals as pigments and stabilizers, fire retardants, plasticizers, anti-oxidants, and fillers such as silica or asbestos. In the case of polyvinyl chloride, acrylic, and polystyrene, for example, under certain circumstances, traces of unreacted monomers are released including vinyl chloride, styrene or acrylonitrile. All of these trace monomers are rated carcinogenic. This type of thermal breakdown also occurs with a class of plasticizers known as phthalates, a powerful hormone-disrupting chemical. The different polymers produced are divided into two main classes: Thermoplastics and thermosets.

Thermoplastics are linear or branched polymers that can be repeatedly softened and reshaped with the application of heat and pressure. Within the class of thermoplastics many contain various additives to impart special characteristics. Some of these include: polyethylene, polypropylene, polyvinyl chloride, polystyrene, acrylonitrile-butadiene-styrene, styrene-acrylonitrile, polyacrylates, fluoropolymers, nylon and cellulosics.

Thermoset materials undergo a chemical reaction that results in a permanent cross-linked polymer that cannot be re-heated and reshaped. They are heat resistant and used for various foam products and insulation. Some of these include: polyurethane, epoxy, aminos, Isocyanates and polyesters.

Additives: Additives are often mixed and blended into these different polymers through a process called compounding, in order to protect the final product from degrading -- or to induce special characteristics. These additives often include: antioxidants, fillers, pigments (cadmium/lead), flame retardants (brominate/chlorinated compounds, surfactants, extenders, emulsifying agents, plasticizers (phthalates), stabilizers (lead), catalysts, extenders and hardeners.

Many fabricating operations perform their own compounding, thus workers handle various additives that are blended with the polymers. Because of individual toxicities associated with monomers, polymers, and additives, it is important to know the detailed ingredients in the polymers and what is added during the entire production process. It is not uncommon for an operation to change over time, as was the case with Pebra, thus it is important to carefully review the history of the company's production processes when assessing exposures retrospectively.

The additives of greatest concern include: plasticizers composed of phthalate esters such as diethylhexyl phthalate (DEHP) -- 80% of which are used in PVC plastics; pigments such as lead, cadmium, chromates, iron oxide, molybdenum, titanium dioxide, and carbon black; flame retardants such as antimony, phosphorous, boron and bromine and chlorinated, brominated and non-halogenated phosphate esters that are used extensively in plastic resins; lubricants to enhance mold flow that include soaps and stearates as well as fatty acids and paraffin.

Plastics Products Production Methods: Among the different methods used to fashion plastic products, the following: thermoplastic injection molding, reaction injection molding, extrusion molding and blow molding best illustrate the major techniques used in the production of thermoplastic and thermosetting plastics.

Injection molding (thermoplastics): The most widely used technique for injection molding involves melting polymer resin pellets under high temperatures into a liquid state, then moving it under pressure by a reciprocating screw to force (inject) the liquid into a closed mold. Once cooled the part is retrieved by the worker, then trimmed, drilled, sanded, painted and buffed. This is the principle production method used at Ventra.

Reaction Injection Molding (RIM): This is similar to injection molding except that the thermosetting polymers used require a catalyst to trigger a reaction causing the materials to rapidly expand in an enclosed mold when both a thermosetting monomer and polymer are instantaneously injected into the mold's mixing head. This was previously, the principle method used during the Pebra era.

Extrusion Molding: Extrusion molding is similar to thermoplastics injection molding except that the resin is pressed through a die of a determined profile, rather than an enclosed mold, coming out of the die in the predetermined shape and allowed to cool in the open.

Combustion and Thermal Decomposition of Plastic: Thermoplastics must be heated to maintain their fluidity; the process varies with the composition of the polymer and the additives. Overheating is a frequent occurrence that results in thermal decomposition resulting in the release of oligomers, monomers, and other combustion by-products. The result is a complex mixture of gases and vapors, depending on the chemical constituents. At lower temperatures combustion is incomplete, releasing larger more complex molecules, while higher temperatures complete the combustion, producing lower weight molecular gases. Some decomposition by-products have been identified, although generally it is difficult to identify specific pyrolysis products. See detailed review in **Appendix A**.

Some of the known decomposition by-products include: monomers, CO, CO2, carboxylic acid, formaldehyde, acrolein, aldehydes, styrene, benzene, ethyl benzene, toluene, HCN, NH3, nitriles, NOx, HCL, phosgene, carbonyl fluoride, carbon tetrafluoride, methane, ethane, phenol, acetone. This will also include the monomers as well. The character of the chemicals, in conjunction with the temperature, will determine the nature and identity of the decomposition by-product. For example, in the case of PVC used as meat wrapping, it was plasticizers in PVC, usually di-(2-ethyl) phthalate (DEHP) that vaporized more quickly than the polymer, that were eventually identified as the culprit in “meat wrappers’ asthma”.[32]

In addition, secondary operations, such as sanding, grinding, sawing, cutting, drying, buffing and torching molded plastics release plastic contaminants into the atmosphere that are likely inhaled, ingested and absorbed through the skin in hot, sweaty, work environments. In this regard, exposures might include: fillers such as silica, fibreglass, asbestos; traces of chemical ingredients including fire retardants, plasticizers, heavy metals, and stabilizers; and various solvents and mold releasing agents.

Studies by Forest et al. 1995, on a variety of commercial plastics undergoing thermoplastic processing such as PVC, Nylon 6, high impact polystyrene (HIPS), low density polyethylene (LDPE), and high density polyethylene (HDPE) have demonstrated that, in some cases, monomers were detected at levels that ranged between 0-2 mg/m3 during normal processing and up to 10 mg/3 during purging operations. Importantly, these researchers identified that the positioning of the air sampling train can have a dramatic effect on the results, as well as type of adsorbent materials used to collect the samples **(See both section on limitations of air monitoring and the plastic processing literature review in APPENDIX A).** [33]

Chemical Emission from Thermal Plastics Processing: [33]

Along with other thermal processing studies, Forrest et al. found a wide range of chemical species emitted during thermal plastic processing. While concentrations are low, we know very little about the health effects of many species, and, with respect to carcinogens there is no known safe level of exposure. The following identifies some of the species emitted during the processing of Acrylonitrile Butadiene Styrene (ABS), High Impact Polystyrene (HIPS), and Polyvinyl Chloride (PVC). (For a more complete review please see **APPENDIX A.)**

ABS: chemical species detected during thermal processing included: 245C-acrylonitrile, styrene, trichloroethane, 111 trichloroethane, benzene, trichloroethene, alcohol, toluene, xylene isomers, benzene, methyl, ethyl isomers, benzene, propyl isomer, benzene ethyl, methyl isomer, dichloro isomerethyl, dimethyl isomers, methyl diethyl isomer, naphthalene, tetrahydro isomer, siloxane, naphthalene, tetrahydro, methyl isomer, BHT, alcohol.

HIPS: dichloromethane, toluene, alcohol, xylene, propyl benzene, benzene, ethyl, methyl isomer, benzene, trimethyl isomer, benzene, dichloro isomer, HC.

PVC: acetone, methyl methacrylate, dichloromethane, ethyl acetate, ethane, trichloro, xylene, cyclic alkene, a-methyl styrene, Benzene, alkyl derivative, benzene, methyl, propyl isomer, benzene, butenyl isomer.

Presence of monomers will depend on temperature and the percentage of monomer in the polyol mixture/composition.

In addition to air sampling techniques used by Forest et al., another way of determining the level of worker exposures is to directly measure actual concentrations of these chemicals absorbed into the body, i.e. the body burden of chemicals entering the body through inhalation, ingestion, and absorption through the skin, referred to as a **biological exposure index (BEI)** whose concentrations are measure in blood or urine.

The literature review in APPENDIX A presents data gathered from a number of studies measuring the concentration of numerous substances (prevalent in thermoplastics processing) in the blood or urine of workers involved in the processing of plastics. In some studies, researchers measured the air concentrations in an effort to determine how these correlated with one another. The review provides a table of data on actual absorption of a number of chemicals used in thermal plastic processing as measured in urine and blood of plastics workers. Significantly, these urine/blood concentrations are an order of magnitude higher than those found in referent populations. The Table in **Appendix E** presents the data from these studies. What is not yet established, is the impact on human health. However, from the view of endocrinologists these results are alarming.

The table below attempts to provide some indication of the possible health effects of substances used in thermal plastics processing.

TABLE 2

HEALTH EFFECTS OF SUBSTANCES PREVALENT DURING THERMOPLASTICS PROCESSING

Substance	**Chemical Code**	**Mammary Carcinogen**	**Endocrine Disruptor**	**Carcinogens *IARC **EPA**	**Other + AMES +**
Acetone	130.01				Arrhythmia Reprod.
Acrolein	120-02				Asthma
Acetaldehyde	120.01			*2B	
Acrylamide	260.02	Y		*2A/**B2	

Substance	**Chemical Code**	**Mammary Carcinogen**	**Endocrine Disruptor**	**Carcinogens *IARC **EPA**	**Other + AMES +**
Acrylonitrile	210.02	Y	Y	*2A /**B1	
Bisphenol-A		?	Y	CA	
Butadiene	106-99-0	Y	?	*2B/**B2	
Carbon Black	010.04	?	?	*1	
Carbon Tetrachloride	190.01	Y	Y	*2B/**B2	
Caprolactum	105-60-2				
Chlorobenzene	201.04				
1,2-Dichloroethane 1,1-Dichloroethane	190.07	Y Y		*2B/**B2 **C	
Dichloromethane	190.08	Y	Y		
1,4 Dioxane	100.04	Y	?	*2B/**B2	
Dimethyl Ether	115-10-6				
Ether				*2B/**B2	
Ethylene Oxide	110.03	Y		*.1	
Formaldehyde	120.03			*2A	
Formic Acid					
Methyl Ethyl Ketone	130.03				
Methyl Methacrylate	142.04				
Napthalene	160.05				
Isoprene	78-79-5	Y		*2B	
Isododecane					
Isopropanol	67-63-0				
Perchloroethylene	190.10			*2A	
Phthalates Anhydride	151.01	?	Y		
Polycyclic Aromatic Hydrocarbons	160.00				
Polyvinyl Chloride Dust	10.14				
Polybrominated Biphenyls			Y	*2B	

Substance	Chemical Code	Mammary Carcinogen	Endocrine Disruptor	Carcinogens *IARC **EPA	Other + AMES +
(PBDE,PBP,TBBPA)					
Phosphororganic Compounds (TDCP,TBPP,TEHPP, TPP,TCPP,TDBP)					
Styrene	160.04	Y	Y	*2B	
1,1,1,2-Tetrafluoroethane	811-97-2				
Tetrafluoroethylene					
Tetrafluoromethane					
Trifluoroacetyl fluoride					
Trichloroethylene	190.13			*2A	
Trichloroethane	190.12				
Toluene	160.02			*2B	
Vinyl Chloride	190.14			*1	
Xylene 160.03					**
METALS					
Aluminum	020.01				
Antimony					
Cadmium	020.12	Y	Y	*1	
Chromium Compounds				*1	
Lead	020.21 020.22		Y Y	*2B *2B	
Tin	020.362 020.361		Y		
Titanium	020.48				

Substance	**Chemical Code**	**Mammary Carcinogen**	**Endocrine Disruptor**	**Carcinogens *IARC **EPA**	**Other + AMES +**
Zinc	020.392				

COMMONLY EXPERIENCED EXPOSURE RISKS

In the course of Advisory Committee meetings and discussion, there emerged a repetition of issues related to air quality and chemical exposures that were issues of concern to all workers and in all work areas, in that they were widespread and viewed as "common" to the plant as a whole. Frequent plant and department-wide work refusals, particularly as the plant expanded in size and production in the early to mid-1990s (with no changes or improvements to the already inadequate and admittedly "stressed" ventilation and heating systems working to their maximum) are an indication of "commonly experienced" air quality/chemical exposure problems. Major contributors to these common health concerns included:

- the close proximity of workers/production processes contained in an open-concept building (including a large oval, metal covered, "paint line" in poor repair circling through many different work areas).
- intensification of work and the expansion of production and its impact on worker exposures and work effort;
- impact of the business cycle that restricted expenditures on health and safety given the growing financial insecurity of the company;
- on-going problems with ventilation and air-flow throughout the system as a whole;
- ventilation system breakdowns regularly occurring throughout the line;
- inadequate local ventilation at the point of production;
- poor/lack of maintenance of filters, portable/permanent fans, and down-draft tables;
- negative pressure throughout a basically "open" facility influenced additionally by the opening/closing of doors/vents in the paint kitchen, sludge room, tank farm, and inside paint tunnel;
- 24/7 production in one or more department(s) during those years;
- a rotating workforce of "assembly" workers;
- massive amounts of MEK and/or Pebra 5 (perchloroethylene, tetrahydrofuran and cadmium) used daily by workers (AM/PM/downtime) to clean and wipe down literally "everything" including machines, tables (even cafeteria tables and chairs), floors, and workers' themselves; These chemicals were also used in large quantities in post laminating, glue lines, and in assembly as a glue;

- wide-spread use of “air guns” to disperse dusts and particle waste;
- generally poor “housekeeping”;
- poor preventive maintenance;
- poor work practices;
- the regular morning and evening sequential cleaning and purging of all injection mold machines with highly irritating spray cleaners including purging agents, smoldering purged polymers;
- continual over spraying of release agents on large injection mold machines (at times every few minutes) 24/7, to ensure clean release of plastic parts;
- exposure to outside/inside vehicle (gas/diesel/propane) fumes, as well as outside fumes from nearby factories;
- absence of appropriate personal protective equipment;
- poor training and enforcement for effective use of protective equipment;
- frequent large volume spills associated with handling large amounts of paints/solvents as well as regular breakdowns in feeder lines/joints behind mold/clamp machines and paint booths;
- large amounts of dust and particles produced daily in all major departments from sanding buffing, and grinding;
- open “sluiceway to sludge room” system for dispersal of paints and solvents winding more than 100 feet through the plant;
- the lack of attention and enforcement of regulations on the part of management to deal with problematic ventilation and heating systems, as well as a general, laissez faire attitude towards health and safety at the plant (See MOL reports, JHSC logs in **Appendix B**).

A COMPLEX CHEMICAL EXPOSURE MIX

Handling large volumes of highly toxic and carcinogenic chemicals: A major exposure risk encountered at the plastics plant was the sheer volume of the large number of different chemical products used containing a wide range of chemical species. Complicating this is the larger number of species produced during the thermal processing stage, as well as the chemical reactions going on in the paint line and in curing ovens, causing further vaporization of paint chemicals -- which has a wide ranging impact on the entire plant.

In this latter regard, we have noted previously the large number of chemicals in the form of primers, paints, hardeners/catalysts, base coats, thinners, solvents, sludge treatments and the more numerous hazardous ingredients. The paint line alone was estimated to use approximately 250,000 USG per year, emitting over a millions pounds of volatile organic compounds annually as well as 25 different solvents in its operations.[29] There were 35 hazardous ingredients in the

11 different primer coats, many of which: are known or suspected carcinogens; test positive for chromosome abnormalities; are fetal toxins; disrupt the hormonal balance of the body thus pose a serious risk to personal and reproductive health.

These same chemicals are known to have other serious health effects including neurotoxicity that can lead to brain and central/peripheral nervous system damage from chronic long-term exposures. Others can damage the kidneys, liver, and gastrointestinal tract.

Added to this chemical burden are the equally numerous chemicals used in injection molding and post laminating operations involving significant amounts of PVC resins, glues and solvents including: MEK, acetone, toluene, methylene chloride, xylene, alcohols, perchloroethylene, tetrahydrofuran, trichloroethylene, butyl acetate, cellulose acetate, butanoate, 2-butoxyethanol, 2-pentanone, 4-methyl, 1-propanol, methyl, 2-propanone, 1-propanol, 2 methyl, methyl n-amyl ketone, naphtha, n-butyl acetate, 1 methoxy-2-propanol acetate, ethyl3-ethoxypropionate, dimethyl adipate, dimethyl succinate, pyrrolidone, propylene oxide, ethyl benzene, carbon black, titanium dioxide, methyl isobutyl ketone, 2-ethyl hexyl acetate, white pigment, propylene glycol monoethyl ether acetate, ethyl 3-ethoxypropionate, isopropyl alcohol, 2-pentanone, 4 methyl-carbon, silica, polytetrane ether glycol, ethyl 3-ethoxypropionate, n-pentyl propionate, methyl isobutyl ketone, 2-butoxy ethyl acetate, and n-butyl acetate.

Readers are encouraged to review the large listing of chemical products with summaries of MSDS data, including hazardous ingredients, decomposition products, and health effects (**APPENDIX C**).

Early symptoms of neurotoxic effects have been noted as workers/patients present at the occupational health clinic as well as evidence of significant numbers suffering from obstructive lung diseases, including lung cancer.

What is unacceptable is the number of years it took the company to develop a protective exposure control program for its employees. The vital ingredients to such a program are still missing and must include: 1. Information and training on hazard recognition and 2. A method to effectively control exposures, based on a well-informed hierarchy of controls **starting at the source**.

MOL inspection reports up to the present show a continued pattern of non-compliance with the OHSA and its regulations. This often occurred over the most basic protections such as providing MSDSs, and labelling of toxics and toxic chemical piping required by the Act and ordered by inspectors -- with the employer arguing that MSDS information was not needed because the operators are aware of the chemical contents. The provision of training and information on hazard identification continues to be a problem, particularly for contract cleaning staff, unaware of the hazardous chemicals in the paint booths they were cleaning. Another recent example occurred when the company refused to comply with the provision of drainage in storage rooms where flammable chemicals were being stored. **See Appendix B—FV# 5449699**.

There have been other instances where the employer engaged workers in procedures that were clearly hazardous and in violation of the Act and regulations. For example, in order to maintain production when robotic painters broke down, the employer ordered workers to spray paint AD-Pro outside of the clear coat booth, a very hazardous procedure that not only exposed painters who were not wearing proper respiratory protection, but contaminated other areas of the plant. **See Appendix B—VF# 02756flzp263**.

There were still instances where workers lost consciousness as a result of exposures to chemical emissions from the paint line. **See Appendix B—18/09/09; FV# 02756FBRP116; 13/01/12.**

As well, problems controlling exposures with the current ventilation system continue to be a major issue. Workers' identified chemical exposures were aggravated by the unanticipated consequences of changes to the ventilation system to deal with environmental contamination from the paint line after installing a thermal oxidizer. The new installation placed the ovens under positive rather than negative pressure, causing oven off-gasses consisting mainly of xylene to flow into the general areas of the plant where some 50 workers were adversely affected and sought treatment at the local hospital. There have also been problems with respect to the control of hazardous dust as a result of lack of preventive maintenance. Sources of these dusts varied, including plastic dust from re-work/grinding room and dusts associated with vehicle exhaust. An inspector was advised by the doctor assessing workers in the isocyanated control program that most workers in the sand and trim department were suffering from obstructive lung conditions. Inspection reports indicate that ventilation ducts had not been cleaned since they were installed many years previously. **See: FV#00588lDZP062; 1080113; in Appendix B.**

THE VENTILATION SYSTEM

A Flawed Ventilation System: One of the most significant factors contributing to adverse toxic chemical exposures is the flawed functioning of the mechanical heating and ventilation system at the plant and its inability to achieve the main function of controlling worker exposures to very toxic chemicals.

The following hygiene analysis of the company is ventilation system is based on the professional analysis carried out by OHCOW hygienist, Sonia Lal in 2004. In our own review of the OHCOW report -- as well as observations from key informants and focus group participants, together with reports from MOL inspectors and industrial hygienists -- we find that her observations and assessments are well supported by various third party findings.[7]

Major flaws in the ventilation system, continually have caused contaminants from various production processes to migrate to other work areas instead of being exhausted outside of the plant. In effect, these fugitive emissions represent an additional burden of exposures, some of which contain chemicals that are immediately more hazardous, such as isocyanate vapors from the paint line and RIM departments, or fumes and vapors from the thermoplastic injection molding operations.

The work area most subject to contaminant migration was the assembly area located in the middle of the plant, and because of its location, to adjacent department ventilation systems. At the same time, other processes were affected because their local exhaust systems were also compromised due to negative pressure plant wide.

In addition to the general problem of negative pressure, was the added effect of regular usage of large, floor standing, oscillating fans in an effort to create air movement to dissipate high temperatures (ranging from 80-100 F) in production departments. Consequently, in an attempt to deal with heat stress, the use of independent floor-fans, inadvertently, further sabotaged the local exhaust system as well as creating an air-borne dust hazard from the trim and sanding operations throughout the plant.

Inadequate Make-Up Air: The major problem with the ventilation system was the fact that it could not supply sufficient make-up air to create a balance between in-take and exhaust ventilation. The system could not bring in a sufficient level of make-up air in terms of cubic feet per minute. Consequently, the general atmosphere was constantly under negative pressure, encouraging contaminated air flows from other production areas into adjacent operations.

Multiple Failures in the Ventilation System: Lal diagrammatically described several scenarios that would be encountered leading to contaminated air flows as a result of ventilation system flaws or malfunctions, reflecting routine daily occurrences:

Scenario #1: "Normal Conditions:" paint department (mid/west) is under positive pressure and blowing air outside its area; Sludge room (north/west) is pulling air into its area and thus exhausting outside via exterior exhaust unit; the RIM department (north/east) and post cure oven (mid/east) and area is exhausting out and thus pulling air in; and assembly (middle) under make up air and no local exhaust is possibly affected by the paint line fumes if balance is not maintained. Thus, even when working "normally", paint/solvent spills in paint line would migrate to the assembly areas.

Scenario #2: Air flow in Sludge Room fails: If sludge room exhaust fan fails or external door left open, sludge room ceases to draw in air from plant and air pulled from RIM exhaust will draw fumes/vapors/odors from paint line, injection molding and sludge room (easterly) over to and through the assembly and glue lines centrally located and ventilated with make-up air.

Scenario #3: Air flow in the RIM department fails/insufficient exhaust draw: causes the negative air pressure from the sludge room to pull the contaminated air from RIM department and paint line toward the sludge room (westerly) right over to the assembly lines, exposing these workers to contaminants from RIM and the paint line.

In regard to Scenario #3, Lal points out that a RIM department Facility Air Balance Study conducted by Pebra in June 1993, confirmed that all six make-up air units were not operating at the CFM designated capacity.[7] The report concluded that the area is under tremendous negative pressure. Although many fans vary in their design capacities, the overall net pressurization is close to design capacity level. This tremendous negative pressure drew fumes from both the

Sludge room and Paint Line across to the Assembly area. [7] (See Sonia Lal, Ventra Retrospective Report)

The other well documented flaw in the ventilation system was the fact that the air intake system was located in proximity to the air exhaust, thus drawing contaminated air back into the plant through the "fresh air" intake.

The following factual account provided in a MOL hygiene assessment exhibits the types of ventilation system problems alluded to above. According to MOL hygiene consultant Kim Gordon in report **# 244814; 31/10/88 (see MOL reports Appendix C):**

"*Post Lam hot gluing operation inadequate exhaust ventilation; RIM molding operation inadequate exhaust ventilation and isocyanate control program had limited worker coverage; RIM needs immediate attention to ISO leaks; inside paint line found to be blowing paint and solvent vapors into the general work area; sludge room a confined space not addressed."*

The important conclusion to be drawn from the functioning of the ventilation system was that workers were being exposed significantly not only to their own process/chemical emissions, but also emissions from adjacent operations. This was particularly significant for workers on the assembly and glue lines. Even without the failures described in the scenarios above, if there was a paint or solvent spill in the paint line, vapors from that event would instantly migrate to the assembly area, exposing workers to chemical mixtures that included isocyanate-laden paint as well as a variety of chemicals known/suspected to be carcinogens and hormone disrupters.

It is important to note that most complaints and adverse health symptoms, including hospitalizations and work refusals, occurred on assembly and glue lines. As well, observations recorded in MOL inspector/hygiene reports document many instances of air flow failures linked to strong odors, vapors and fumes from adjacent operations. We can't emphasize enough how ventilation problems dominated committee discussions and how consequent exposures to contaminants led to occupational diseases among workers (See **APPENDIX B** for summaries of MOL reports and union logs of incidents).

The other important evidence supporting workers' contention that they were being overexposed to harmful chemicals due to long-standing faults in the ventilation system came from MOL inspectors' investigative reports which focused primarily on indoor air quality and chemical contamination. An analysis of MOL investigations indicates that a majority of complaints and work refusals were related to air quality, specifically adverse health effects/symptoms from contaminated air in the plant. Yet air tests conducted by inspectors or management consistently failed to show that contaminants exceeded TLV/OEL levels despite tests documenting the poor functioning of the ventilation system combined with the physiological effects and symptoms workers reported; these two factors alone support the contention that workers were, in fact, overexposed.

As inspectors routinely reported not being able to find OEL exceedance (sometimes in frustration that "you've got to give me something"), their reports described conditions of insufficient capture velocity/no exhaust ventilation and major sources of chemical contamination (e.g. paint/solvent spills). Such challenges to the Ministry's sampling results, in the context of their own documentation that included health symptoms that were clearly signs of worker overexposure, were never addressed. Such anomalies are frequently noted in inspector reports found in **Appendix B.** As well, workers regularly complained to inspectors that the building had been aired out and/or production ceased prior to their visit. In many cases, inspectors would identify significant sources of exposure, e.g. 5 gallon open pails of MEK soaking glue applicator parts and workers stacking large numbers of freshly glued car parts while product was flashing off, and in both cases with no personal protective equipment or exhaust ventilation -- yet inspectors appeared to rely only on air sampling in concluding that the situation was "not likely to endanger." Committee members frequently spoke about workers' frustration at never receiving a MOL report that decided in their favour, "except the ones that didn't matter."

In one such report an inspector notes in advice to management: *"Management and the JHSC should continue to work with the employees….with a view to minimizing or eliminating all ventilation faults, inappropriate work practices, spills, etc. which can result in exposures to various smokes, fumes, vapors, etc. The general ventilation of the plant should be assessed by an appropriate consultant to minimize the possibility of capture of exhaust gases by the air intake system* ***(93E220MOBR, 04/05/93)" (See Appendix B).***

This statement, as well as others, constitutes an acknowledgement that: 1. significant exposures were occurring routinely but were not addressed by the ventilation system; 2. that inappropriate work practices were being tolerated by the employer; and 3. that adequate personal protective equipment was not provided or not used by employees. It was clear that the ventilation system was faulty, thus was not protecting workers from toxic exposures.

The major flaw in the MOL enforcement system and the way MOL hygienists practiced industrial hygiene was to rely on exposure standards: 1) that are not health based, 2) that had little empirical evidence to support them, and 3) were sorely out of date with respect to scientific information available at the time.[34] As well, their single focus on air concentrations as a measure of exposure, neglected to take into account exposure via the dermal route or if swallowed. What is most reprehensible is the extent to which MOL occupational hygienists and occupational health physicians ignored the serious symptoms exhibited by workers during frequent over-exposure episodes—symptoms that were clearly noted in the product MSDSs as predictable signs of over-exposure.[35]

LIMITATIONS OF INDUSTRIAL HYGIENE SAMPLING IN ASSESSING WORKER HEALTH EFFECTS

Extremely problematic is the extent to which inspectors and hygiene specialists put blind faith in air sampling during site visits, whether with color-metric short term grab samples (whose accuracy is typically +/- 25 percent) or with long term personal or area sampling, while ignoring workers' symptomology and the general state of the ventilation system. According to the

American Industrial Hygiene Association manual "Accuracy of detector tubes is considered to be +- 25%..." based on the U.S National Institute of Occupational Safety and Health certification criteria.[37] Well-known questions and shortcomings about the accuracy of industrial hygiene monitoring have been well studied. [36]

Some of these concerns include: Conditions at time of testing may not be representative of conditions at the time of complaints. Many times workers pointed out to inspectors that tests were conducted after the employer had aired out the plant and shut down the offending process or diminished production levels. Testing for volatile organic compounds and isocyanates is particularly problematic with respect to the adsorbent materials used in the sampling train. Studies show a marked difference when using different adsorbents; Tanex, for example, is shown to be satisfactory, but not in all cases. In the case of isocyanates, there was little monitoring of isocyanate levels at the plant especially when investigating workers' complaints about adverse effects. Researchers have found that measurements can be affected by the positioning of the sensors during area sampling. In addition, very rarely do analytical labs report the 95% confidence interval to assess statistical significance that is normally required when using NIOSH monitoring methods.

Unrepresentative monitoring conditions: An example of how results of air concentration sampling can be manipulated by altering conditions was exhibited in the industrial hygiene monitoring report from the Queens University study that was done for Pebra management in 1988. At one point in their report, the consultants note: "However, at the time of sampling, 'less than normal activity' occurred at this (sanding) table. On two subsequent visits the (non-exhausted) table was still not in use." Consultants also noted that the work crew walked off for an unscheduled coffee break shutting down production at the time of sampling. And during sampling for HDI on the paint line, the consultants noted: "However, an unpredicted shutdown of the paint line prevented the collection of a representative long-term sample. During the 24 minute sample period, only 12 minutes of clear-coat spray painting occurred." (Hygiene Consultants Report, Queens University, Occupational Health Department) The hygiene report further acknowledges that "inside solvent levels may not be reliable, as the sampler tubing disconnected from the pump, at some time during the sampled period (14/06/88)" (See Appendix B).

It is important to note that we did not find a hygiene air concentration report that identified what sampling strategy was employed, what adsorbents were used, what desorbents were used and what analytical method was used. Nor did any report indicate that the laboratory carrying out the analysis was a certified lab. There was no indication of the analytical method the sampling strategy was based upon. Were adsorbents subsequently analyzed by thermal desorption gas chromatography, or mass spectrometry? Or were adsorbents subsequently desorbed via solvent desorption prior to analysis? Adsorbent tubes can be very specific, and as a consequence, certain species of plastics at low concentrations and very low occupational exposure limits, often go undetected. [33]

There are other factors to be considered in air sampling, based on some of Forrest et al. other findings with respect to assessing plastic thermal processing emissions: 1. Purging operations result in higher concentrations of chemical species; 2, Normal thermal processing will emit a large number of species of chemicals including some monomers that require different adsorbents such as charcoal and solvent extraction; 3. While Tenax is satisfactory, Chromosorb and Poropak offer some advantage with the low molecular weight/high volatility region, e.g. HIPS injection; 4. The position of the monitor can have a significant effect on results as well, e.g. drafts from other sources or location of the mold; 5. Background levels not much different than those near the process, are an indication that by-stander exposure of other workers would occur.[33]

The Queens University Consultants' report further noted that during the sampling period ***"less than normal activity"*** occurred at the trim tables and that ***"the sludge room is operating on a batch water treatment schedule until full production levels are achieved,"*** indicating that sampling occurred during reduced production levels on the paint line, and that *"....While worker exposures in excess of the solvent TWAEV will not occur under existing conditions, this could change if production levels for the paint line should increase"* (See the comprehensive literature review in **Appendix A** and the consultants' reports in **Appendix B**: Consultant Reports).

Dermal Route of Entry: Most testing only measures air concentrations, ignoring other routes of entry. For example, it is now recognized that there is significant body uptake of chemicals through skin absorption. In this regard, we note the concluding comments in the Queen's University hygiene sampling report, dated 14/06/88 where the report states:

"A skin notation for a substance indicated that absorption through the skin can significantly contribute to a person's overall exposure to that substance. Exposure by skin contact is not detected by air monitoring"

Ingestion of Toxic Chemicals: Ingestion can also be a critical route of entry when workers eat, drink, and smoke at work stations. We have provided a review of body burden studies of chemical contaminants used primarily in the plastics industry through biological monitoring, e.g. measuring metabolites of chemicals or chemicals themselves in blood and urine. We have reviewed several studies comparing levels in workers' bodies with "unexposed" referent populations to ascertain what is actually taken into workers' bodies. These can be found in the table in **Appendix E and the references cited in the literature review in Appendix A.**

We note that levels found in these biomonitoring studies, particularly in the case of endocrine disruptors, are very significant and of serious concern for human health in general, and reproductive health in particular. Compared to unexposed referent populations, workers tested had levels that were significantly higher. These levels have stimulated grave concern by endocrinologists noting that even the levels found in the general referent populations were hundreds of times higher than those shown to produce mammary tumors in lab animals, as well as other adverse reproductive effects.[37] What should be alarming to the Occupational Health

Community is that levels found in plastics workers are significantly higher than those found in already threatened general populations.

PROBLEMS WITH EXPOSURE STANDARDS: ACGIH TLVS AND OELS

These last research-based observations on the health effects of substances used in plastics' production raise serious questions about the relevance and validity of the entire system of exposure limits. In addition to problems measuring "exposures" there is the important question of whether these exposure limits are health based limits, i.e. limits that protect the health of workers based on medical evidence.[34] In recent studies of exposure limits, a large number of limits have been shown to have adverse health effects below the established limits. In fact, only a small number of chemicals have demonstrated no effects below the established limit.[38] (See **Appendix A** for a literature review of occupational health in the plastics industry; See also Castleman and Ziem "corporate influence", Ziem and Castleman "historical perspectives", Rappaport, and Stouten.)

In taking an historical perspective on the setting of TLVs and other OELs, Ziem and Castleman point to the medical inadequacy of the TLV. They identified that with at least 90% of TLV chemicals, sufficient data on long-term effects was unavailable, either from animal studies or studies of industrial workers with long term exposures to known concentrations of these chemicals. They noted that "the very concept of **daily average exposure limit** has been attacked as inconsistent with what is known about toxicity -- evidently originating more from economic than scientific considerations."[40] Indeed, for the most part, regulatory development has been in the hands of industrial hygienists who lack in-depth training in biomedical health. While their knowledge in controlling exposures is vital to occupational health, their focus as a discipline is on mechanical engineering and practical imperatives of production and impact of controls, rather than on biomedical and health concerns arising out of exposures at work. [40] Another challenge to the empirical basis of TLVs noted by Ziem and Castleman, is the failure to use information available in the medical literature. Their investigation identified the absence of systematic literature searches done in preparing the documentation for hundreds of chemicals. Literature reviews were usually done by hygienists or other non-biomedical professionals.[39] Consequently, and based on even a limited sampling of the scientific literature on the health effects of exposure to a number of the TLV chemicals, Ziem and Castleman found evidence of profound health effects from exposure to those substances at levels far below the TLV. [39] They found, for example, the following:

TABLE 3

LOW LEVEL HEALTH EFFECTS

Acetone	neurobehavioral effects after 4hrs at 250 ppm	TLV 750ppm (stel)
Cadmium	changes in renal function at 0.003mg/m3	TLV 0.01 mg/m3
Ethoxyethanol	low sperm, red, white blood cell at 2.6mg/m3	TLV 5ppm
Formaldehyde	respiratory cancer 10yr at 0.1 to 1 ppm	TLV 1ppm
Ethylene diamine	respiratory sensitization at 1 to 10 ppm	TLV 10 ppm
Methylchloroform	behavioral deficits at 3hrs at 175 ppm	TLV 350 ppm
Silica	lung scarring at 0.5 to 2.0 mg/m3	TLV 2.0 mg/m3
Styrene	asthma at 62 mg/m3	TLV 215mg/m3
Sulfuric acid mist	laryngeal cancer at 0.2 mg/m3	TLV 1.0mg/m3
Toluene	neurobehavioral 20min at 125 ppm	TLV 100/150ppm(st)
TDI	asthma within 1 yr at 0.002 ppm	TLV 0.005ppm

A more recent update (2008) to the Ziem and Castleman earlier findings (late 1980s), involves an in depth review of the documentation of TLVs by the Health Council of the Netherlands which included international medical experts. The health council concluded that the data bases for only 40% of the chemicals listed, met the committee's criteria for health-based limits.[34]

Low-dose health effects:

When it came to assessing workers' complaints of symptoms or odours, inspectors rarely treated these as signs of adverse health effects, preferring to rely on short term/grab sample monitoring data, or concluding that no adverse effects should be expected at these levels. At times they attributed worker complaints to "chemophobia" and as "psychological" rather than a true physiological effect. However, as Ziem and Davidoff have argued, such conclusions are based on the erroneous assumption that current TLVs/OELs are scientifically sound. In this regard, the many studies previously mentioned should by now challenge this unsupported assumption. First, the conditions associated with low-level exposures to chemicals in the workplace remain poorly understood. Second, it ignores how little we know about low-level exposures and toxicity of the many thousands of chemicals found in the workplace – as well as the glaring absence of research conducted to fill this gap. According to the National Research Council's own estimate, only 2% of at least 60,000 chemicals in use have been studied for their toxic effects. And most of these have been on animals with far fewer studies of humans. Without such critical information, prevention truly rings hollow.

The National Research Council identifies that chemicals have rarely been evaluated for chronic low-level effects on the nervous system, the central and peripheral nervous system, the immune system, the endocrine system, the reproductive system and for neuro-behavioural effects. In fact, much of the limited extant toxicological data base **has not been used** to formulate TLVs.

Ziem and Davidoff illustrate that when the New Jersey Department of Health extrapolated the US EPA's Integrated Risk Information System (IRIS) data base, identifying 'no effect levels' for non-carcinogenic chemicals, they found that the 'no effect levels' were three orders of magnitude below the current OELs. In the context of current "knowledge" and "practice" they make a strong case for **accepting symptoms and odor complaints** as an indication of physiologically based health effects and not dismissing them as "chemophobia," or some form of mass hysteria.[40]

A further issue with respect to whether the existing TLVs/OELs provide protection from harmful exposures, is the degree to which vested interests such as major corporations, employers, and manufacturers have undue influence in the promulgation of TLVs in particular, and OELs generally. This was brought to light initially by Castleman and Ziem in their expose` of the ACGIH's TLV Committee that was populated mainly by company industrial hygienists/doctors. They exposed the fact that documentation of TLVs was: not scientifically based; way out of date with current knowledge; largely based on telephone calls between the committee members and company hygienists; and included no conflict of interest disclosures.[41] These revelations have been followed up by other researchers over the years, again showing that standards were not based on biomedical evidence and are heavily influenced by corporate interests.[41-44]

DISCUSSION

The findings of this retrospective exposure study raise major issues about the occupational disease risks at Pebra plastics over the years, and how they have been handled.

Pebra Workers were Heavily Exposed:

First, it was documented through extensive focus group and key informant interviews and reviews of hundreds of Ministry of Labour inspection reports, union logs, joint health and safety committee minutes, and private consultant reports, that workers at the plant, have for years, laboured under very poor and hazardous conditions. These are characterized by large scale worker exposures and consequent work refusals including plant evacuations that are documented in this report.

The key point is that over-exposure was indicated by the workers' experiences of physiological symptoms and adverse health effects during the many events where exposures were documented and source(s) of contamination noted. In these cases, major sources were identified: paint kitchen spills of paint/solvents; similar spills and leaks in the paint booths coupled with errors in the ventilation system's relative air pressure; Sludge room contaminants migrating to general plant areas as a result of errors in the ventilation system air flows (doors left open etc.); fumes and vapors from glue lines, post lam gluing, injection PVC molding, and widespread use of Pebra 5 without proper exhaust ventilation as indicated in MOL inspection reports; dust containing silica, fibreglass, urethane and isocyanate monomer in the trim and sand areas with poorly functioning, or non-existent, down-draft units aggravated by the use of large, standing floor fans that spread dust throughout the plant. In addition, MOL/WSIB assessments of the company's safety programs have been extremely critical of the extent of the company's non-compliance with the provisions of the OHSA and the lack of any health and safety policies and programs that were in place and functioning.

In most instances the physiological symptoms/health effects experienced were consistent with the health effects and symptoms described in the manufacturers' MSDSs as signaling over-exposures. Equally important, the control measures recommended by the MSDSs to control worker exposures were rarely in place. In many instances, workers were sent to hospital for assessment and treatment, with workers subsequently filing occupational injury claims under the Workplace Safety and Insurance Act. These factors further confirm that the "putative" exposures did, in fact, occur.

In cases where air sampling was carried out by the MOL or employer, it was rare to find air concentrations that exceeded the TLV/OEL. Yet these air concentration findings can be seriously questioned because of the following: 1. There is question as to whether sampling was carried out under representative conditions; 2. There is reliable evidence that sampling was carried out after areas were aired out and/or production suspended; 3. Testing was done with draeger colourmetric collection tubes with a low accuracy rate of between -+25 percent and are exceedingly problematic when measuring volatile organic compounds; 4. Long-term sampling did not identify sampling or analytical methods used and rarely tested for isocyanates; 5. There is serious question as to whether TLVs/OELs are health based limits. And, while limits were not exceeded at time of monitoring, in many cases, inspectors noted that local exhaust ventilation was inadequate, personal protective equipment was unavailable, and they would issue "advice" or orders to address such inadequacies.

In addition, a review of the industrial hygiene literature pertaining to thermal plastics processing in this industry found in depth studies showing that numerous chemical species are emitted during thermal processing in addition to original chemical properties. Importantly, biological monitoring studies confirm that such chemicals enter workers' bodies at levels several times higher than identified in "unexposed" referent populations (See literature review in **Appendix A** and Body Burden Table in Appen**dix E**).

These hygiene studies of the plastics industry further confirm the presence and extent of exposures that this current study has endeavored to document, retrospectively.

Chemicals Used in Plastics Processing Are Highly Toxic:
Automotive plastics workers are exposed to hundreds of toxic commercial products that contain a large range of hazardous ingredients, many of which are designated, or suspected, human carcinogens and endocrine disruptors capable of causing chromosomal damage, adverse reproductive effects, and sterility. Many can damage the functioning of the liver and kidneys. Most are neurotoxins that can affect the brain, central and peripheral nervous systems. As major

irritants, these cause: irritation and inflammation of the lungs and upper respiratory tract; asthma; and chronic obstructive pulmonary disease (COPD). These health effects were noted in a large majority of the MSDSs reviewed.

A recent rating of the toxicity of various plastics, by Swedish scientists, demonstrates the high degree of toxicity of many monomers. The study ranked 55 polymers used in plastics production according to degree of toxicity and seriousness of health effects based on monomers classified as mutagens and or known or probable carcinogens. Thirty-one of the 55 polymers contained monomers belonging to the two highest levels on a scale of five—in particular, PVC, ABS and styrene-acrylonitrile (SAN).[45]

An important feature of production at the plant was the use and handling of a very large number of toxic commercial products -- at least 500, containing, on average, close to 1000 hazardous ingredients that were handled daily **in the context of a very weak exposure control system.**

Reviews of toxicological data bases and health effects' information provided in MSDSs indicate that many of the chemicals are: known or suspected carcinogens; mutagens; fetal toxins; reproductive toxins; hormone disruptors; lung; upper respiratory tract; GI irritants; sensitizers; and those that can damage both kidney and liver (See **Appendix C** for summary of MSDSs). Importantly, the fact that chemicals were used in large volumes, handled directly, and involved detailed manipulation of materials without effective exposure controls – (individually and in combination) raised the risk of worker exposures. Such large scale exposure was confirmed by an environmental assessment identifying that annually, the company used over 250,000 USG of paint, generating over a million pounds of VOCs.[30] Importantly, the general ventilation system contributed significantly to exposures. Its design and layout, practically, ensured that chemicals would migrate to, and contaminate, other areas of the plant. Local exhaust to address toxic exposures was non-existent, ineffective, or non-functioning. Indeed, this is the major underlying cause of the intense exposures experienced by workers over the nearly forty years the company has been in Peterborough. Yet company management has continually resisted worker and MOL initiatives to remedy the ventilation system, up to the present.

Many Plastic Chemicals are Endocrine Disruptors:

A significant concern, with respect to the relationship between health impact and level of exposure, is the fact that a large number of chemicals used in the processing of plastics are endocrine disruptors that have identified adverse effects at extremely low levels—giving lie to the old toxicological dictum that "the dose makes the poison". When dealing with exposures to EDCs, effects are produced in part per trillion. The molecular structure of these chemicals is such that some are estrogen mimickers and perceived by the body's endocrine system to be estrogen-- a powerful, known tumor promotor. In other instances, these chemicals have a structure that promotes certain critical hormones that regulate numerous functions of the human body. These have been implicated in the development of mammary tumors, thyroid cancer, and disruption of the body's reproductive system. This is why endocrinologists have been calling for a rethinking of society's approach to chemical risk assessment for more than a decade. [37, 46-48]

A critical issue that continues to be ignored by officials with responsibility for protecting the health of Ontario workers, is the impact of mixtures of carcinogenic and, especially, endocrine disrupting chemicals (because of their health risk at such minute exposure levels) and the possibility of synergy. In this regard, a study by Ibarluzea and colleagues on the enhanced biological effectiveness of a toxic load of several endocrine disrupting pesticides acting together on the development of breast cancer has serious implications for assessing risks associated with exposure to similar mixtures in the plastic industry. Their work adds support to the contention that exposures to complex mixtures must be considered when assessing potential causal links, and assessing risk generally. From an epidemiological perspective, it is important to note that these same researchers found weak or no association when chemicals were studied individually, yet produced a robust association (fivefold increased risk) when a body burden index based on a "collection of EDCs" were used in their analysis, even in the absence of any known body-mass index risk factor.[49]

Workers Experienced Significant Adverse Health Effects:

It is necessary to acknowledge the pattern of harm experienced by employees. The daily experience of workers was a chemical assault on their senses that began with the constancy of chemical and solvent odors followed by burning and tearing eyes, difficulty breathing, sore throats, headaches, dizziness, muscular weakness, nausea and disorientation. These are the daily symptoms of chemical assault.

Over time, more serious and permanent diseases have emerged. As of this writing, some 133 workers have been registered with OHCOW including 33 workers with cancer diagnosis. Some of these cancers were diagnosed when workers were in their 30s, a highly unexpected occurrence. In some cases, cancers have occurred at multiple sites, including in some instances up to four different diagnosed cancers. In addition to cancers there has been a pattern of lung and upper respiratory tract disorders including many cases of asthma, COPD, and respiratory distress as well as widespread reports of heart disease and a variety of neurological disorders.

While these OHCOW data are very serious, a more recent occupational disease survey by the Advisory Committee shows an even more alarming potential disease trend among these workers. That investigation reveals a possibility of 116 cancers including 32 lung cancers, 22 breast cancers, 8 kidney, 7 gastrointestinal and 47 other cancers including: liver, pancreas, brain, nasal passages, thyroid, skin, sinus, cervical, bone, lymphoma, Non-Hodgkin's Lymphoma, salivary gland, bladder, leukemia, mesothelioma, jaw cancer and prostate cancer. The number of workers in this cohort during this 1986-1996 era numbered approximately 521 with approximately 20 percent falling victim to some form of cancer. This is an exceptionally high rate of cancer -- much higher than expected rate in the general population and even more so when we compare the incidence rates of the leading cancers in this study—i.e., 32 lung, 22 breast, 8 kidney and 7 GI cancers.

We cannot ignore other non-cancerous occupational illnesses suffered by these workers (and these are based on what is "known" personally by committee members, or that could be confirmed by documentation). Equally disturbing is the large number of serious illnesses that include to date: 41 cases of cardiovascular disease, 35 cases of reproductive abnormalities, 54 neurological disorders, 15 cases of C.O.P.D., 23 GI disorders, 12 cases of asthma, 10 thyroid disorders and 17 reported respiratory problems.

The important message is the fact that the entire group of diseases occurring among these workers is consistent with what is known about the toxic effects of chemicals used at the plant. Much of the scientific literature has identified these chemicals in terms of their carcinogenicity as tumor initiators, tumor promotors, and immune suppressants. Many others have been classified as neurotoxins, respiratory and skin irritants, cardiovascular stressors, immune suppressants, fetal toxins and endocrine disruptors.

Unfortunately, for workers, regulatory authorities at the Ministry of Labour ignored workers' complaints and symptoms, preferring to rely on questionable time weighted average air concentrations in comparison to TLV/OEL guidelines—exposure standards that are clearly not based on current medical evidence. Reliance solely on average daily air concentrations does not take into account: the synergistic interaction of a complex mixture of chemicals, the severe impact of short-term peak exposures, the dermal route of exposure, and level of physical activity -- coupled with work in a very hot work environment (80^0 F or greater).

CONCLUSION

A review of these retrospective exposure findings indicating heavy chronic exposures as detailed in production process templates, in addition to documented toxic properties of chemicals and their by-products to which employees were exposed, leads these researchers to conclude that Pebra workers were at high risk of harm from daily chemical exposures. It is also our view that these workers were frequently exposed to transient peak exposures that exacerbated the physiological impact of these chemical exposures, further impairing the immune system.

This conclusion is based on the very poor exposure controls, lack of worker information on the hazards of the chemical being handled, inadequate PPE, lax health and safety culture, the faulty and ineffective ventilation system and the hazardous production methods used. At the same time, it is important to acknowledge the role that weak enforcement of the Occupational Health & Safety Act and its regulations plays in putting workers at risk. In many instances there was an unwillingness to take seriously the physiological symptoms experienced by workers, resulting in the unsubstantiated interpretation that such symptoms were signs of minor discomforts or 'chemophobia'.

It is time, as occupational health professionals, that we exercise the "precautionary principle" in the face of scientific uncertainty when human health is at risk. This should be the starting point in our efforts to protect workers from harm, as well as in assessing the harm already inflicted on workers. We do this in both cases when we give workers the benefit of the doubt by acting proactively to provide care for victims and their families through just compensation, and even more importantly by ensuring workers right to physical and emotional well-being through regulation, and its enforcement, in the workplace.[50,51]

DETAILED DEPARTMENTAL FINDINGS

The section that follows represents the body or "substance" of this report -- that is the area/department-by-department breakdown of the various work processes and the chemicals workers used and/or were exposed to during the different operations; and, the type and level of risks associated with these various activities and the specific worker categories (set-up, operator, production, and maintenance) most at risk.

The body of this report provides detailed exposure profiles for the major work processes carried out, and the chemicals associated with these different processes. The information is presented in column form with "Production Process" listed on the left column and "Chemical Exposure Risk" listed on the right.

From the "Production Process" descriptions we formulated a risk exposure probability through identification of a constellation of risk factors for each process. In describing how work was carried out we are able to infer risk factors such as: was the worker directly involved; did the worker directly handle the materials; what was the physical state of the material(s); what was the probable route(s) of entry; what volume was used; what was the production rate; how much time was spent on the tasks; were exposure controls available and adequate; what is the toxicity rating of the material; and did workers have knowledge of the hazardous chemicals and protective measures required to control exposures? From Advisory Committee notes, supported by MOL and JHSC reports, we were able to systematically document adverse symptoms and complaints.

The "Chemical Exposure Risks" set out in the right hand column arise out of how production was carried out for each of the work processes described in the left hand column. The right hand column reflects a qualitative assessment of what the exposures were like, given the way production was carried out by workers and the existence of the risk factors identified above. Where reliable hard data is available this is presented, but always in conjunction with the workers' experiences arising from the production process itself.

The departments or areas (i.e., processes that shared close physical space or worker classifications associated with a high degree of mobility) analyzed in depth include:

1. ROLL FORM/POST LAM, AND INJECTION MOLDING OPERATIONS;

2. R-RIM (Reaction Injection Molding) OPERATIONS;

3. PAINT DEPARTMENT (INSIDE/OUTSIDE, PAINT KITCHEN/SLUDGE ROOM/SLUICEWAY OPERATIONS/CART MAINTENANCE;

4. ASSEMBLY/QUALITY CONTROL/MAINTENANCE (mobile job categories);

5. SHIPPING/LABORATORY

1. ROLL FORM/POST LAM, INJECTION MOLDING AND ASSEMBLY OPERATIONS

Introduction: 1986-1989: Pebra manufactured metal and plastic body side moldings and urethane body parts for the automotive industry. The major production processes included "roller forming" and post laminating to form side moldings for car doors that were then shipped to several automobile companies. It also included small-scale injection and extrusion molding for small auto parts and trim.

ROLL FORM, POST LAM AND INJECTION MOLD OPERATIONS

PRODUCTION PROCESS	CHEMICAL EXPOSURE RISKS
ROLL FORM/POST LAM, AND INJECTION MOLD OPERATIONS (1986-1993): **<u>General Description of Work Processes</u>:** Three separate production processes were located together in one large open area or department. The two parallel Roll Form and Post Lam operations together produced metal automobile side moldings and door panels, laminated or over-laid with extruded strips of PVC molding and coatings. This involved a roll-forming layout that was over 100 feet long, six feet wide, and five feet tall. The two roller forming machines shaped the five inch wide roll of stainless steel sheet metal into the general shape required for the trim part being produced, which was then cut into sheet lengths approximately four feet long. When the Ford line of products was added, parts were larger and pre-cut to size, with glue and PVC strips manually pressed onto the metal piece by workers resulting in greater handling/chemical exposure during the Ford product roll forming process. The worker component per shift/per line in the department included: (non-Ford) Line: one set-up, two operators, one stacker, two saws operators; Ford Line: five press	**<u>General Chemical Exposure Risks</u>:** The size and volume of the roll form line production, especially the larger Ford line, generated significant vapors, fumes, and mists from the various washing, heating, gluing, coating and sealing processes. All workers in roll form were exposed to: chemical spray/droplets during wash; glue fumes; PVC fumes. The set up worker was exposed dermally to glue and degreasing chemicals during fill up. No PPE provided, only shop coats worn by workers. Production workers were exposed to heavy fumes from heated glue and PVC. In Non-Ford line, glue was automatically applied and workers' exposures were primarily inhalation and dermally when handling hot parts. With Ford line, workers manually applied glue at the presses with an applicator then pressed the part with high heat, releasing mists and fumes. **Chemical Exposure Risks**: Each of the two lines would produce up to 1000 parts per shift, indicating the high volume of glues, resins, and solvents used in the area. For example, each line would utilize approximately 5 gallons of glue per shift.

operators, one glue set-up person. Adjacent to the two roll form lines was the Post Lamination operation consisting of 12 Arbourgs, or small injection mold machines (six per line) that attached PVC covered "plugs" onto the ends of the trim parts produced by the Roll Form lines. Each Arbourg utilized 3 to 4 bags (25kg) of resin per shift. After roll form and fine cutting, parts moved by conveyor belt through Post Lam where three Arbourg (small injection mold machines) operators on opposite sides of the line attached left and right plugs to the part which was then coated in PVC. These "plugs" were used to attach the trim part to the car body. After PVC coated plugs were attached, finished pieces were sent to quality control for inspection. If a part had small flaws or imperfections it would be sent to the sand, trim, and buff assembly area for repair, prior to painting, or at times directly to packaging and shipping. In the same general area, was a separate Injection Molding operation utilizing four mid-sized Injection mold machines. This process produced small plastic components for a variety of different automobile models and companies. Each machine's hopper was filled manually by material handler or set-up from bags of various resins including PVC, acrylic, polypropylene, styrene, etc. plus other additives. At the beginning of a shift, molds were hand	After roll form, parts (with the exception of Ford line) went through an additional cutting and shaping operation prior to being sent to post lam. Inspectors were located at the end and between the two lines, exposing them to mists and glues from both Roll Form and Post Lam as bystanders. **Chemical Exposure Risks**: In the adjacent Post Lam area, twelve Arbourgs (small injection mold machines) used large quantities of PVC resins during molding, cleaning, and purging operations, in addition to large quantities of solvents including **MEK, trichloroethylene, acetone, and toluene.** There was also substantial gluing with Pebra 5 (containing **perchloroethylene, tri-chloroethylene, tetrahydrofuran, cad-mium and MEK)** that involved continually cleaning products **with large volumes of MEK** (in big open pails as well as workers' personal containers of the solvent). These chemicals were applied at relatively high temperatures with enhanced vaporization and increase exposure through inhalation. **By-stander Exposure Risks**: Inspectors, packers and box builders worked in an assembly area close to Post Lam exposing them to dust and off-gassing as well as fumes and vapors from glue/PVC, as bystanders. **Chemical Exposure Risks**: Injection Mold material handler exposed to excessive amount of dust during filling process with little or no exhaust ventilation or PPE. Mold operators and nearby workers were exposed to heavy fumes and vapor from excessive overspray and heavy use of toxic cleaners

cleaned by the mold operator with 201B cleaner then hand sprayed with Rocket Release or other mold release between resin shot (every 3 or 4 minutes). The freshly molded part was trimmed and torched to remove flash and burrs then sent to quality control. Purging of machines, done several times daily, involved manual loading of purging agents and polymers into the hoppers. Purging required higher temperatures creating more intense fumes and smoke as well as hazardous decomposition products. When small regrind machine was added, waste plastic (PVC and polyol) was fed into a grinder, producing heavy fumes and dusts with hazardous ingredients.	and other agents during preparation and use of molds**. Due to high heating of resin during molding process, fumes and gases containing monomers. Vinyl chloride monomer (VCM), styrene, acrylonitrile, phthalates, heavy metals, flame retardants and release agents represented a high exposure risk for operators and those handling newly molded parts.** With purging there was high risk of inhalation exposures to resin fumes and vapors containing various chemical formulations as well as thermal decomposition products including acrylonitrile from acrylic resins and strong solvents such as toluene, MEK, and acetone. **Regrind operations created heavy exposures** to dust and vapor created by the high heat and blade friction **containing VCM, phthalates, FG, silica, and other toxins.**
1. ROLL FORM PROCESS: The mainly automated roll form operation included a layout approximately 100 ft. long and 6 ft. wide. The operation consisted of eight separate processes including: **wash stage** (two nozzles, top and bottom using tap water with degreasing solution; **blow dry stage** (to dry parts); **heat oven** (to prepare metal for gluing at approximately 180 F degrees); **glue station** (felt strip dipped in glue automatically applied to size and shape of PVC application); **second heat oven** (to activate glue); **PVC hand fed onto the metal strip** by production worker; **PVC pressed into place** (by belts above and below the metal); **metal cut to rough size** by chop saw. For regular Roll Form there were 3 workers per shift/per line including: 1) Two Set-up	The entire roll form area was noted for strong odours from the glues used in attaching PVC. Many work refusals, especially on the Ford line, were due to large size production, hands on work, and high temperatures and bystander exposures. **Chemical Exposure Risks: Wash and drying cycle:** Set-up operator was exposed to steam, mist and vapors during the wash and drying cycles in maintaining a constant level of degreasing product, including possible metal treatments such as anti-corrosion and anti-oxidant products, or oils on the metal stock. Workers described a mist in the surrounding area of the wash cycle. Parts then moved through a hot air blow drying station to remove moisture, which

workers to maintain/fill wash station (product additives evaporated quickly and continually needed refilling); 2) Production worker to ensure the rolled sheet metal moved smoothly along the rollers and to feed PVC onto glued area; 3) A second production worker to remove and stack parts on skids across aisle from saws area (where product was shaped and fine cut to size). Parts handled at the end of a roll line were very hot, giving off strong fumes and resulting in dermal exposure.

The roll form process was basically the same for all product lines except the Ford Line, which applied the PVC pieces manually rather than mechanically to much larger parts. The part was first masking taped by hand then heated in an oven. The PVC piece was hand applied, then heated again and hand pressed. The "Ford Line" involved substantially more exposures to the following toxic chemicals: Pebra 5, MEK, PVC, and chemical by-products from heating and application, because of the larger sized door panels, and greater amount of the glue used containing Pebra 5 and MEK. In addition, there was a greater degree of direct handling during application of PVC and manual use of large heated presses. For example, a much larger area of the Ford part was covered with glue. The swatch of PVC applied was approximately 2" wide, covering top and bottom of panels that were approximately 48"x24". Operators manually applied a layer of glue across the large area using a foam brush or rag.

Glue mixing and pouring: The set-up operator filled the machine's glue-station

created additional aerosols and mists.

Chemical Exposure Risks: Application of Pebra 5/MEK on hot metal sheets: The set-up operator would over-see the process and was likely exposed to vapour from the Pebra 5 coating during the preparatory heating of the metal to enhance malleability prior to shaping and application of the heated glue on hot metal. This operation was partially enclosed and exhausted, but the exhaust system was deemed ineffective by an MOL hygienist. Workers also exposed when affixing PVC strip. Chemicals: tetrahydrofuran, Perch, TCE, MEK, cadmium.

MOL: 891865EAAV 10/11/89: work refusal in FN-36 (Ford Line) Two workers on the fn-36 line complained of solvent levels and intoxication. The glue applicator is vented but freshly glued parts are stacked on carts without ventilation. (See two hygiene reports that follow.)

MOL: 286154 13/09/89: work refusal FN-36 (Ford Line): Adverse health effects experienced by refusing worker. 5 USG pails of glue (A11048) were around the glue applicator machine and not appropriately labelled. Glue diluted with MEK and toluene. Applicator was vented but face velocity was 200fpm. The 5 USG pails used as dipping tanks to clean glue station head. Pails did not have appropriate ventilation, were not labelled, and no MSDS. Testing noted with following results: MEK=50ppm; toluene=25ppm; alcohol=not detected. Inspector: not likely to endanger. Orders that the dipping pails be located in area with

applicator with a mixture of Pebra 5 and MEK, which was mixed by paint kitchen operator in pails, then brought to the machine. Re: Ford Line: *"The parts were four feet in length with large strips of PVC being pressed down and large amounts of Pebra 5 and MEK mix used to clean parts resulting in fumes that were just terrible."* After the PVC went through the press and was removed by worker it was still hot and would often burn workers. *"Often you'd have a sticky mess that was still smoldering and it always smelled terrible."* (There were 6 of these "presses" associated with the Ford line.) Committee member During the Ford line era people were continually going to local hospital with headaches, nose-bleeds and black outs. One committee member described how workers would have blackouts and not know how they got home. **<u>Glue Station Cleaning:</u>** Upon completion of the roller forming/laminating process the glue stations that held the Pebra 5/MEK were purged with MEK and put in open pails of MEK overnight. Also likely that methylene chloride was used. At the next shift prior to start up, the glue stations were cleaned and wiped down to get the MEK off the station parts. During this cleaning operation the set-up operator would be highly exposed to Pebra 5 ingredients and MEK. Set-up operators wore lab coats and cotton gloves.	adequate ventilation and bonding, properly labelled, and respirators worn. **Chemical Exposure Risks:** During glue mixing procedure, production workers inhaled vapors as well as absorbed solvents through skin contact while carrying and pouring the glue mixture and in handling and moving hot pieces coming off the presses at the end of the line. Large amounts of glue were used and workers were provided with cotton gloves, lab coats, and "dust" masks at best. Often no PPE was used by workers and gloves deteriorated quickly. **MOL: 288316 09/05/90:** WCB claim in Ford Line: The WCB requested MOL investigate worker's illness caused by exposure to solvent vapors in the FN-36 area when sludge room exhaust fan not operating. This fan is associated with the cooling equipment, also providing a negative air pressure environment that prevents chemical vapors from solvents and paints from migrating to the general work area including the FN-36 area. It was noted by inspector that fan was not operating and vapors were migrating at the time of visit. This has been an ongoing problem that had led to many episodes of adverse health effects, complaints, work refusals and MOL investigations. Citing previous solvent exposure measurements in both FN-36 and sludge room areas, hygienist concludes: "Solvent vapor, while present, are at levels such that worker exposure will not exceed exposure limits." No tests to confirm this conclusion were indicated in the report. **Chemical Exposure Risks: MOL: 292916**

	03/10/89: hygiene report Ford glue line refusal: MEK=50ppm; toluene=25ppm; ethanol=<10ppm. Hygienist indicates that these levels may not be representative of a full shift exposure given the brief (10-15 minutes) operating time of the line. Notes also that 5 USG pail of MEK will have made a significant contribution to the solvent concentrations. Indicates that it is advisable that control measures be implemented to limit solvent exposures on the F-36 line. **AUTHORS' COMMENT: It is important to note that as a rule of thumb a concentration of ¼ of the TLV should be taken as a significant exposure.** Hygienist recommends installation of a heated flash-off tunnel with local exhaust ventilation to control vapour concentrations and emissions. Also recommends installing drip tray under the applicator to contain and prevent accumulation of glue drips and spills that would vaporize and release into the atmosphere. This line uses 15 USG of diluted glue per 8-hour shift. The line runs 24 hours a day, 5 days a week. One worker feeds metal strips into the glue applicator and a second stacks the glued strips. A vinyl strip is then bonded to the metal. **H&S log: 11/05/90:** work refusal in Post Lam area (glue line/ paint kitchen glue spill FN36 approximately 2-3 USG near sludge room. Workers adversely affected). **MOL: 228249 20/06/90:** FN-36 refusals: Workers experiencing health problems on the FN-36 glue line. Fumes from the paint kitchen and sluiceway. No log for changes in chemical concentrations in gluing operations. High levels of fumes and smoke during

	purging of the injection molding machines e.g., Arbourgs and Engels. MSDS for resin pellets, use of 201B (n-methyl-2-pyrrolidone, ethyl glycol, monobutyl ether).
Saws Processes in Roll Form: 1. Fine Cut: After "rough cutting" of part at end of Roll Form Line, a second, "fine cutting" to shape was done by two operators at the Saws Station. Precision angle cuts were made according to product specifications then the finished part was placed on conveyor and sent on to Post Lam. Operators continually used pressurized air guns to clean the work area. 2. Sharpening and Shampering: There was a second Saws area where blades from the cutting operation on the two Roll Form Lines continually required sharpening and "shampering" (buffing). This work was done by two operators per shift, one who sharpened and one who shampered. The sharpening operator would place a saw blade on their machine then sharpened each tooth individually using a grinding stone. A large magnifying glass was used to ensure the blade was set at exactly the right angle. A hand crank held the blade in place, while the operator activated the grind wheel. A second operator then buffed the sharpened blade to remove burrs or other imperfections that could interfere with cutting.	**Chemical Exposure Risks: Saws**: Fine cut operators were exposed to metal working fluids, and fine metal and plastic particulate from cutting through plastic covered metal. The sawing operation was mainly a dry cut operation, which produces very fine dust with little in the way of dust suppression. Other than dust masks, no PPE was ever used. Use of compressed air guns aggravated exposure risk to inhalation and ingestion. The sawing of stainless steel sheets treated with Pebra 5 glue and PVC strip produced very fine particulate containing chromium 6, as well as residues of glue and PVC dust and fumes during the sawing operation. **Sharpening and Shampering** saw operators were likely **exposed to: grit from the stone; heavy metal (possibly carbide) from the blade; and droplets from the metalworking fluids (MWF)**. The likely route of entry involved absorption through the skin, ingestion of particulates from MWF, metals and grit in combination. Inhalation is also likely, but particle size from grinding is usually greater and more likely ingested. Possible chemicals include: nitrosamines, heavy metals, biocides, PAHs.
2. POST LAMINATING PROCESS: After roll	**General Chemical Exposure Risks:** The

form and fine cut, parts were notched at a small station to make holes for clips, then restacked on a skid and sent on to Post Lam where there were 12 small injection mold machines called Arbourgs. There were three workers per shift, per line plus the set-up person who manually filled all the Arbourg hoppers with PVC from a large bag (25 kg) containing small pellets, sending up a cloud of "greasy" PVC dust. Each of the two Roll Form Lines, was serviced by six Arbourgs (a total of 12 in the post lam operations with three machines located on each side of a line (six per side). One worker attached the plug on the left side of the part and a second worker attached the right plug). The injection molding operation used approximately two to three large bags of PVC pellets for each of the twelve Arbourgs per shift. The molder took any burrs off with a mortar knife, put Pebra 5 on with glue stick then put a plug in at either end of the part and clamped it into the Arbourg machine. The operator then pressed a button and the machine heated and sealed the end parts. Down the line a production inspector (3 per shift) would take parts off the line, trim off excess plastic, wipe them off with MEK or Pebra then set them aside for packer who put them in boxes, sealed them with tape, then put the boxes on a skid for shipping. Each Arbourg line (six machines) would produce approximately 1000 parts per shift utilizing approximately 3 to 4 bags of resin per machine, per shift, to coat the injected parts. After plugs were attached and cleaned they were sent on to inspection and maybe to a final trim and cleaning with MEK before	manual operation of opening bags of pellets during the drying process and pouring into hoppers exposed both material handlers and nearby workers to **PVC dusts**. Further**, vinyl chloride, formaldehyde and other chemical vapors were likely during the heating and melting process** as well as at the point of extrusion. There was the additional risk of chemical exposures to thermal decomposition by-products from heating and over-heating the combustion of PVC and components including vinyl chloride monomer. Given the flexibility and rubbery texture, it is highly likely that plasticizers were in the PVC formulations, which likely included **phthalates** such as DEHP as well as lead in some formulation. This family of chemicals is suspected of being carcinogenic and acts as an endocrine disruptor by mimicking estrogen, a known tumour promoter. **Chemical Exposure Risk:** Workers would be exposed to **resin dusts** when opening bags or drums containing pellets**.** Exposure to resin dust would also occur during pouring or scooping pellets from containers. Resin dust exposure would also occur when pouring pellets into mold machine hoppers**.** Exposure would take place through inhalation of dusts. This would also occur through ingestion and skin absorption. Workers reported that they would find a layer of resin dust under their breast, armpits and in groin area when showering after work. Other than dust masks and cotton gloves, no PPE was worn. Pebra 5 was classified by the company as a trade secret and only two ingredients are

going on to final inspection. Initially at the plant, defective parts were disposed of and not reground. Committee members describe this operation as: *"extremely hot and smelly with fumes smelling of burnt plastic and solvents, and you would leave work with a sore throat and red eyes."*	listed in the MSDS – perchloroethylene and tetrahydrofuran, but cadmium is suspected. The local union leadership was advised that the Pebra 5 used in the Peterborough plant also contained the metal cadmium (See letter from Rose Wickman in Appendix D) former president of Unifor local 1987). **On at least two occasions, a MOL industrial hygienist noted that** *"...The local exhaust ventilation at the glue application and glue heating stations on the post laminate roll forming lines is not effective. It was observed that drafts interfere with the capture at these areas".* (**see MOL report: 89D888EAAV-15/05/89, findings during forty-four work refusals investigation; and MOL hygienist, Kim Gordon, report dated: 31/10/88)**. These work refusals on the post lam involved adverse health effects including headaches, light-headedness, burning eyes, sore throats. (MEK, butyl acetate, acetone as well as Pebra 5 were suspected as possible causes of these adverse reactions). **MOL: 90E865EAAV 18/05/90: work refusal** glue **A-1104B: butyl alcohol, toluene, MEK, methyl methacrylate, acrylic co-polymer, ethyl acetate, ethanol, isopropyl alcohol, formaldehyde.** Hygiene assessment adverse effects from exposure to glue spill of 3 to 4 USG of A-1104B located 15 ft. west of the glue line area on May 10, 1990. On May 11, ten workers refused to work because of vapors that caused adverse physical effects. Consultant noted several previous work refusals for the same reasons. See previous investigations in response to these earlier refusals. Note also that previous reports include hygienist recommendations

	to enhance ventilation and create ventilated flash-off area to reduce exposure. Chemicals of concern: MEK, toluene, ethyl acetate, isopropyl alcohol, butyl alcohol. Ethyl acetate levels at 25-50ppm. Noted also was the drips and accumulation of glue on the table and floor underneath the gluing machine. Need for preventive maintenance (PM) to address leaks and drips noted. **H&S log: Jan 27, 1994**: re: **air make-up shut down/refusal in assembly.** *"When workers sought (supervisor) to inform him of their refusal because of feeling ill they were told to wait because we're in a meeting.* (Workers' response:) *Fine, we will call the ministry. Then all the supervisors started coming to the cafeteria. Our question: How come the (air make-up) charcoal filters were replaced with dust filters? Any (i.e., No) amount of money or training will change things here."* **MOL: 060290V3 10/01/90: refusal after fire in Fn-36:** After a fire occurred on molding machine #6 in FN-36 line, 37 workers refused to return to work because they were not trained on what proper procedures to carry out to ensure their safety in the event of a fire. Inspector issued order for employer to train workers in the plant fire plan and what precautions to take. Inspector noted that workers had never received instructions and training on the fire plan. **Re: MOL visits in response to work refusals in Ford Line**: Advisory Committee felt that the company was advised prior to

	MOL visits: *"If you remember, the company always knew when they were coming. No welding, don't do anything till they're gone. It's funny, we can't open up the doors* (for ventilation) *because it will cause dust in the paint line but we can open the doors when there's a purge team or Ministry of Labour. So how is this working?"* **H&S log: 02/05/94: work refusal assembly** line in Post Lam area over strong oily odours.
<u>Glue Line Operations in Post Lam</u>: There were 8 separate glue lines located throughout the area (generally in each corner, although they often moved from place to place). Glue was used to attach mylar, PVC or other material, but also "glue lines" could refer to other applications such as Adpro (as a protective primer) on raw metal products. Contains: cyclohexane, xylene, ethyl benzene, ethyl alcohol, toluene, carbon black, chloroform. Each line consisted of a moving carousel on which parts were hung and either sprayed manually with a pressurized hand gun, or sent through a mechanical spray machine that applied the glue automatically. The glue product was contained in a sealed pressure pot, mixed, and setup in the Paint Kitchen, by the paint kitchen operator. There were risks associated with the pressure containers requiring the attention of a paint kitchen operator. Following spraying, parts were sent through a curing oven, then taken off the line and stacked on skids, or in boxes, if the	**Chemical Exposure Risks**: The glue spraying of large fenders was described as "being done completely in the open", next to injection molding. **There was no local exhaust ventilation and the operation posed a significant risk of inhalation and absorption of glue ingredients.** The glue pressure pots could contain Pebra 5 or Adpro Adhesion Promoter plus other ingredients that might include: methyl Isobutyl, toluene, n-butyl acetate, alkyd resin, nitrocellulose, ethyl alcohol, phosphoric acid, xylene, Isopropyl alcohol as well as Pebra 5 containing perchloroethylene, tetra-hydrofuran and possibly cadmium (See Letter from Rose Wickman in **Appendix D**. No PPE was worn other than dust masks and cotton gloves. **MOL Hyg. Report 31/10/88 (Kim Gordon**): Post Lam hot gluing operation **inadequate exhaust ventilation.** **Chemical Exposure Risk: Post Lam glue**

parts were fenders. **Glue Lines** in the Post Lam area were supplied with glues mixed in the Paint Kitchen by the Paint Kitchen operator. These could be either **Pebra 5 (tetrahydrofuran, perchloroethylene, TCE, cadmium or Adhesion Promoter from 3M (cyclohexane, methyl alcohol, xylene, ethyl benzene acrylate, chlorobenzene, furandione, ethyl alcohol).** **Glues were contained in a pressure pot equipped with a spray wand that workers used to spray glue on the parts. There was a great deal of over-spray and the use of MEK to clean hands and parts. These were supplied at each work station.** **Glue operations were prevalent throughout the plant as the vapors and fumes permeated the air in the plant.**	**lines**: Glue line operator would incur substantial exposures from spraying the glue mists and vaporization of the glue containing MEK. Exposure was likely through inhalation as well as dermal absorption through contact. MEK solvent would likely defat the protective barrier of the skin leading to greater risk of absorption and skin irritation. The glue consisted of a mixture of Pebra 5 and MEK prepared in the "paint kitchen." Since this was carried out manually, it is highly likely that set-up personnel would be significantly exposed to the MEK and the ingredients in Pebra 5. All adjacent operations would be exposed to the vapors from the glue application as well as vapors from the curing ovens. **<u>NOTE:</u>** In total, there were eight glue lines in Roll Form/Post Lam, similar to that described above. These included: two in Assembly; two in Roll Form; two with the Ford Line presses; and two in Post Lam. This generated a substantial amount of Pebra 5, Adpro, 1104B, etc. chemical vapour in each work area as well as adjacent areas. According to informant descriptions Pebra 5 was used universally in almost every work process and *"MEK was used everywhere to soak parts with workers up to their elbows in it when cleaning parts."* MEK was supplied in pump pails to nearly all work locations in the plant. This was used to clean parts, as well as used by workers to routinely clean their hands of glue residue. It was typical for most workers to have their own "**cup full" of MEK at work stations to clean both hands and parts.** The other glue regularly used on glue lines was Adpro Adhesion Promoter (**see**

	opposite column and Appendix E for ingredients) **H&S log: July 20, 1990: fumes refusal**: "(names worker) *and I went down to glue line. The glue line had a large fan which was blowing air toward the touch up area. The fan was moved so it wouldn't be blowing fumes towards the touch up area."* **MOL: 89D888EAAV 15/05/89: work refusals** in Post Lam: An investigation of 44 work refusals in the post lam area due to chemical exposures causing adverse symptoms: headaches, dizziness, eyes, nose and throat irritation and nausea. **Hygienist findings include: inadequate exhaust ventilation in the hot glue area of roll form; internal paint line vapors blowing into the general work area; RIM Isocyanate control program deficient with respect to coverage of all workers exposed and inadequate ventilation; failure to comply with confined space entry regulations and eye wash requirements in the sludge room**. See also report **#288596** reprisal investigation against the refusing workers.
<u>PVC purging in Post Lam:</u> As with all injection molding machines, the Arbourgs were purged regularly during maintenance and at the beginning and end of each shift. (production was 24/7 with two shifts) This was performed by set-up worker using various purging agents, e.g. Rapid Purge or Ventra Purge. These contained a combined mix of strong solvent and polyol under	**Chemical Exposure Risks:** PVC purging operation: At the start and end of each shift the extruding machine was purged with "Rapid Purge" or possibly MEK or other solvent as well as an acrylic based polyolefin to complete the purge. The purged material would be extruded in a pile onto the floor and left smoldering. This process produced very strong fumes and smoke containing

extremely high heat to aid the flow and to burn-off residues of polyol and additives used in the previous run. An inspection report indicated that these machines were purged with an acrylic resin (MOL hygienist Kim Gordon, 31/10/88).	numerous pyrolysis **by-products and compounds known to be carcinogenic and endocrine disruptors including benzene, formaldehyde, heavy metals, acrylonitrile and a variety of PAHs.** This would also occur when there was a colour change. **Chemical Exposure Risk is high** since the purging operation required cleaning of the molds with solvents and using compressed air to blow off residues with dirt and debris adding to the burden of toxic exposures. **Chemical Exposure Risks**: high risk of inhalation of fine plastics particulate, fumes and smoke containing VCM, ABS, in addition to additives during purging.
<u>Regrind of PVC/Polyol in Post Lam</u>: The first small regrind machine in the plant was, for a short time, located in the North end of the Roll Form/Post Lam area, near the 4 mid-sized (200-300 ton) injection mold machines. Damaged or defective molded plastic parts were sent there for regrinding. This process was not adequately ventilated and produced large quantities of fine plastic particulate as well as fumes and vapors from the high temperatures generated during the grinding process. This was the subject of many complaints as well as MOL investigations**.** Frequently, the exhaust system on the grinding station would be clogged and rendered ineffective. The ground product was very hot and could not be touched (it was reported by inspectors to be still warm to the touch the following day) and it created a great deal of fumes and dust in the	**Chemical Exposure Risk: Grinding operations inhalation of** high concentration of fine particulate and fumes containing residues of various thermoplastics molding operations. Monomers, additives, phthalates, stabilizers, flame retardants, etc. **See Appendix C for information on hazardous ingredients in resin products.**

atmosphere as well as being layered on surfaces and in workers' clothing, including underwear.	
3**. <u>INJECTION MOLDING OPERATIONS</u>**: Injection molding operations for production of small auto parts initially consisted of four small (300-400 ton) injection mold machines. This operation involved manual feeding and drying of pellets containing polyols consisting of PVC and a number of other additives**.** This molding operation was situated across from the Roller Forming/Post Lam processes. Initially, molding tasks were carried out manually. Pellets were contained in cartons, bags, or barrels and carried and opened by the material handler/production worker. Pellets were scooped or poured into pails and manually poured into hopper/dryers to remove any moisture. When dried, pellets were poured into molding machine hoppers**.** The thermoplastic injecting molding process involved heating the resins into a liquid state at high temperatures then forcing the resin into the internal chamber with a reciprocating screw, pressuring this action via injectors into the enclosed mold. The steam and vapour would be exhausted from vents built into the mold. The operator would remove the part when sufficiently cooled. Depending on specifications and types of parts required by a client firm, the polymer formulations could vary considerably. These could include: PVC, polypropylene, polyethylene, and polycar-bonates with Bisphenol-A, among others. It could also include other additives including: monomers, phthalates, heavy metals, flame	**<u>Injection Molding: Chemical Exposure Risks:</u>** Set-up personnel were exposed to resin dust while manually handling resin pellets or powders. Exposure would likely involve inhalation, ingestion and absorption of chemicals through the skin. Exposure to Resin Fumes/gases was highly likely. The process of heating resins to high temperatures under heavy pressure would release substantial vapors and gases from mold vents during normal operations; further exposures would continue when opening molds to retrieve hot parts, as well as handling parts released from molds. Along with malfunctions leading to fires, these events would lead to the release of numerous thermal decomposition by-products. These vapors and gases would contain a number of chemical compounds including residues of monomers e.g., vinyl chloride, styrene, acrylonitrile, brominated or chlorinated flame retardants, anti-oxidizing agents, phthalates, formaldehyde, benzene, heavy metals from pigments and a broad range of hydrocarbons. **(see literature review in Appendix A re: PVC decomposition products).** **Chemical Exposure Risks:** Much higher exposures occur during purging operations with purging compounds such as "Rapid Purge" in preparation for colour and polyol type changes, which involved raising the temperature significantly to assist the purging process. Along with malfunctions leading to fires, these events led to release of

retardants, BPA, stabilizers, catalysts, initiators, cross linking agents, fillers, extenders, and mold release agents.	numerous thermal decomposition by-products. These vapors and gases would contain a number of chemical compounds including residues of monomers (e.g. vinyl chloride, styrene, acrylonitrile), brominated or chlorinated flame retardants, anti-oxidising agents, phthalates, formaldehyde, benzene, heavy metals from pigments, and a broad range of hydrocarbons. **Note:** It is important to note that in contrast to resin production, which typically employs closed-looped containment systems keeping exposures and handling to a minimum, molding and fabricating are relatively open systems involving direct handling. **MOL: 90F865EAAV 04/07/90: hygiene report. Cleaner201B/resin fumes Injection Molding:** Workers complained about smoke and fumes that were intense during the purging operation. Injection molding uses PVC, acrylic and polystyrene resins although the latter two are not used as much. Hygienist notes that during the purging process various thermal decomposition by-products are generated and that the seven molding machines were not locally ventilated. Purging started at the beginning of each shift as well as during the day when necessary. Inspector recommends local exhaust ventilation. Testing for hydrogen chloride gas (HCL) was not detectable near the barrel vent. No measurements taken by the purge waste dropped on the floor however. **H&S log: 26/06/90: work refusals** (9) while working on injection molder. Fumes,

	smoke coming out the 1500-ton resin pellet dryer. Refusal of assembly workers affected, working in outside paint. **H&S log: 27/01/94: work refusal** over contaminated air in assembly area from injection molding because the maintenance failed to insert a proper charcoal filter in the exhaust of the unit. **MOL: 93EO35EAAW 03/05/93 Hygienist report re: 13 work refusals** odour/health complaints: *"**It was noted during visit that the company's detector tube pump had a slight leak. C**orrective action in this regard is appropriate. Workers expressed concerned over **vapors coming from sludge room**. Effluent from a temporary holding tank was draining over a mesh basket containing bromicide disinfectant pucks. The effluent was splashing in the nearby work area. Repeated contact may cause skin problems."* **NOTE:** The various monomers and additives do not permanently bond to the plastic and are released either through vaporization or leaching. The normal injection molding process, involving high temperatures and high pressure promotes the release of such agents into the atmosphere. **H&S log: 23/11/94: work refusal (8) fumes from resin pellet dryer at 1500 ton mold**. Clogged filters in ventilation system. Workers experienced adverse health symptoms – headaches, irritated eyes, nose

	and throat, nausea. Signs of overexposure. **H&S log: 27/10/94: work refusal (8) workers: strong fumes in assembly area from injection molding operations**. Imbalance in injection molding caused plastic and solvent vapors to flow into the fascia assembly area. Workers experiencing strong odour, irritated eyes, nose and throat.
<u>Purging Operations in Injection Molding</u>: Injection molding machines were purged, cleaned and maintained daily usually at the beginning and end of a shift. This would involve manual application of purging compounds such as "Ventra Purge" and "Rapid Purge", as well as solvents including: Trichloroethylene, MEK, Perchloroethylene and toluene. The purging operation involved very high temperatures (far beyond the normal processing temperatures) in addition to pouring purging agents, polyols, and solvents into the machine then forcing the mix through the injectors, usually onto the floors in a smoldering heap – with strong vapors and smoke coming off the waste product. High temperatures and the presence of solvents and resins would at times lead to the combustion and the release of combustion by-products including Polycyclic Aromatic Hydrocarbons (PAHs), monomers, additives including heavy metals, phthalates, benzene, and formaldehyde. According to workers, events involving combustion during normal	**Chemical Exposure Risk:** Workers report the purge result as *"a hot stinky gunk that would sit there and smoke and off-gas and choke you."* The purged material would be extruded in a pile onto the floor and left smoldering. This process produced very strong fumes and smoke containing numerous thermal decomposition by-products/compounds known to be both carcinogenic and endocrine disruptors including benzene, formaldehyde, heavy metals and PAHs. As well, this would occur in the event of a change of colour. Purging also involved cleaning the mold with solvents and using compressed air to blow off residue dirt, and debris. **90E865EAAV 06/19/90: Adverse Effects Purging:** Hygiene visit over adverse health effects from purging in injection molding using PVC, polyethylene, cyclic amide. Strong fumes and smoke during purging and use of mold cleaner 201B. Thermal decomposition by products. Molding machines not vented. Discussion also regarding high level of MOL interventions regarding repeated work refusals on the FN-36 gluing line and workers being hospitalized on many occasions. MSDS

operation and purging would occur approximately nine times a month.	used in this investigation only had an incomplete document for 201B and no ingredients listed and no MSDS for cyclic amide. MOL hygienist noted the lack of local exhaust controls and hazardous exposures recommending the MOL Industrial Health and Safety Program issue an order to the employer to provide effective local exhaust ventilation, preventive maintenance, and safe work practices. **H&S log: 12/01/94: refusal in injection mold:** workers (2) refusal from mold release agent, possibly Rocket Release. No exhaust ventilation in place on molding units. Chemicals as well as fork-lift exhaust fumes. Workers experiencing irritated eyes, nose and throat, dizziness, headaches. **MOL 95I235EOAR 06/11/95 Hygiene report**: re E702 rocket release (ether blend, dichlorofluoroethane, dimethyl ether): used with thermoplastic polyurethane machine: 150-300 applications per shift. *"There is visible overspray and is seen as mist at top of injection molding enclosure. According to MSDS contains a halogenated hydro-carbon/ether blend. INFORMATION SUBSEQUENTLY OBTAINED FROM SUPPLIER (not on MSDS) indicates this blend contains dichlorofluoroethan and dimethyl ether which have suggested workplace environmental exposure levels (WEELS) of 500 ppm and 1000ppm respectively. No exposure limits established in Ontario for these materials. Based on automated nature of the IM process, the distance of workers from source, and available information on product, it is unlikely that workers are exposed to either in excess of suggested exposure limits. However, the*

	provision of upgraded controls would help to reduce overspray and minimize product wastage." **(AUTHORS' COMMENT: Ignored worker symptoms and health effects**)
<u>Regrinding of Polyol and TPU in Injection Molding:</u> Damaged or defective molded plastic parts were reground. The operator hand-fed the damaged polymer into a large-bladed grinder. The re-ground polymer was captured in a 4'x4' Gaylord. This process produced large quantities of dust and particulate; the machine was not well-ventilated and subject to frequent malfunction. In addition to particulate, the heat generated by the grinder produced fumes, smoke, and vapour. The dust from the grinding operation was broadcast to a large area, exposing bystanders. The Nelmor Model 1012RGII, a portable, electrically powered grinder, was used to grind defective plastic parts -- typically 1376 and 1103 TPU. It was situated in the injection molding area along the north wall. The operator manually fed defective parts into the loading chute as the parts were ground by rotating blades. The ground plastic was gravity fed to an enclosed hopper and the operator dumped the hopper into an adjacent Gaylord bin. Lacking local exhaust, visible signs of fumes and dust being produced, were noted by MOL inspectors. (**Report number 93E326EAAV 18/05/93)**	**Chemical Exposure Risks**: Regrind of polyol and TPU constituted a major source of exposure to PVC and likely VCM as well as pyrolysis by-products and compounds. Operators would complain that when they blew their noses, there was a large quantity of particulate in the mucus and they would find particulate in the groin area when they showered. **<u>Chemical Exposure Risks</u>**: The regrind process was inadequately ventilated, and produced large quantities of fine plastic particulate as well as fumes and vapors from high temperatures generated during the grinding process. This was the subject of many complaints as well as MOL investigations. Frequently, the exhaust system on the grinding station would be clogged and rendered ineffective. Workers reported that ground material was very hot and could not be touched or disposed of and there were *"'lots of' fumes and dust in the atmosphere and layered on nearby surfaces."* This would constitute a major source of exposure to monomers and additives as well as decomposition by-products and compounds. **93E326EAAW 18/05/93: Hygienist report**: 4 employees refuse work due to health concerns associated with regrinding machine and vapors emitted***..."Workers may***

As production expanded, resulting in 24/7 operations, the re-grinder was employed extensively for three entire shifts. Because of the heat generated, a wide variety of air-borne organic vapors and dusts were generated. Indeed, an MOL hygienist noted that during his inspection ***"....the blades and residual ground plastic material within the housing was still warm to the touch during this visit <u>from use the previous day."</u>***	***be exposed to these emissions under current circumstances due to a lack of effective controls. Upgraded controls (e.g., local exhaust) are considered reasonable and appropriate. Dispersion of airborne contaminants produced during use of the regrinding machine into the adjacent work areas is likely under current circumstances. Information from manufacturer indicates volatiles released during heating (550F) of the 1376 resin may include: carbon dioxide, water, tetrahydrofuran and styrene.*** *Other emissions may be released during heating of the resin…"* Also: 442406 18/05/93: NIOSH certified dust respirator shall be used by workers handling or transferring ground up TPU.
Information obtained from the manufacturer indicates that the major known volatiles released during heating (550F) of the 1376 resin may include CO_2, water, tetrahydrofuran and styrene. Other emissions may be released during heating of the resins. The MOL hygienist noted that the grinding process, lacking effective exposure controls, produced and caused dispersion of emissions to adjacent working areas where workers were present, and likely to be exposed.	**93D501EAAV 14/04/93: work refusals (5) re: TPU drying:** Local exhaust system for drying barrel was not locally exhausted on day of refusal.
A 1500 pound TPU dryer was employed to extract moisture from the urethane pellets prior to thermal processing. Hot air currents would cause vapors and dust to be released during the drying cycle. These were not properly vented.	**MOL:449334 report on work refusal (due to odours from TPU dryer) 19/03/93:** At time of visit, management indicated that only about one more hour of TPU production was needed to complete the production run. After that it was not expected they would be doing a TPU run for about two weeks. It was agreed the refusing workers will not have to work in the area until the extra hour of production run is completed.
<u>Trim Operation in Injection Molding:</u> After the molded part was released and inspected, it was taken to the trim table	**<u>Trimming:</u>** Products were trimmed of flash after being molded using a hand knife. Workers reported significant build up of dust

where operators would trim any flash with a knife; the part would then be inspected, then packed, and sent to shipping.	and debris on tables and floor area. These were not adequately ventilated and inspector advised management that workers were suffering obstructed lung function. Ventilation was restricted by felt covering on table to protect products which allowed dust build up and its migration elsewhere.
Injection Thermal-plastic Molding (Post 2000): With the phasing out of R-RIM in the late 1990s and early 2000s, large scale injection molding essentially replaced R-RIM for the production of larger parts in greater volumes. Gradually larger and larger injection molding machines have been introduced to produce large plastic parts. These machines range in size from 3000 to 5000 ton units. Currently, the injection molding department comprises a larger area of the plant and is located in a new addition in the south end with 17 large injection molding machines. These are slightly more automated, requiring less manual handling. However, given the size of parts and volume of production, there is a very much larger volume of resins, additives, mold releases, cleaners and purging agents used in production and a greater likelihood of substantial exposure to the mold operators and material handlers, as well as exposures to workers in other departments.	**Chemical Exposure Risks** (Post 2000): Operators spray the large mold with substantial amounts of mold release agent using individual cans of spray (rather than pressurized spray guns). The mist and vapor would broadcast far beyond the mold itself and impact a worker retrieving parts as they come off the mold. The surface area is very large, producing vapors **composed of mold release ingredients in "Rocket Release" (ether blend, dichlorofluoroethane, dimethyl-ether) and paintable mold release (TCE, perch., formaldehyde, methyl dodecyl, phosgene).** With the introduction of increasing numbers of far larger mold machines and production of larger parts, the production of plastic contaminants have become far greater. **Chemical Exposure Risk** when retrieving the finished part also entails a risk of exposure to chemical residues when the mold opens and the part is handled for further processing. **Chemical Exposure Risk: Torching**--As part of the trimming process with thermoplastic parts, was use of propane torches to burn off

	and smooth excess flash. This process produced substantial thermal combustion by-products such as formaldehyde, benzene, vinyl chloride, acrylonitrile, propylene, phthalates, HCL, CO2, CO. These emissions could be considerable given the size of the parts at between three and five feet in length. This would also include propane gas emissions and carbon monoxide. The torching of excess flash would be carried out every 80 seconds steadily for an 8 hour shift by two to three workers without exhaust ventilation and adequate respiratory protection.
P**urging operations have now been automated** somewhat, but fumes and smoke generated do remain the same.	**Chemical Exposure Risks: Purging operations** produce very strong fumes, vapors, and smoke. These include mold release, purging agent chemicals, monomers, additives, and thermal decomposition by-products from running at the very high temperatures required as well as risk of combustion. The other exposure risk is from leakage of hydraulic fluids used to open and close molds. This leakage is fairly substantial and these are suspected carcinogens.
Vacuum Hopper System: The newer machines are equipped with a "Vacuum Hopper System" which transfers resin pellets of thermoplastic olefin (TPO) or TPU into the injection machines' hoppers from 6 large silos located outside the south end of the plant. Aside from this transfer system, the thermoplastic production processes are essentially the same as described in the case	**Chemical Exposure Risks:** The vacuum hopper system generates heavy particulate as a result of the high-speed movement of the pellets which produces large amounts of dust due to collision of the pellets in the vacuum tube. The build-up of dust requires that tubes be cleaned and maintained leading to considerable release of resin dusts. Maintenance and trouble-shooting these

of smaller units described above.	large injection molds requires the operator to change screens and filters on the units, and to clean out the build-up of resin dusts containing the pellets various formulations and additives.
TPU drying system: A dryer system is set up to remove moisture from the TPU pellets. They are pneumatically transferred to the drying barrel about three feet in diameter and five feet in height. The electrically heated air at temperatures of 200-220F is introduced at the bottom of the barrel which is locally exhausted outside. The dried pellets are transferred to the mold unit where they are heated to 400-430F changing into a liquid state and then injected into the mold by a reciprocating screw. The local exhaust system for the drying barrel also serves the mold injector head of the 3000 ton mold and two other injection mold machines (80 ton and 175 ton). Total air-flow is approximately 4500 cfm.	**Chemical Exposure risks: Dusts** from the pellets and the drying system continue to be a risk factor, particularly when cleaning filters and screens. There is a greater build-up of dust associated with the vacuum loading system. This includes residues of chemicals in the formulations including fillers such as fibreglass and forms of silica, phthalates, hardeners such as BPA and polycarbonates. Exposures to vented chemical fumes and vapors emitted would occur during heating and injection processes, including mold release agents sprayed on the entire mold to prevent sticking between each shot. There is additional risk of exposure when repairing vent exhaust ducts. Over spray of release puts both operator and other workers nearby at risk of exposure. There is the added risk of exposure to thermal decomposition by-products when machines overheat. In 1987 during a MOL hygiene visit to “assist with the new H&S program” an inspector gave the following “advice to management” in response to worker complaints of “possible exposure to solvent vapor from the marker-like pencil” (used in the Ford glue line): “1. Respirators need not be worn if exposure to solvent vapors for dust is below the respective TWAEV. However, if worker asks for respirator a NIOSH-approved respirator should be offered and the worker should use it in accordance with manufacturer’s

	instructions. 2. At a more frequent exposure to solvent vapors, portable fans or local exhaust should be considered." 871537NOVB 14/09/87. (AUTHORS' COMMENT: This questionable type of advice repeated many times over by inspectors.) **H&S log: 27/04/93: work refusal (51)** after three women began vomiting and experiencing severe headaches, reduced motor function, nausea and coughing in assembly and over injection area. Women were taken to hospital, assessed and treated."

2. R-RIM—REACTION INJECTION MOLDING ERA (1989-2000)

Reaction Injection Molding (RIM) was introduced during the Pebra era in 1989. In the early years it was used on a limited basis, later replacing the "post laminating/roller forming process for making side molding, rocker panels and fascias. Reaction injection molding is similar to injection molding except that the thermosetting polymers used, require a catalyst and curing reaction within the mold. Polyurethane is a widely used thermosetting polymer. Similarly, thermoset foam molding such as "reaction injection molding" used at Ventra involved injecting two chemicals into a mold that, when combined, expands, taking the shape of the mold which solidifies into a thermosetting cellular plastic, usually polyurethane. Polyurethane plastics are complex cellular polymers formed by the reaction of a diisocyanates with a polyhydroxy macroglycol known as a polyol, or a combination of macroglycol and a short-chain glycol extender. The macroglycols used in the production of polyurethane are usually polyethers, polyesters, or a combination of both.

During processing, many other materials are added to alter the resin's properties. These additives can include heavy metal stabilizers, phthalate plasticizers, antioxidants, blowing agents, lead or cadmium pigments, brominated flame-retardants, curing agents, and lubricants.

R-RIM DEPARTMENT

PRODUCTION PROCESS	CHEMICAL RISK EXPOSURES
General description of work processes: At the height of its operation, the RIM department utilized eight large RIM Clamps (10 to 12 ft wide by 20 ft. tall) that were fed by a system of overhead pipes leading from	**General Chemical Exposures Risks:** This area employed large amounts of ISO (and other chemicals) in their specialized reaction injection mold process which produced large plastic parts. ISO was the

the main polyol and Isocyanate tanks in the tank farm to a mix station that prepared the specific daily mix required for the part to be molded. After the mix was prepared, the two separate resins were piped under 125 lbs of pressure to a series of 3 smaller sets of day tanks feeding into the 8 large clamps.

Each clamp had 1-2 mold operators who by pressing a button allowed a quick shot from the two lines of resin into a mix head where an immediate chemical reaction occurred expanding and filling the mold. The new part was removed by molder, then runners were cut off and the part was notched at the work station then sent on to a sand and trim table where flash and imperfections were cut, sanded, or buffed. If the part required more extensive repair it was sent to the grey putty area where holes or areas were filled and then sent on to be notched or punched according to specifications. The part then went to the cure oven before inspection, and when approved sent on to the paint department. The full component of workers in the department included: 3 set-up people, 13 molders, 16 sand/trim workers, 1 material handler, 1-2 assembly workers in grey putty, 1-2 notch and punch workers, 1 cure oven loader, and 2 quality control monitors. There was 1 maintenance person to deal with malfunctions in the lines and serious spills (mill right, electrician and tool and die mechanic).

The RIM department was south of the Tank Farm, separated only by a partial wall. All workers who entered the plant walked through the RIM department. The employees' cafeteria was east of the RIM department on a mezzanine level. During the early period the cafeteria was fully open and subject to chemical fumes and particles, but later enclosed with glass partitions. An enclosed Laboratory department was located below major (i.e., "only") concern of workers in the early Pebra era. Even so, the company's safety record on implementation and enforcement of provincial ISO regulations were continually ignored, despite repeated "orders" from MOL inspectors. Other serious contaminants in the area included: different cleaners and inner mold releases sprayed on the large clamps in large amounts, large amounts of chemically contaminated dust created by assembly workers in sand and trim operations (16 workers per shift). With all operations local ventilation was either lacking or inadequate.

All of the above, including frequent spills and leaks, were major sources of inhalation and skin absorption risks.

the cafeteria during this period.	
1**. The Tank Farm:** The Tank Farm was the resin supply source for the R-RIM processing operation. It contained four 5000 gal tanks approximately 20' high. Two of the tanks contained polyol and two contained Isocyanates (originally TDI and latter MDI). These supplied the two major mold ingredients to the RIM mold clamps. These different resins were kept separate until they were injected into the "mixing head" of a mold where when combined under pressure, reacted and expanded to take the desired product shape of the mold. The tank farm also contained a "mixing station" where pure polyol was mixed with filler(s) and other additives. The farm stored a large supply of Wollastonite filler (replacing fibreglass which was used initially) and Inner Mold Release (IMR) in 45 gallon drums as well as other solvents including MEK, trichloroethylene, and acetone. For a short time, the Tank Farm housed the "Regrind" operation for grinding defective or damaged thermoplastics for re-use.	**Chemical Exposure Risks:** When mixing in Tank Farm there was major risk of inhaling and absorbing ingredients during mixing. There was manual handling of and exposure to several products used in the RIM process, in particular, Inner Mold Release, extenders, surfactants, flaked fillers such as Woolastonite and fibreglass which were described as creating a layer of white dust over everything in the area. In addition, workers monitored and were required to clean up spills and leaks from the huge supply tanks of ISO and Polyol. In both cases, workers often did these tasks bare-handed, and without any PPE provided.
3**. Distribution of the Batches in Rim Department:** After the polyol mix was complete, it was pumped to three polyol 'day' or holding tanks supplying the eight RIM "clamps" (molds) with mixed polyol. At the same time methylene bisphenyl Isocyanate (MDI) was pumped to three separate day/holding tanks serving the same eight RIM Clamps. In short, each Clamp would be supplied with a pre-measured shot of each of the two resins that was then injected into a mixing head where the two resins instantaneously mixed, and under pressure	**Chemical Exposure Risks**: Workers were often exposed to the mix of chemicals due to the amount of chemical being distributed and the fact both lines were under pressure and heated resulting in frequent stress breaks along the complex distribution system leading from the day tanks to the clamps. Especially the polyol lines were susceptible to frequent breaks due to deterioration and increased pressure associated with the heavier polyol product.

expanded into the mold.	**MOL: 325-71-2 24/08/90: Investigation of ISO spill:** A major spill of 25USG of MDI in RIM department near clamp #6. **Operator not informed of spill** and not wearing respiratory protection. **Supervisor wearing protection but not worker** who was told two days later that ISO spill had occurred. **MOL report: 082980 12/05/92:** Area below (ISO) day tank shall be appropriately cleaned of any isocyanate containing material in accordance with Act, also: leak on floors at North side of (day) tanks shall be cleaned up and appropriate drip trays used to prevent the spread of the polyol in accordance with Act. **H&S log: 23/01/92: work refusal in RIM** over muriatic acid spill from overflow in day tank, sewage odours. Workers experiencing nausea from sewage odours. **H&S log: 20/09/94:** work refusal in RIM over an Isocyanate leak in the hoses in the RIM department that covered the floor. **Pebra Inc. 08/08/90:** Company's official report to MOL re: ISO spill in RIM: Report describes a leak in RIM on 07/08/90 when a bolt blew off from the mixing head of Clamp #6 during maintenance causing a heavy release of ISO from the ISO day tank. The maintenance employee put his bare hand over the leak to attempt to contain the leak to the front of the Clamp until it was cut off at the source. Worker was covered in ISO, had to take clothes off and shower and put on a contaminated Tyvek suit. Worker sent to hospital for

	assessment.
<u>4. Rim Molding Processes:</u> At the start of the shift the mold operator gathered necessary cleaning solvents and tools, consisting of steel wool, scrapers, rags and 201B mold cleaner supplied in buckets. Operator would soak the rags in the 201B cleaner and scour the mold with the soaked rags to top and bottom halves of the "clamp" or mold. While the workers wore neoprene gloves, the mold cleaner ran down their bare arms while applying the cleaner to the top half of the mold. This resulted in dermal absorption as well as physical burns. And, because molds were heated to between 150F to 180F degrees, the neoprene gloves would quickly fail to protect workers from contact with the cleaner. The molds were scoured with steel wool and scrapers when necessary throughout the shift. In preparation for the mold cycle, the operator would blow off any loose dust or material with a compressed air gun causing the residue from the cleaner and loose materials to become airborne. This was followed with a spray coating of mold release over the entire mold. The spraying action would scatter the fine mist of mold release in the operator's breathing zone as well as make contact with the operator's skin. Nearby sanders and trimmers were also exposed to these chemicals. A Committee member who worked in RIM described how sprayed mold release "would regularly drift over to the production tables," stating that if molders didn't overspray "it was a fight to get the product out." Next, the mold operator would go to the control panel and initiate closing of the mold and injection of the polyol and Isocyanate into the mixing head where these were	**<u>Chemical Exposure Risks</u>**: During this cleaning task with 201B, operators would experience quite substantial exposures through dermal and inhalation routes. **201B cleaner contains N-methyl-2-pyrrolidone (fetal-toxin), ethylene glycol, monobutyl ether, solvent blend, MEK, N-hexane and toluene (neurotoxic, encephalopathy and adverse central nervous system (CNS) effects).** The cleaner would be absorbed through the skin when running down the operator's arms; the operator would be inhaling both vapors and particulate while scouring the mold. This would involve daily exposure to this cleaning agent, 3 to 4 times per shift, which took from 20 to 30 minutes to complete. **During the plant's 1992 "cyclical" visit, the MOL inspector issued an order that "containers of 201B (a WHMIS product) shall have legible workplace labels attached in accordance with Act**." A second order stated that: *"Areas of the floors at the back and sides of the clamps shall be cleared of excess plastic debris in accordance with section 12 of the Act."* A third order stated*: "Materials such as nuts, bolts, rags, flammable containers stored at the entrance of the ventilation system shall be removed in order to allow proper air flow"* And a fourth order concluded*: "Mold machine mix-head valve shall have electrical connection repaired or replaced in accordance with the Act."* 082980 12/05/92 **522258 07/10/94: MOL report** (New type of) gloves were obviously defective and had torn. (Worker) claims skin rashes due to penetration of solvent and

combined to produce a chemical reaction in the heated mold resulting in formation of a plastic part. This violent reaction would produce gases and vapors containing residues of the polymers and monomers as well as the mold releases to prevent sticking.	concerned temperature of mold causes breakdown. Inspector (based on information received from glove manufacturer) concluded that "Solvex nitro glove will protect the hands from exposure to mold cleaning solvent." Worker offered barrier cream and special under-glove to use with "new" gloves.
While the molds were equipped with local exhaust ventilation, these were situated so low and far to the side that the contaminants were evacuated only after first entering the breathing zone of the mold operator. Also, the exhaust ventilation was not continuous. It would start when the operator pressed the mold release trigger, and stop when trigger was released.	**614610 09/04/96: MOL report re**: refusal in RIM re: R-602 clamp spray: Workers felt they were being exposed to mist from R602 chemical as they were wearing incorrect respirators. They experienced nausea, reddening of the eyes, and headaches. It was established that incorrect respirators were being worn.
The operator then retrieved the still hot part, cut the gates and runners with a blade, then "notched" the part in nearby notching machine, next sending the part to trim and sand table. The operator would return to the mold, blow off any dust and debris with compressed air gun, and coat the mold again with mold release agent using a spray gun. The operator would return to the control console, press the switch to close the mold and begin the injection and molding cycle again.	**MOL: 467970 21/11/94 MOL report**: Workers complained of headaches, dizziness, sore throats and one worker was sick to her stomach and with a nose bleed; she was sent to hospital. No trained person available to conduct air sampling at the time, done later by JHSC with no findings. Inspector's decision: *"ventilation will be improved, no hazardous ingredients in mold release."* See below:
The operator would repeat this process approximately 180 to 250 times per shift. The operator would initiate a more thorough cleaning with 201B mold cleaner, as described above, between 3 to 4 times per shift depending on the state of the mold and condition of the part being produced.	**MOL: 568519 19/10/94 MOL report**: Union H&S rep stated s/he was trained in flow rate testing but not told what the flow rate should be. Inspector notes: *"During this visit to this workplace I saw numerous contraventions and hazardous conditions that the certified members and other JHSC members did not notice.* (Names company H&S rep) *also noted that supervisors need training in how to discharge their duties under the act."*
	Also during the injection and reaction cycle, resin residues containing unreacted

	monomers and release agent vapors would be given off due to the high temperature during the mold operation. Also confirmed by Queens University Hygiene Report. This would also occur when opening the mold and retrieving the product. This cycle would be repeated 180 to 250 times per shift making for a chronic daily exposure to these chemicals. It has been noted that exhaust ventilation was situated so that vapors would reach the worker's breathing zone before being exhausted, and was not continuous. Workers were not provided with respiratory protection or local exhaust ventilation and were only provided with cotton gloves during molding cycles. MOL **31496 28/08/91:** A 1991 work refusal due to heat at clamps. Workers asked to have two additional ten minute breaks. Inspector advised there is no heat temperature in the legislation. **Event 3474 (H&S log) 21/04/92:** In 1992, 9 clamp operators refused to work due to the ISO monitor not functioning properly due to lack of calibration. **Chemical Exposure Risks:** During the molding cycle, including blowing-off, dust and debris would expose the operator to particulate through inhalation as well as residues of mold release, and resins containing Isocyanates, polyol, polyurethane, Wollastonite, and mold release. This would also involve exposure to mold release during the process of spraying down the entire mold cavity with release agent, containing trichloroethylene, perchloroethylene, methyl-dodecyl, methyl(2-phenoxypropyl-siloxane) in addition to thermal decomposition by-products formaldehyde,

	phosgene, and chlorine. Workers observed that when spraying the mold release on the hot surface, vapor and steam would appear during application. **MOL: Hyg Report 31/10/88 (Kim Gordon**): *"RIM molding operation has* <u>*inadequate*</u> *exhaust ventilation and ISO control program had limited worker coverage; need immediate attention to ISO leaks."* **MOL:244814 30/11/88 Assessment of ISO Program**: The MOL's assessment of the ISO control program resulted in orders for the company to provide continuous ventilation during the entire RIM molding process and to include all RIM personnel in the control program. Up to this point, only the mold release spraying process was ventilated and only the molders were included in the control program. There was a high probability of vapors during the mold cycle during part extraction and handling, during spills and leaks, as well as while sanding and trimming parts that were just 30 to 60 seconds out of the mold, and dust that likely contained ISO. **Bickis et al. (1988) <u>Evaluation of airborne midi levels</u>. (Occ Health Centre, Queens U.)** Report re: Methylene diphenyl di-isocyanate (MDI) exposures in RIM: This report indicates that *"Although MDI is less volatile than many other Isocyanates, the elevated mold temperature does create a potential of over exposure, if the exhaust ventilation is ineffective. Importantly, it should be noted that between 1987 and 1992 the exhaust ventilation at the RIM clamps was not continuous. It was only operational when the molder triggered the mold release spray prior to the molding cycle. It was shut down*

	during the mold cycle and when the mold was opened and the part removed. It is highly likely that over exposure was occurring during this period. It was over a year after the MOL ordered the employer in 1989 to implement continuous ventilation at RIM that ventilation might be judged as adequate. Moreover, according to the MOL reports this assessment was deficient in that it did not designate all workers in the RIM department including the sanders, grey putty operators and post cure oven personnel as coming under the ISO control program." **MOL:288454 02/02/90: ISO leak** at day tank: hydraulic fluid (Mesamoll) from Clamp pistons leaking deemed "not hazardous;" two drip trays below day tanks not cleaned, order issued; ISO pumping units are leaking ISO; still not fixed; ISO evacuation procedures and training as per "control program" still not carried out – orders issued. **H&S log: 21/11/94: work refusal** RIM: workers experienced adverse health effects from over-exposure to mold release R-602 (soap and alcohol). See **MOL reports 522291 and 5222142.** A committee member noted: "*We discovered the scotchbrite we used for scrubbing the molds contained nickel and had a hazard warning on the box saying it was a carcinogen."* **H&S log: 17/01/92: work refusal** (5) on Mold #4: a defective polyol hose disconnected from the mixing head under high pressure so that workers were sprayed with large quantities of polyol. Workers sought medical attention at local

	hospital and went home to shower and change clothing. No emergency showers provided. **Chemical Exposure Risks**: According to Ministry of Labour inspector, E. Swindells' testimony before the director of appeals, the following exposure risks were prevalent during the molding process and during the sanding and trimming operation: (prior to 1991) *"….ventilation at the mold comes on only when the mold spray release gun is operated. There is no ventilation during the molding operation itself. The highest likelihood of exposure is at the end of the molding operation, which involves chemicals being pumped in from the day tank, a 30 second reaction time, and then the opening of the mold. Any unreacted isocyanate is then next to the warm mold, and may come off in a puff. It may also escape if there are any leaks on the fitting head where the chemical come into the mold."* **MOL hygiene consultant, Kim Gordon, also testified *"…there are limitations to air sampling techniques. Only MDI can be measured.*** *The monitoring does not measure short-term peaks or changes in the equipment such as leaks. The fact that the operator is 4 feet away during the molding operations is not relevant. Without ventilation, isocyanates will not be cleared from the area, and the operator will immediately approach the mold."* **Chemical Exposure Risks: Dr. Leon Genesove, medical consultant**, testified also *"that sanders, de-flashers and preparation workers…are presently affected….because of their proximity to the clamps and to any airborne vapors. The workers are positioned on the opposite side*

	of a table from the mold operators, and are handed the freshly molded products, when only one or two minutes old. There is also a possible exposure through the sanding process, from MDI dust. There is no sampling method for this and the extent of hazard is unknown." (Appeal Decision, Eleanor J. Smith, February 28, 1989; File Numbers AP 88-140 and AP 88-159) The neoprene gloves worn during the application of 201B were not effective because they would dissolve when in contact with the mold cleaner and the heated mold. And when cleaning the top half of the mold, the cleaner would run down the gloves and unprotected forearms thus causing absorption and chemical burns to the skin.
5. Leaks, Spills, and Line Breaks in Rim: Breaks and leaks in resin lines and joints, in addition to spills were regular occurrences at injection molding, particularly at hose joints at the mixing heads and valves. Since these lines were under great pressure, when breaches in the lines occurred, isocyanate and polyol contamination would be extensive and molding staff highly at risk and lacking protective equipment. Prior to 1993, any worker in the plant could be called on to clean up spills (except in the case of Isocyanate which came under its own guidelines). In the event of accidents, maintenance staff were called. Later an emergency response team (1993) equipped with positive pressure hoods and Tyvek suits would initiate containment and clean up. Hoses would be drained of leftover polyol and isocyanate in separate open pails. After	**Chemical Exposure Risks:** When resin hoses blew, either at joints or valves, mold operators would endure heavy exposures given that these were unexpected events and operators were not equipped with appropriate PPE to prevent exposures. Informants described instances in which operators would experience a full frontal blast of resin, or where operators would be covered with resin. At these times, inhalation and dermal absorption is highly likely. This is evidenced in those exposures that resulted in sensitization after exposure. **Chemical Exposure Risks**: Risks of exposure to MDI were high when either system was disassembled. The atomization of MDI while under high pressure in the system, as well as the large quantity when disassembling the lance seals and transfer pumps and valves. Exposure to polyol was also at high risk when disassembling polyol lines

containment and clean up, maintenance and mechanics would clean and rebuild mixing heads and hose connection after soaking the parts in solvents, usually MEK or TCE. While leaks and breaks in the supply line occurred regularly, leaks and spills were more likely to occur behind the RIM mold and not be immediately noticed by the mold operator. If a leak was spotted by an operator, they would shut down the mold and call out to other workers and then call for the Emergency Response Team (ERT) for clean-up and repair. Often mold operators would be unaware of leaks (occurring behind the clamps) thus were unable to take control measures to prevent exposures. Explosion hazards were always present when working with Isocyanates. Focus group informants recalled close call events involving the inadvertent dumping of ISO in a 45 gal steel drum that had residue of inner mold release in it. That combination caused the ISO to expand violently in the sealed drum and eventually explode. Fortunately this occurred in the Tank Farm away from a populated area.	particularly from skin contact which caused severe itching and rashes. The precautions taken included: positive pressure hoods, Tyvek suits, neoprene gloves and a MDI monitoring alarm which was to operate throughout the repair and provide continuous readings. Mold operators were advised of the work and were to leave the area. **<u>Chemical Exposure Risks</u>**: For maintenance staff and ERT staff who would be equipped with positive pressure hoods, neoprene gloves and Tyvek suits, as well as Isocyanate monitors, exposures were likely to be more controlled, but continued to carry a risk of exposure because equipment was not completely sealed and at times appropriate equipment was not immediately available.
<u>6. Rim Trimming and Sanding:</u> After the mold operator placed the part on the sand and trim table the assembly worker would trim any excess plastic or flash off the part, then sand it with a retractable palm sander (located over head) to smooth out rough surfaces on the part. The sander was retracted by a spring and disturbed the build-up of dust when it hit the shelf. Once sanding was complete the worker would hang parts on a cart containing racks. The sand and trim tables were equipped with a down draft system designed to prevent exposure. However, since felt pads were laid on the table surface to prevent damage to the parts,	**<u>Chemical Exposure Risks:</u>** Workers were heavily exposed to resin dusts from handling parts and through inhalation of resin and mold release residues contained in the dusts thus both dermally and through inhalation. Workers described the accumulation of dust in nasal passage mucus, which was likely swallowed. Dust accumulation was also found under breasts, armpits, and crotch/scrotal areas, further contributing to skin absorption of unreacted monomers, solvent and mold release residues. Workers were not provided with respiratory protection and

dust would quickly accumulate and clog the openings, thus defeating the purpose of an exhaust system. Workers reported very heavy dust accumulation on all surfaces. *"Within 15 minutes you would be covered in this white dust, and look like a snowman".* This department was very hot and dusty with large free-standing fans used to provide air movement and cooling.	only cotton gloves. **MOL: 288440 29/03/90: WCB ISO** claim: a number of workers developed sensitization from isocyanate-exposures in sand and trim. It is important to note that sanding-dust contained residues of Isocyanates, polyurethane, polyol, monomers, mold release, and Wollastonite or fibreglass. The use of standing fans caused dust to become airborne and migrate widely in the plant contributing to widespread inhalation of the dust. MOL inspector advised employer that "too many" workers have obstructive lung condition. **Workers described the RIM department as very hot—between 80 and 100F as well as dusty and extremely smelly (a solvent like irritating odor). It was: *"very oppressive to work in."*** As testimony to such exposures, there were many work refusals with workers becoming ill with upper respiratory inflammation, headaches, nose bleeds, eye irritation, itchy skin, nose burns and difficulty breathing. Such occurrences are documented in MOL investigation reports of complaints and work refusals under the OHSA. **H&S log: May 9, 1990:** failure to provide necessary protection: *"The following people* (names) *have been asking and asking for improvements and vented tables. Refused work because filters have not been cleaned out since Christmas. The plugged filters resulted in dust blowing out into the air and onto people. Workers can taste the dust....itchy skin, burning eyes, bloody noses. (names Worker without vented table)*

	sometimes has to sand and has no vented table. She has been very patient for one year and still hasn't got one. They have asked for a shop vac and still nothing."
<u>7. Rim Grey Putty Operation:</u> Grey Putty contained a mixture of diphenyl methane diisocyanate (MDI), talc, silica, MEK and asbestos. After being trimmed and sanded, parts would be examined by the grey putty operator who would look for defects and apply grey putty on the damaged surface with a foam-tipped brush, then rub it off with a cloth soaked in solvent. This task was performed in a three walled room with a ventilation system nearly always rendered inoperative because of excessive noise levels (over 90 db) from the ceiling exhaust system. Putty was applied, rubbed off and sanded without respiratory protection, gloves to protect the skin, or local exhaust to prevent inhalation. After smoothing the putty, the operator would hang the part on a moving rack where parts were taken to the cure oven. The grey putty product contained isocyanates, a designated substance, yet for years workers were unaware of the dangerous ingredient and excluded by the company from the plant's ISO program. (AUTHORS' NOTE) We learned that several grey putty operators died of cancer at a relatively young age).	**<u>MOL: Exposure Risks:</u>** The Grey Putty contained HDI, talc, silica, asbestos, MEK. Exposure was likely through inhalation as well as being absorbed through the skin. The solvent in the putty would exacerbate the exposure by defatting the skin tissue and thus allowing increased absorption. **MOL: 90GB63MOWV-C 16/10/90:** hygiene monitoring for HDI, MDI: RIM/Grey Putty: No detectable levels found at RIM molds and Grey Putty (HDI). Observes that *"comfort fans were operating in the sand/trim which could possibly have interfered with the monitoring."* Mondur PF and MDI C-961 used (see Appendix E). **MOL: 2933241 14/03/90: ISO program** re-assessed: MOL initiated an audit of the ISO control program found deficient on worker coverage under the program. The Grey Putty operator was not formally written into the program and had not been advised that the Grey Putty contained HDI. The product, also called "Porenwischfuller 3311," is diluted with clear coat hardener (AP19513) and diacetate alcohol. The control program was found deficient in providing documentation on engineering controls and air monitoring frequency, and has not adequately identified workers who must be covered by the program or developed a proper medical surveillance program and reporting procedure for occupational illness. **H&S log: 23/02/93**: work refusal in grey

	putty area: chemical bin broken and fumes building up – exhaust fan was turned off.
<u>8. Post Cure Ovens in Rim:</u> After being prepped for curing, parts were sent by overhead carousel through an oval tracked conveyor that moved parts through an overhead oven heated to approximately 325F. The oven cure took about 1.5 hours to cycle. Ovens were open at entry and exit points.	**<u>Chemical Exposure Risks:</u>** The thermal curing operation would produce a number of thermal decomposition by-products including: unreacted monomers, formaldehyde, HCL, NO, CO, CO2, nitrosamines, benzene, phenol, phosgene, acetone, NH, methane, HCN, and styrene, toluene, to mention some possible thermal decomposition by-products. Lower temperatures were more likely to result in the release of unreacted monomer and thus be more biologically reactive. Most affected was operator monitoring the curing process who may need to enter the oven to clear a jam. Notch and Punch operators working directly under the ovens would be at risk of exposure to vapors from chemical by-products. Employees in the maintenance office below the ovens would also be affected. Workers who handled "cured" parts would incur exposure via dermal route and inhalation of vapour from heated parts that may contain unreacted monomer, additives and combustion by-products.
<u>9. Touch Up Area in Rim</u>: This area was located between post cure ovens and paint line. Fish eyes, blisters and other defects would be sanded and touched up with the grey putty at worktables. This work process involved a great deal of sanding and was extremely dusty. Approximately 90% of the	**<u>MOL: Exposure Risks</u>:** Exposure to dusts containing MDI, polyol, silica, asbestos, and MEK was very high through inhalation of dust and skin absorption. Curing operations in RIM added additional contaminants to the ambient air of the plant thus burdening the work

work here involved sanding.	environment with additional risk of harmful exposures. These bystander exposures must be counted as significantly contributing to worker exposures. In this regard, it is important to emphasize the fact that this building is completely open concept and ventilated under negative air pressure, which causes local generation of contaminants to spread throughout the plant complex. **MOL: 90E873EABR 25/06/90**: MOL assessment of sanding tables ventilation: MOL hygienist conducted air flow and air monitoring tests for the 12 standing tables used to smooth out imperfections on RIM molded polyurethane pre-painted parts. The inspector found that the exhaust grills on the table were blocked and dust exposure was evident. The face velocity measurements indicate that exhaust is less than the minimum required to capture the dust generated from sanding. The felt pads on the grill clogged with dust, restricting air-flow and capture efficiency. Often exhaust filters were clogged too. Recommendation not to use felt pads. Preventive maintenance schedule not available.
<u>10. Quality Assurance in Rim:</u> After post cure, the finished parts would be examined by an inspector in the quality assurance area. Inspector would check for any defects or imperfections in a part and cull those out for repair, touch up, or (initially), to be discarded as waste (Later, discards were reground). Quality Assurance "Auditors" were in all departments except for the inside paint line. In addition to checking for production quality, these laboratory technicians tested all chemicals and materials including the various resins (e.g. TPO and TPU) that were	**<u>Chemical Exposure Risk: Quality Assurance</u> QA workers** handled freshly painted or molded parts and performed various stress and destructive tests on material, which posed a risk of inhaling or absorbing the various ingredients in the paints and thermal plastics used. QA workers were at risk from handling freshly painted or cured parts containing residues from paint, resins and additives. The tests run by quality assurance would expose them to these as a result of

shipped to Pebra. These personnel would have all necessary information on resin formulations and additives. Operators would incur exposure to residues on surfaces by handling the cured parts as well as the inhalation of vapors since these were still rather warm after the post cure process. Quality assurance personnel were required to perform material integrity test that involves scraping with a coin and closely examining the texture and bonding of the paints. This would involve exposure to the contaminants mentioned above, likely wearing only lab coats and gloves. Potentially, technical staff were subject to exposure to almost every chemical used in the plant. Lab safety precautions would be crucial for controlling these exposures. Once parts passed quality assurance, a material handler would carry 8-10, often dusty, parts then place them on a moving cart attached to an in-line dragline destined for the paint line. During this period the handler inserted a dry-wall screw into a slot on the part, then clamped this onto a rack on the cart to hold the part in place.	physical breaks in part surfaces. Dermal and inhalation routes were significant.

3. PAINT DEPARTMENT: INSIDE/OUTSIDE PAINT, PAINT KITCHEN, SLUDGE ROOM

The Paint Department was, and still is, a massive operation that every part produced went through, prior to assembly. It was a complex system with many points where problems could, and did occur, making quality control an on-going issue. There is both a self-contained "inside" paint line, and open outside paint assembly area. The original inside paint line consisted of a tunnelled cart track that transported plastic parts through a wash stage then through three separate paint booths reflecting a three stage paint application of: primer, base coat, and hard clear coat. After painting, parts entered a 4-stage cure oven to set and harden the paint. The "inside" paint line, while enclosed by metal cladding, had a number of pathways for paint line contaminants to migrate throughout the plant. Workers reported continual breaks in the metal, from heat and other stressors, which were often repaired with metal coated tape requiring continual replacement. In addition to substantial direct exposure to paints and solvents for inside paint workers, there was considerable outside, bystander, exposure due to fugitive emissions. These exposures were made worse due to ongoing problems maintaining appropriate air pressure balance throughout the paint line, and with the ventilation system in general, including serious deterioration of the paint booths' stacks in the Pebra years.

The paint line went through major changes after 1993, including expansion from three to five booths (adding secondary base and clear coats) to address ongoing adherence and curing problems as well as extensions in length of cure oven and load/unload areas to accommodate larger parts then being produced. After these changes, paint was delivered in premixed 45 gallon drums that still allowed for manual addition of solvents to adjust viscosity. The premixed paints were no longer two-part formulations requiring a catalyst. The other major change was automation of the paint line with the installation of robot painters. Despite these changes, the perennial problem with the ventilation system continued to result in chemical over-exposures in and outside the paint line -- affecting paint quality as well. Workers reported that 80% of painted parts produced in the Pebra era required re-painting. Paint lines required regular purging with solvents and purging agents resulting in substantial spills as well as misting of solvents and paints into the broader environment. Such contaminations were intensified because the paint line system was also under pressure. Most spills were cleaned up using Pebra 5 and MEK, then squeegeed into the sluiceway leading to frequent, and substantial, contamination and worker exposures to paint and heavy solvent mists and vapors.

PAINT DEPARTMENT: INSIDE/OUTSIDE/PAINT KITCHEN/SLUDGE ROOM

PRODUCTION PROCESS	CHEMICAL EXPOSURE RISK
GENERAL OVERVIEW OF PAINT PRODUCTION PROCESSES: **Preparation of parts:** As parts were being loaded on carts for painting (paint line wipe ramp), they were inspected and wiped down with a tack cloth, possible soaked in alcohol. During this process no PPE or exhaust ventilation was available. **Inside Paint Operations:** The (inside) paint line consisted of a large covered oval conveyor system linking a prewash station,	**General Chemical Exposure Risk:** This was a major area of contamination associated with the massive use of paint, solvents and other additives in the multi-stage coating of every product produced in the plant. The ventilation system was inadequate and working "at its maximum" according to a consultant brought in by the MOL to review the system in 1990. Many paint and solvent MSDSs had a manufacturer's health warning noting that signs of over-exposure included the following symptoms: irritated eyes, nose

three (later expanded to five) enclosed paint booths, and a cure oven. The paint line utilized two parallel pump systems that included: 1) a circulating water system carrying water and chemical overflow by deep trough from the paint booths to the sludge pit where contaminants were removed, and 2) a series of pressurized overhead lines connecting the day's mix of paint through a system of pumps leading from the "paint kitchen" to paint booths. The pump system transferred paint solvent, HDI, and Adpro (an adhesion promoter), from the kitchen to each of the booths. These chemicals were pumped from a 60 gallon tank, through a pump surge suppressor, filter pressure regulator, colour valve stack, and back pressure valve to another 60 gallon tank. At the entrance of the Inside Paint tunnel, was a 6-stage 'wash' cycle that cleaned and degreased parts to be painted during separate wash cycles containing water, hydrochloric acid, caustic soda, sulfuric acid and Parco Plast (descaler). Initially, parts went through three separate paint booths applying a 2K primer coat, a 2K base coat, and a 2K clear coat. This was a partially automated process with overhead sprayers in the booths. It was reported in focus group sessions that the system was not well designed leading to a great deal of overspray and need for manual painters to paint areas missed by the overhead sprayers. The three booths were later expanded to five booths, adding a needed second application of base and clear coats. (Booth 1 primer; Booths 2 and 3 base coat; Booths 4 and 5 hard, clear-coat). Further down the enclosed paint system was a 4-stage curing oven where paint	and upper respiratory tract, dizziness, disorientation, nausea, vomiting, tightness in chest, and difficulty breathing**. These symptoms were frequently exhibited by workers indicating, in accord with manufacturers' warnings, that workers were being over-exposed.** **Chemical Exposure Risks***: "We never painted a good part…80% of the parts we made had to be painted again…they wanted us to rework those parts and start sanding them* (immediately out of the hot oven) *and then put them through the paint again so we were getting a double dose of the stuff. It was years before we made a quality product."* Committee member *"In early years of manual painting the excess paint and solvents from the* (inside) *paint booth were vented out putting bystander workers at greater risk of exposure than the painters themselves."* Committee member **Chemical Exposure Risks:** touch up painters at risk of exposure through inhalation and absorption. Many instances where PPE had flaws, exposing workers to ma Supply air vented to the ambient air outside of the booth. Workers were drawing ambient air that could be contaminated. Improper fitting suits allowed skin contact while in spray booth. There were many instances in which air pressure balance led to major releases of airborne isocyanate

hardened or "cured." It was difficult to maintain the required temperatures in each of the four ovens due to leaks and air imbalances in the deteriorating tunnel and stack structures. After exiting the oven/tunnel, parts were inspected and either approved for shipping or sent to "outside paint" assembly area for touch up, or rework, prior to final assembly and shipping. In later years if a part was unsalvageable, it was sent to "regrind."	paints. Curing oven was also a significant source of risk of inhalation particularly when ventilation system was not functioning properly.
<u>Outside Paint: Assembly, Quality Control, Cart Maintenance</u>: In outside Assembly, production workers inspected, cleaned, repaired, reworked and boxed newly painted parts in preparation for shipment. There were two production workers per table/per shift assigned to both "sand/trim/buff" and "rework" operations (the number and specific tasks of workers were dependent on what was required for parts produced that day) In "cart maintenance," male workers (2 per shift) were responsible for keeping the inside paint carts free of paint build-up and properly functioning. This was, dirty, smelly, heavy work involving welding and use of power tools, including air chisels, grinders, and high pressure water sprayers.	**<u>Chemical Exposure Risks:</u>** Outside Paint and Assembly were at significant risk of exposure due to direct handling of recently painted parts, some still wet. Inhalation of fumes and dermal absorption was also high. Exposure to releases from inside paint, as well as fires, would expose outside paint workers to very hazardous by-stander exposures. **<u>See below for specific risk factors identified in the outside paint in this section and details for assembly operations</u>**
<u>Paint Kitchen:</u> The paint kitchen, where paints and solvents were mixed and stored, employed two "kitchen" operators per shift. This was a dangerous area due to the tasks involved and large amounts of toxic chemicals that were used and stored in the area. **<u>Sludge Room/Sluiceway:</u>** The entire paint operation was linked to a large 4 ft deep trough system which continually carried	

both "clean" and "waste" water that continually circled beside the paint tunnel ending/beginning in the Sludge room which contained several Olympic pool-sized, twenty ft. deep "pits" where chemical waste products were separated into their liquid and solid properties and removed (far too infrequently, leading to major contamination and exposure risks for workers). Both were a constant source of unpleasant and toxic fumes for some -- and often many, even all the workers in the plant.	
<u>Ventilation Problems</u>: While the paint tunnel was ventilated and designed to suck paint fumes and vapors inside, to prevent exposure of outside workers, if the ventilation system was turned off or compromised, fumes and vapors from the paint operation would contaminate the area at entry and exit. When this occurred, workers would be evacuated from the area. There were many documented complaints, work refusals, and MOL investigations, in response to these episodes.	**Chemical Exposure Risk**: **MOL Hyg Report 31/1088 (Kim Gordon):** A hygiene assessment *"…inside paint line found to be blowing paint and solvent vapors into the general work area."* (Inside paint and outside paint at high risk of inhalation exposure during these episodes).
<u>DETAILED INSIDE PAINT PROCESSES</u>: The in-line carts carried parts on racks through the paint line which included the following stages or processes: 1**. <u>Wash System</u>:** An automatic six stage wash system consisting of a pre-rinse with water; an HCL bath; a caustic soda bath; parco plast; blow off tunnel; and a dry off with hot air. Set-Up workers responsible for filling and monitoring station.	**Chemical Exposure Risks**: Set-up workers at risk of exposure to various caustic agents because of exposure to mists and sprays from this process. These ingredients (HCL, Caustic soda, parco plast) were continually being added to the wash water at the different stages. No PPE other than gloves and lab coat worn.
2. **<u>Paint Booths</u>:** In the early years, two paint operators were stationed in each	**<u>Exposure Risks</u>**: The paint department had the largest concentration and variety of

booth to touch up and apply paint to areas missed by the reciprocating overhead sprayers They wore anti-static boots, gloves, Tyvek suits and respirators (with improper cartridges) for this application. The painters would enter the booth, purge the paint lines and guns with Pebra 5 and begin spraying the parts. The hand painters sprayed the bottom and edges as well as any spots missed by the automatic sprayer overhead. By 1993 when inside paint was first modernized all five paint booths were fully automatic with robots replacing inside painters. The paint operators were responsible for cleaning up over-spray episodes. This would involve removal of their gloves and Tyvek suits and wiping down the over spray with a rag soaked in either Pebra 5 or MEK. They were also responsible for clearing cart collision stoppages in the paint tunnel. **Paint Line Set-up Operator:** The set-up operator wore PPE, anti-static boots, rubber gloves and a respirator and was not required to wear a Tyvek suit at the outset. The set-up operator's tasks included: setting the air pressure in the booths, monitoring the paint pressure, repairing overhead reciprocating spray guns, flushing and filling paints, cleaning booth windows, mixing paints at the booths for cold and hot pots, and cleaning air caps in container filled with Pebra 5. In the early years, an automated cart carrying parts would pass between the two painters who would spray the bottoms and edges while an automated reciprocal paint arm sprayed the tops of parts. According to focus group worker reports, *"most times painters did not wear proper PPE and respiratory protection."* Painters wore Tyvek	toxic chemicals used in the plant. Based on the number of different MSDSs there were 98 chemical compounds with each of these containing a number of chemical ingredients. These ingredients included primers, catalysts, solvents/thinners, wash caustics, paint kitchen chemicals, sludge room chemicals, and cart maintenance chemicals. For example, in the 11 compounds used as primers there were 35 different hazardous ingredients noted in the MSDSs for the main products. **Chemical Exposure Risk**: The primary sources of VOC emissions from surface coating operations (which result almost exclusively from solvent evaporation) include: the application area, flash-off area and curing ovens, with less significant sources being the storage and mixing of coatings and solvents, surface degreasing, and equipment clean up, including line purging for colour or material changes. Storage vessels for paints and solvents as well as mixing kettles usually fitted with breather pipes from which VOC emissions emerge. **Chemical Exposure Risk:** VOC emissions (coming from 50-80% of the coating operations) arose from the application and curing of the primer, primer surface and topcoat, of which 75-90% emitted from the spray booth and flash off area, and 10-25% from bake oven. The remaining 20% of VOC emissions result from final topcoat repair, clean up, and miscellaneous sources, including the coating of small components and application of sealants. (Ed Wong, 1996) Inadequate PPE would increase the risk of exposure to paint chemicals as well as poor work practices. **Queens U hygiene report: Aug 1988:** Re:

suits and ambient air hoods only in the clear booth where they were "vented" through a flexible air hose connected to their hood and leading to the ambient air outside the booth. This was not a sealed positive air supply system. The painters were in fact breathing contaminated ambient air from the outer room and whatever contaminated air there was from the paint operation. All paint booths shared a system for capturing paint over-spray. This consisted of electrostatic charged particles drawn down to a grate over a sluiceway filled with water, as well as a water wall that further captured paint particulate and drew it into the sluiceway. The sluiceway, approx.-imately 24" wide by 4' deep, traveled through all the booths then down to the "sludge room." The sludge room contained two open pits approximately 75'x12x20' deep and a third about 7' deep where five pumps moved sludge water overhead through a 10" pipe to the side of each booth. To further assist in preventing fugitive emissions of paint and solvents vapors, the booths ventilation system was under positive pressure. However, this was often subverted as a result of doors left open within the paint line system resulting in migration of heavy vapors from all booths including the clear-coat booth, which contained Isocyanates and catalysts. Operators described the later mix as large, visible, mushroom-shaped clouds of vapour and mist that would flow throughout the paint line and out into the general area of the plant. This latter condition has continued to the present day. Workers indicate that the ventilation system continues to fail and expose workers to highly reactive paint fumes and mists. **<u>Chemical Monitor</u>**: The tasks of the "chemical monitor" included: testing for proper chemical levels in the 6 stage wash	heat stress in paint booth: the Wet Bulb Globe Temperature (WBGT) *"measured outside clearcoat booth was 27.2C. This would marginally exceed TLV of 26.7 for continuous work of moderate workload. Painters standing one arm work would likely be classified as light work therefore the permissible WBGT index for a paint sprayer in work clothes would be 30C. However, the WBGT device cannot quantify heat stress within air respirator paint suit. Judging from the observed redness of skin and degree of perspiration, painters likely experienced considerable thermal stress while clear-coat spray painting.* And in the same report: *The inside solvent level ... may not be reliable as the sampler tubing disconnected from the pump at some time during sampled period. However, an inside suit solvent level was determined to also be below the analytical detection limit. Solvent vapour was detected inside the suit of one painter* (on a different day). *This may have occurred before the hood was in place while the other painter tested his spray gun with several short blasts."* <u>It is important to note that a number of the paint and solvent chemicals used in the Paint Line have been rated as carcinogenic, fetal toxins, teratogens, mutagens, neuro toxins and sensitizers.</u> **MOL288460 22/01/90: MOL** follow-up re: fumes, ventilation, ISO exposures in paint line: MOL inspector notes previous orders still not complied with: WHMIS training not completed; paint fumes from paint line still a problem; and no action taken to date. Management suggests workers just move out of the way of the fumes which inspector rejects as a solution not in accord with regulation 132. **P90-01-70 22/01/90:** documentation of

cycle; monitoring the sludge water for paint and solvent levels; adding chemicals to kill paint and removing solids with a "weir box"; adjusting pumps for water and chemical applications; changing filters for water wash system and chemical applications; adjusting water and air flow in paint booths; and monitoring temperatures in paint system ovens, paint temperatures, viscosity, air temperature and humidity throughout the inside paint operation. Their other duty was to change roof filters. Inside Paint Maintenance (skilled trades): Workers maintained and repaired all components of the inside paint operation. Each shift had dedicated 2 millwright mechanics and 1 electrician. Their work involved the daily rebuild of paint components (e.g., pumps, air motors, surge suppressers, back pressure valves etc.) as well as responding to any breakdowns. Repair involved soaking components in large pails of MEK and later Flush solvent. Specific chemicals which maintenance workers were exposed to included Purge solvent, HDI, and all paints and solvents used in the department.	two fires in paint line, fumes coming out of tunnel. Paint Line Chemical Monitor requested a review of air system referencing two fires in paint tunnel at the manual paint gun site. **MOL 288244 15/06/90**: Ventilation evaluation/fires in paint: MOL orders engineering evaluation of ventilation system to correct current imbalance between replacement/exhaust air causing the migration of toxic chemicals from other departments to enter general (assembly) work area. Noted that illegal modification made to paint spray system was cause of several fires in paint line due to electrical static discharge sparks igniting paints/solvents. Ordered to correct and not make changes without consulting manufacturer of the paint system. **Chemical Exposure Risks:** maintenance. See separate treatment of maintenance personnel below. Millwright especially exposed because of detailed work repairing and purging paint pumps and lines. Heavy exposure to ISO paints, solvents, and thinners for prolonged periods. **MOL: 90D855maav 23/05/90**: worker sensitization: MOL advised that worker in paint line had been sensitized to isocyanates. He noted that safe practices and procedures not strictly followed as required by ISO control program. **MOL: 244907 12/04/89:** work refusals Inside Paint: *"Workers refused to install a stairway in the inside paint line due to presence of toluene vapors found previously on 10/04/89 that might present a fire and explosion hazard. Fan turned off in the sludge room caused the migration of toluene to*

	migrate into the main plant. Four workers were sent home. A combination of factors noted: make up air unit turned off blower in another area changing air flow in plant from positive to negative, and water levels in sludge room were too high." **MOL: P90-01-70 22/01/90: refusal re: paint fumes** coming out of the paint tunnel due to failed ventilation system and a fire in the paint line **MOL: (Swindells) 08/02/90 MOL inspector re: ISO control program:** *"MOL observed worker entering spray booth without respirators immediately after ISO paint spraying; no ISO control program training for painters; worker observed entering ISO booth with respirator not strapped and fitted properly – orders issued."* **H&S log: 07/05/90**: **work refusal (10) workers:** *"Work refusal over air-flow problems in inside paint. Airflow in the wrong direction and booth filled with cloud of Isocyanate paint. Maintenance workers entering booth without respiratory protection; Scott air-packs inside the booth and not available for those working in the booth. Logs show a constant problem with air-flow throughout the year. One worker was given another person's respirator to wear and refused. The paint vapor and mist were flowing out into the tunnel and into outside paint."* **MOL:288184 13/12/90:** work refusal slippery floors: Worker refused after slipping and falling in the paint booth

	because of slippery grates in the paint booth. In violation of Act, another worker was assigned to the booth without being advised of the work refusal. Solvents were used to clean grates coated with paint and grease. **H&S log: 22/04/90:** Clear coat hardener (UN1263) spill 200 litres in paint line loading and unloading area at end of the paint tunnel. Area evacuated. **H&S log: 16/01/91**: work refusal in paint line: leaking solvent line in base coat booth. Air flow was only working 50% capacity due to fans being plugged. ***"Excess fumes in paint booths were initially exhausted into the work environment through hoses to reduce exposures to inside workers,"*** *committee member* "**H&S log, May 7, 1990**: hazy smoke in paint booth refusal inside paint: *"There was haze around the lights and air flow was going the wrong way. Again there was a cloud coming out of the filters. Air Flows been getting worse and worse by day. Air-flow problem documented in log books over and over. Never addressed* (After calling MOL about refusal) *Management all went inside and started moving things and doing something to the system before the investigation. All the doors were opened…People in and out of there like flies before investigation was done."* **MOL 288460 22/01/90:** follow up visit re ventilation: MOL inspector notes previous orders not complied with. WHMIS training

	not completed; paint fumes from paint line still a problem; and no action taken to date. Other issues noted: JHSC still not doing specific hazard analysis; ISO units in tank farm still leaking; cartridge respirators in paint kitchen still not stored separately and still absorbing solvents; sludge room still not provided with life lines and belts; no WHMIS labels in compressor room; no formal written operating procedures in the sludge room; improper respirators used in sand and trim; still no adequate policies and procedures manual (suggest WCB "Workwell" Program); failed to get pre-medicals for ISO workers. Failure to conduct a first stage work refusal investigation in accord with Sec. 23 of the Act. Orders issued a second time on this visit. Fires in paint booth due to electrostatic discharge during use of paint spray gun. **MOL: 288244 15/06/90**: Ventilation evaluation ordered/fires in paint: MOL orders an engineering evaluation of the plant's ventilation system in order to correct the current imbalance between replacement air and exhaust air which causes a negative pressure environment and causes the migration of toxic chemicals from other departments to enter the general work area. It was noted that illegal modification made to the paint spraying system was a cause of several fires in the paint line due to electrical static discharge sparks that ignited the paints/solvents. Ordered to correct and not make changes without consulting the manufacturer of the paint system. **MOL: 288434 11/04/90**: Paint Line: ISO sensitization claim WCB. MOL requests medical consultant review. Also noted problems with the ISO control program and

	problems with skin exposure and respirator use and training.
3. Cure Oven: After parts were coated with final clear coat, they would pass through a curing oven (325 F) for several hours. The curing process generated fumes and vapors from curing paints. These fumes migrated from any cracks in the curing tunnel walls and ceilings as well as at point of entry and exit when the positive air pressure system was compromised. In fact, the exit was equipped with a jerry-rigged "wind sock" to warn workers waiting at the exit that contaminated air was escaping from the oven. At times, the painted parts would come out of the ovens with paint runs or "fish eyes" on the painted surface. These would have to be sanded and touched up and then "re-cured." However, there were also instances where paint failed to cure properly either because of an oven malfunction or a cart crash in the tunnel. These uncured parts would be taken off the line and handled by production workers, subjecting them to uncured wet Isocyanate.	**Chemical Exposure Risk**: The Cure Oven was a major source of chemical contamination into the plant. The heat from the oven would cause the paints and solvents to flash off and escape into the general atmosphere. This was especially acute when the introduction of a thermal oxidizer unit caused air pressure in the ovens to become positive instead of negative. This led to a major migration of contamination into the plant. Vapors would contain various ingredients in the paints, solvents, and thinners that became airborne and were inhaled by employees. **Chemical Exposure Risk**: When there was a temperature control problem in the ovens uncured monomers coming off products would also be released into the atmosphere creating inhalation and dermal risk exposures.
DETAILED OUTSIDE PAINT OPERATIONS: **1. Load and Retrieve**: After post cure, parts were retrieved by the armful, then hung on racks with alligator clips attached to paint carts and brought to the outside paint area for quality control inspection. Loading the parts from post cure was a dusty operation and production workers	**Chemical Exposure Risk**: material handlers would be exposed to high level of dust picking up parts that were just sanded and buffed. They would be covered in dust containing ISO, urethane, monomers, and additives.

described being covered in dust.	
<u>Inspection:</u> two inspectors per shift worked on each side of the line as parts came out of the cure oven.	Inspectors often handled heated parts, and also were exposed to off-gassing from uncured parts which they regularly handled. Also exposed to releases of vapor and gases. No PPE worn.
<u>Repair and Rework:</u> Painted parts that were damaged or defective were culled from the line by an inspector as parts exited. These could be sent for light repair (sanding, buffing, and repainting) or to be reworked (puttied, sanded, and repainted). Repairs were made on some parts by applying Finesse cream and then buffing.	**Chemical Exposure Risks: Assembly workers** were exposed to considerable contamination including breathing of fumes and dust, dermal exposure to solvents, buffing creams, grey putty and touch up paint. As well, they were exposed to contaminants from three departments which is documented. Poor/no ventilation or PPE. Many work refusals, hospital visits and illness reports. **MOL: 90E859MAAV 14/05/90:** Obstructive Lung Disease: Inspector advised by company doctor that a considerable number of workers in sand and trim have obstructive airways as indicated in pulmonary testing. Likely due to dust exposure from sanding polyurethane painted parts. Respiratory protection ordered.
<u>PAINT KITCHEN</u>: The paint kitchen was where all paint was mixed and stored. It contained a number of 85 gallon mixing kettles which fed into the different paint lines. The paint storage/mixing room measures approximately 155' L x 24' W x25' H. In the mid-90s, the area was divided into separately enclosed mixing and storage areas but prior (to a serious accident) it was one large open area where large quantities of more dangerous "live" paints were stored	**Chemical Exposure Risks**: *"There were always heavy solvent smells and exposures in the self contained kitchen and sludge pit area."* committee member **MOL**: During regular inspection of the plant in 1991, strong organic vapour smells were noted in large paint mixing room and in sludge room. One of the ventilation systems at south end of mix room was not working

in the same space where paints were mixed in huge quantities with solvents and other additives. The area(s) was served by the following mechanical ventilation systems: three independent, roof mounted exhaust fans with vents at floor level providing 10,000 cubic feet per minute (cfm); a heated air supply system providing approximately 7,000 cfm into this area; and two heating and air conditioning units with a collective air flow of 14,000 cfm, a <u>majority of which was recycled air.</u> Two work shifts were carried out in the storage area and paint kitchen. The first was 8 hours and the second 10 hours, both 4 days per week. The workers spent the majority of their shifts setting up and monitoring the paint mixing. From 1988 to 1991 the workers lacked respirators in this highly toxic area. Respirators were later provided but they were stored in open areas and not cleaned or protected. The three separate coats required for the paint booths (primer, base and clear coat) were prepared and mixed by the operator who wore a Tyvek suit, anti-static boots, rubber gloves, and safety glasses. No appropriate respiratory equipment was worn. The tasks included mixing the paint, adding solvents and additives manually in 5 gallon pails, and transferring each to 85 gallon tanks -- one for each booth. The final mix contained 40% solvent and 60% paint plus additives. The paints used contained the following: MEK, acetone, xylene, and Isocyanate HDI. These are in relatively equal proportions. All tanks, lines, and hardware were purged, washed and soaked in Pebra 5. It was also used to mop floors and clean up paint spills. During the early period all paints were hand	adequately (very low air flow) **MOL 28018 23/09/91.** During follow-up inspection the following year one of 16 orders included: *"The ambient air blower on the east external wall of the paint kitchen shall be arranged so that the air used from this unit is drawn from outdoors in an area free of contamination in accordance with section 25(2)h of the Act, on or before May 22, 1992."* Follow-up inspection to above identified serious "bonding and grounding issues" related to present mix kitchen and spill system: *"it was stressed that periodic cleanup should be scheduled to ensure the drain system is working as intended and does not become (or remain) blocked. The need for upgrading the use of bonding when any flammables are being poured or dispensed or mixed was discussed and left for further review…It was stressed that procedures in the MSDSs be followed for spill clean-up. These solvents and paints are generated on a daily basis by cleaning filter units and by back-flushing/cleaning paint lines. Consequently, some day-to-day process is needed to ensure the fumes are kept to a minimum."* (It took a plant-wide work refusal a year later for workers to finally have access to MSDSs and appropriate training). **MOL: 07170 17/12/91** **Chemical Exposure Risks**: This was a highly contaminated area as operators were exposed to enormous amounts of toxic paints and solvents handled manually throughout the day. There was a high risk of spills requiring major cleanups. The risk of exposure via dermal route to fumes, mists and vapors is high when

mixed. Those that included solvents and No. 2K hardener were referred to as a "hot pot" as opposed to a "cold pot" that did not contain any hardener or ISO. According to workers who entered the paint kitchen…*"there were times in the kitchen -- most of the times -- you couldn't breathe".* In addition, the contaminated air was not adequately exhausted from the paint kitchen. The exhaust stacks, approximately 40' high and vented externally, were not effective because of severe corrosion. It was likely there was insufficient capacity and velocity to draw the contaminants up the 40' span of stack, as well as past blockages due to the build-up of particulates. The ventilation system was also subverted by the opening of booth and sludge room doors. At present paint mixing is semi-automatic requiring manual addition of some ingredients. The kettles are closed during mixing, and paint is delivered to booths via enclosed lines. **This can be contrasted with the earlier period when mixing was done manually with operator mixing solvents and paints in equal proportions -- then checking viscosity and adding additional solvent or paint to obtain the appropriate viscosity. Handling was more direct and exposures likely. There were two paint kitchen operators present for the majority of the shift with other workers coming in for brief periods.** Minor and major spills were routine events requiring hazardous clean up procedures with harsh and dangerous solvents. The spills were usually mopped into the sluiceway. In addition, solvents (including MEK and methylene chloride) were	working on these systems, due to the high supply pressures under which it works. These operating pressures run from 125-150 psi and a return pressure of 90-100 psi. The other risk occurs when the colour valve opens to allow a specific colour to be sent to the Mechanical Vapor Recompression, aka Materials Volume Regulator Panel (MVR Panel), which supplies the ratio of paint to hardener to the paint system. Exposure is most likely due to solvent vapors. MOL inspection reports describe workers as not well trained in the care/storage and proper fit-testing of the organic cartridge respirators, and as well, lacking in good work practices and personal hygiene. For example: **MOL: 90D854EAAV 05/08/90:** Assessment of solvent/HDI exposures in paint kitchen: worker exposure to HDI (isocyanate) and MEK possibly when loading paint kettles, repairing and flushing system, and during malfunctions and manual spraying. Orders issued for skin and respiratory protection. Worker observed cleaning equipment parts with MEK without respirator and no ventilation. Working above pail of MEK is 'unpredictable' and may cause exposure in excess of TLV. Cleaning should be carried out in a properly vented area. **Chemical Exposure Risk**: In early period, paint mixing was manual, mixing materials a pail at a time and pouring ratios of paint to solvent back and forth. Risk of inhalation and absorption very high.

routinely used to clean paint equipment. When these spills occurred in conjunction with malfunctions of the ventilation system, migration of contaminants would drift into the general work areas of the plant with serious health consequences for other workers. Supply air was provided by (an oil-less) air pump located outside the paint kitchen. The air inlet to the pump was within the plant on the side of the unit. A trough inside the paint kitchen was originally connected to the sluiceway; it is now an isolated open dry trench that serves as a holding area to contain spills which are cleaned manually. An accident involving solvents flowing in the sluiceway that were ignited by hot welding debris down the line led to a serious fire which, if it had reached the paint kitchen, would have created a major explosion; this near catastrophe led to major changes in the paint kitchen.	**H&S log: 16/05/90: Work refusal: (120) Workers evacuated to cafeteria** because of a major release of HDI Isocyanates in the paint kitchen which rapidly migrated to the outside paint area. A cloud of fine mist paint migrated. The ISO monitoring alarm was malfunctioning and as paint was being flushed, the release became uncontrollable and HDI vapour migrated to the outside where other workers were exposed. **H&S log: 22/08/95: ISO spill**: overflow of clear coat catalyst in the paint kitchen, approximately 4-5 USG. **H&S log: 12/02/96: work refusal paint kitchen:** work refusal regarding irritating vapour from degreasing cleaner (INDO 401 Natural Solvent Degreaser and Terpene derivative) that was used as floor cleaner, and volatiles from cleaner were entering painter's protective positive flow helmet. MSDS indicates an irritant containing sensitizer and has inhalation hazard warning. Worker disciplined for raising issue.
<u>Other Sources of Paint-related Contamination/Fires:</u> Other sources of contamination involved instances of paint spills, which happened frequently. These could happen by tipping over a can of paint, during purging, or the result of a break in the paint lines. Spills would involve major risks of exposure. In later years, major spills were cleaned up by Emergency	*Chemical Exposure Risk:* Spills of paints and solvents as well as fires in the paint line were major risks of inhalation to isocyanate paint, hardeners and solvents such as MEK, acetone, toluene and benzene. Fires would create an even more complex mixture of

Response Team (ERT), but prior to its formation, workers were ordered to clean up spills without proper information on the hazardous nature of the clean-up. This mainly involved squeegeeing spilled paint into the sluiceway, which eventually flowed into the city's sewage system. There are documented instances where as much as 80 gallons of hardener was spilled, flowing into city sewers. Large spills are major sources of exposures due to their volatility and surface area. As well, most clean-ups involved the application of MEK or Pebra 5. In addition to spills, there were numerous instances of fires in the paint line responded to by the local fire department. Such events were a major source of toxic exposures composed of thermal decomposition by-products, for example: monomers, formaldehyde, benzene, oxides of nitrogen, nitrosamines and others.	decomposition by-products In addition, the by-products of these chemical substances catching fire present additional inhalation risks.
<u>Cart Maintenance</u>: Tasks associated with cart maintenance include: keeping carts in proper working order; changing wheels, greasing wheels and repairing damaged carts. The operator would daily remove the build-up of paints on carts using air powered chisels and drills. Maintenance and repair also involved the welding of damaged parts (welding usually but not always done by maintenance workers). Because of paint residues containing isocyanates, hardeners, and solvents, the welding repair operation on carts led to very hazardous thermal decomposition by-products mentioned above. When cleaned, the carts were shrink-wrapped and returned to paint line. Repairing carts was complicated by a build-up of hardened catalyzed paint that would be approximately ½ to ¾ inch thick. This	**Chemical exposure risks**: High risk of inhaling toxic and irritating welding gasses containing heavy metals, VCM, ISO fumes, paint particulates, oxides of nitrogen as well as fumes from decomposition by-products. Because of paint residues containing Isocyanates, hardeners, and solvents the welding repair operation on carts led to **very hazardous thermal decomposition by-products mentioned above.** The paint could be burnt off with welding torches, air chiselled off, or ground off by welders. These methods produced substantial concentrations of fumes, smoke, and fine particulate composed of the thermal decomposition by-products of Isocyanate paints. **Welders described very strong fumes and smoke, affecting not only welders and cart maintenance workers, but others working in the vicinity.** The

build-up was removed in several ways, each presenting a serious exposure risk. The paint could be burnt off with welding torches, air chiselled off, or ground off by welders. These methods would produce substantial concentrations of fumes, smoke, and fine particulate composed of the thermal decomposition by-products of Isocyanate paints. Welders described very strong fumes and smoke, affecting not only welders and cart maintenance workers, but others working in the vicinity. There were no welding curtains provided to isolate these exposures. The cart maintenance operation was a daily occurrence involving 20 to 30 carts per shift and in the case of a major crash in the paint tunnel, it could involve up to 100 carts that needed to be retrieved from the tunnel, then cleaned and welded. This intense work would produce enormous amounts of dusts, fumes, smoke and particulate. As well, welding rods used by welders could contain heavy metals including cadmium, adding contaminants to the mix of toxic exposures. This operation contaminated approximately ½ of the entire plant when heavy activity took place. A heavy coating of welding dust would accumulate on all affected surfaces. Very high-pressure (10,000 psi) water blasting systems used for cleaning paint build-up on carts created fine mists, (containing chemical residues) making significant skin contact, inhalation, and ingestion highly likely. The cart maintenance and repair operation moved numerous times during the Pebra era due to complaints from other workers and departments over extremely heavy and strong welding smoke, fumes, and vapors. Initially, the operation was located in the	intensity of the work and heat generated during the processes contributed to dust fumes, gasses, and higher rates of heart rate and respiration. Cart maintenance workers wore no PPE other than dust masks and possibly gloves. In addition, the use of high pressure water blast system increased the risk of inhaling, ingesting, and absorbing any contaminants in the water after hitting painted surfaces.

middle of "everything"—with at least ½ of the plant affected by the fumes from the welding operation. With growing complaints, cart maintenance was moved to the shipping area -- which also wasn't considered suitable. The operation was finally moved to its current location, somewhat isolated, behind the paint line. In addition, plastic wrapping was used at a later time on the carts to reduce paint build-up and aid paint removal which involved the application of a thin film of PVC that was torched during the cleaning process. Also, workers would apply grease to cart wheels and burn off old solidified grease, producing thermal decomposition by-products as well as skin contact with grease during greasing operations. Committee members identify that there was little local exhaust ventilation and inadequate respiratory protection during this maintenance operation.	**Chemical Exposure Risk:** While the PVC did make it easier to remove paint, the heating and burning of the film and paint product created a highly toxic combination of combustion by-products that included phthalates, monomers such as vinyl chloride and HCL, CO, CO2, nitrosamines, and benzene to mention a few. Workers reported difficulty breathing and some have developed COPD, coronary disease, and neurological injury. As one worker put it: *"You knew that this couldn't be good, when you blew your nose and the snot was the colour of the rainbow…what was that stuff doing to us?"* Another worker said he "*… found that my hair was as stiff as a board by the end of shift from all the smoke and dust that we generated".*

4. ASSEMBLY/QUALITY CONTROL/MAINTENANCE (classes of mobile workers)

Introduction: Assembly or Production workers, Quality Control/Inspection workers and the class of Maintenance workers at Pebra were all mobile, working throughout the plant depending on assignment. Generally speaking, the WSIB or Workplace Safety and Insurance Board, has difficulty identifying "risks" in compensation cases when workers are mobile. (This is yet another weakness in Ontario's compensation system in addition to major issues such as refusing to address "cluster" cases of disease, and setting a standard of proof impossible to obtain, despite the law stating otherwise.)

Assembly: The job classification, **Assembly** or **Production Worker** included the majority of employees at the Pebra plant. They cleaned, cut, sawed, sanded, patched, trimmed, buffed, notched, punched, shaved, glued, puttied, filed, ground, boxed, moved, and likely other tasks associated with the production of plastic trim for automobiles in the decade 1986-1996. Partly because they made up the largest component of the work force at Pebra and continually handled solvents such as MEK and Pebra 5, but also because of major bystander exposures, a large number of complaints and work refusals were initiated by these, mostly women, workers. In the numerous assembly operations there were many complaints about the use of Pebra 5 in its various forms and applications: as solvent/liquid for dipping, cleaning and wiping, as a glue to be sprayed or applied with felt tip applicator, as an ingredient in the plastic part that could be subjected to heat, scraping, cutting, sanding, buffing thus a component of the dusts and particles they were exposed to. In many cases such exposures lasted the entire shift. In all encounters with MOL inspectors and hygienists, dermal exposure (though acknowledged in advice given) is never considered. Workers described the work environment as normally hot and sweaty resulting in many wearing minimal clothing even in winter, thus exposure through skin should be viewed as a major exposure	**Assembly (plant wide) Chemical Exposure Risk**: Production workers were at risk of chemical exposure in every department and area of the plant. Many categories of assembly workers were highly exposed to dust and particles in their daily activities from various sources including plastic, metal, and organic fibres in addition to the fumes, mists and dermal exposures associated with the different processes documented throughout the plant. **MOL: 431932 27/05/94 MOL report**: **phenol/formaldehyde and dust build-up** Buffing area: four buffing units in the buffing area produced large amounts of dust from materials being buffed e.g. freshly made plastic and isocyanate painted parts as well as dust from the buffing disks composed of various grits and phenol formaldehyde adhesives/resins. There was a large accumulation of dust on floors and in the air. While the buffing station was equipped with local exhaust, the **size of the wheel employed actually blocked the flow of air** causing dispersal into the atmosphere. (A worker's comment paraphrased by inspector is followed by his own commentary): *"...the air in the plant is often not fit to breath -- despite the fact that numerous air quality tests do not support this belief".*

source. **In a plant wide investigation of worker complaints conducted by the union in 1990, workers identified as major contributors to their health issues and complaints the following: outdated MSDSs, missing labels on chemicals, wrong labels on chemicals, employer not cooperating with JHSC, employer's failure to maintain minutes and to consult with workers. 325-71-2 03/05/90.**	**MOL: 89L895NOBR 30/11/89**: refusal and investigation into MSDS for Pebra 5 (focus on glue stick): Hygienist noted workers received no training in handling Pebra 5 and conflicting MSDS information and concern about toxic effects of tetrahydro-furan/perchloroethylene (and likely cadmium). Possible exposure when filling the felt tip applicator or replacing felt pad. Hygienist states that exposures to ingredients are negligible. No discussion of toxicity or concern about chronic/prolonged low-level exposures given the toxicity of these chemicals (and the possibility that Pebra 5 contains cadmium). Pen holds 15 ml of Pebra 5. Air concentration: tetrahydrofuran 5 ppm, perchloroethylene 2 ppm.
Especially affected groups of assembly workers (based on number and frequency of complaints or refusals) included assembly workers who worked at sand/trim/buff tables in Outside Paint, the Ford Line in Post Lam, and in the Rim operation. Their complaints about the lack of local ventilation and the company's failure to provide down draft tables, fans and vacuums requested, or to change/clean/or properly replace filters on their tables or machines went largely unaddressed during that period and their frustration was evident in reports, and other documentation reviewed.	**MOL: 90E859MAAV-C 03/07/90**: MOL medical consultant re: adverse health/dust/sand/trim: Medical consultant assessed workers' medical symptoms from dust (polyurethane/paint), i.e., difficulty breathing, fatigue, dirt of varying colour in their noses, itchy eyes and dry skin*. "Several workers describe symptoms consistent with exposure to a dust. Workers are sanding parts consisting of polyurethane with chopped fibreglass and painted with primer, base paint and clear coat. Two workers were found by the medical department to have breathing problems related to the dust in the area* (this was prior to being ordered to be included in the ISO control program) *Use of respirators ordered in response to workers' complaints about insufficient exhaust ventilation on the tables. According to the doctor: "These medical symptoms are consistent with exposure to a fine airborne dust, which on visiting the area is apparent in spite of the exhaust ventilation"* **AUTHORS' COMMENT**: He concludes that the dust levels are below the TLV. A follow up letter from the same doctor dated 22/06/90 states that while respirators may have stabilized the symptoms, there was no need to continue

	using them. **Queens Univ. Hygiene survey 6/14/15 Aug 88:** *"…total suspended particulate ranging from 0.13-0.91 would be* ***excessive*** *in office environment but considered "positive" for an industrial establishment. The highest were detected in RIM/sand and trim areas….assuming that these employees sand and trim for seven hours of a workday, their actual time-weighted average exposures would have been 7/8 times the measured values."*
Another group of assembly workers with major chemical exposures were those, mostly men, who worked in grey putty, applying a highly toxic filler substance by hand in a confined room to repair surface imperfections as an attempt to salvage damaged parts. Exposures would be through inhalation and skin contact. The only exhaust fan in their small, basically enclosed, area was continually being turned off due the high 90+ decibels of noise it produced. Several men who worked in this area died quite young from cancer.	**MOL: 90GB63MOWV-C 16/10/90**: hygiene monitoring for HDI (ISO), MDI/in grey putty: No detectable levels RIM molds and Grey Putty (HDI). Observed that "comfort fans were operating in the sand/trim which could possibly have interfered with the monitoring." Noted that Mondur PF and MDI c-961 were used.
A third group of assembly workers exposed to major chemical contamination (through inhalation and skin exposure) were operators of carousel "glue lines." Using a pressurized glue gun they openly sprayed "glue" as parts moved past them via conveyor belt. The glues used could act as an adhesive or primer for raw metal. This operation was the source of many by-stander complaints. Operators wore NO PPE for chemical exposures in the decade 1986-1996, other than cotton gloves and lab coats.	**Chemical Exposure Risks**: Exposure via inhalation and absorption high among assembly line workers. Performing detailed work with high volume of glues, solvents and dusts.
Others groups of assembly workers including material handlers, quality control people, box builders and packers were exposed to off-	**MOL: 90F889MOWV-C 09/07/90:** MOL medical consultant report as requested by WCB regarding worker health problem

gassing, dust and small particulates as well as dermal exposures when touching or handling parts.	related to exposures in Box areas of RIM used as a loading dock, box assembly and storage. The consultant indicates that in an "upset or spill situation" exposure might be possible and none have occurred. No form 7 indicated to establish date of medical report for worker. (No indication of what chemicals/exposures they reviewed, and no mention of diesel fumes from loading bay). **Chemical Exposure Risks**: These workers would be exposed via inhalation to contaminated ambient air from assembly activities and fugitive emissions from other departments.
Quality control workers/inspectors were located central to production, i.e., between or just after major production lines, often exposing them to significant bystander contamination.	**Risk exposures** were associated with any handling of parts at different stages of production as well as by-stander exposures in the areas they worked, thus the potential for both dermal and respiratory exposures.
<u>Maintenance:</u> consisted of a number of skilled trade workers, including millwrights, electricians, and tool and die workers. Individually, they were assigned, weekly, to a department or work area to maintain and repair the various systems in the plant. They were available to respond to emergencies (specific to their trade). All maintenance personnel were equipped with appropriate respiratory protection in addition PPE to prevent absorption. The normal rotation for maintenance workers was to move weekly from department to department. Maintenance workers were likely to be directly involved	**Exposure Risks: Resins-MDI; polyol and solvents.** Exposure risks to isocyanate resins and paints as well as other hazardous ingredients in RIM and paint line during containment of leaks and spills and when making repairs to pumps and valves and hoses. High exposure risks flushing hoses and pumps and cleaning these with solvents. **Exposure to solvents including: MEK, TCE, toluene, perchloroethylene, and many other solvents.** Workers incur significant inhalation and absorption exposures during cleaning and repair of parts. Exposure to TCE from large (4x4x2) vapor degreasing tank located under the Post Lam

(thus exposed to chemicals) in critical situations including spill, fires, and explosions. Millwrights were likely to have the most chemical exposures due to the specific type of work they did related to purging and repairing of the complex pump systems in the plant. In the decade from 1986-2006 the number of maintenance workers increased from 20 to 28 working three shifts per day to ensure coverage of all operations. Every shift included two mechanics for the paint line and one mechanic each for RIM and injection molding.	oven. These degreasing solvent exposures particularly to TCE and Perchloroethylene may be responsible for cases of kidney cancer and damage to personnel working near this tank and maintenance personnel who frequently used this tank. For example, the maintenance office staff would have been exposed as well as notch and punch staff working underneath the oven in RIM.
Maintenance Tasks (millwrights): dealing with leaking valves in Polyol or MDI hoses in RIM or leaks, line breaks and pump malfunctions in paint line, as well as repairs on hydraulics on clamps. All involved similar features: leaking resins and paints containing isocyanates and solvents or hydraulic fluids. Work involved shutting down, taking off pressure, purging lines or pumps of residues, cleaning parts in solvents (MEK, TCE, toluene, Pebra 5), isolating leaks, collecting and disposing of chemicals, and repairing damaged/replacing parts. Tasks also involved cleaning with compressed air to blow off solvents and dirt.	**Resin Dusts containing TPO/TPU**: Exposure to resin dusts during cleaning of canisters and filters on the injection molding clamps. This would involve exposure to the tremendous build-up of resin dusts TPO/TPU in ducts and filters. **Chemical Exposure Risks**: Inhalation, ingestion and absorption of heavy metals, grinding grits, epoxy resins, MWF including various cutting and cooling oils, nitrosamines, PAHs as well as solvents for cleaning and prepping.
Maintenance personnel were involved in ERT because of their special tasks skills in dealing with leaks. (Tasks as above).	**Chemical Exposure Risks**: exposures linked to fires and mists in the areas under repair in addition to bystander exposures to a variety of chemicals used in other production processes described in this report. Risk of inhalation of solvents and electrical cleaners to insure proper contact.
Maintenance: Tasks (tool & die): dealing with repairs to molds surfaces. This would involve solvents to prep materials for welding, grinding, and polishing with MWF as well as other tooling tasks to repair or make mechanical parts.	
Maintenance (Electrician): dealing with machine computerization problems and	

operations as well as other electrical operations of the plant.	
<u>ERT Team:</u> In 1993 an Emergency Response Team or ERT was established at the plant to replace the laissez faire approach that existed prior, where "any worker could be called to clean up a spill or address an emergency. *"We were just told to do it as part of our job"* (Advisory Committee member). **ERT Team Structure:** a total of 10 people are assigned to the ERT from the union including 2 rotating maintenance workers, three workers on day shift, 3 workers on afternoon shift and 2 from night shift. The union ERT team captain is responsible for determining when workers can return to work. Only management can shut the plant down and make decisions on unidentified spills. Initially, worker representation was based on departments/job categories but later changed to the current designation by shift plus maintenance. (It was noted that on night shift the person designated to decide whether to close down in the event of a spill is the security guard, as management representative.) In the case of a spill either Management Rep on JHSC or night guard (after making a call to management) would deem if spill was hazardous or not and decide whether to call the ERT. The union ERT captain decides **how many** ERT trained workers are needed to carry out the clean-up. If a spill is deemed not dangerous shift workers clean it up. There is always a maintenance person included in the ERT called. *"Maintenance always wore an organic cartridge respirator or a full hood positive pressure respirator during clean ups, even though* (according to Advisory Committee Members) *workers standing next to him would not be wearing PPE.*	RIM and Inside Paint Line were identified as areas where most emergency spills occurred because of the use of ISO in these operations and both operations relied on complex distribution systems in their production. As a maintenance informant stated: *"Anywhere in RIM…behind the clamps; in paint it was anywhere behind the paint booths… because all movement within these lines causes leaks in the valves…and there was continual movement."* **Lack of Controls**: There was evidence in MOL reports and from worker informants that fire and emergency preparation was clearly lacking as noted in numerous "orders" issued for proper training. Inspectors' cited many times that workers cleaned up toxic chemicals barehanded and without proper breathing protection. Management seemed equally uninformed as the following story told by a worker informant shows*: "We had a spill in paint line and we're all dressed up in our gear and air packs on and management was so stupid they brought in a tour. I said what are you doing here? He said I'm bringing in a tour. And I said, get the hell out. And he said, and who are you? I said if you fall down in here, I'll drag you out by your feet….He was really burned up, but later when I explained it to him, he apologized that he didn't know the risk."*

5. SHIPPING

Shipping moved several times during the Pebra era, including to a second building referred to as the "warehouse" in later years, purchased specifically to house storage and shipping operations.

Shipping: Parts and materials were all brought into the plant through the shipping department, and then distributed to appropriate areas, when and where required. Parts and materials were moved from shipping to various production operations throughout plant by various size lift trucks powered by propane.	**Chemical Exposure Risks:** Fumes and gases would be emitted by waiting diesel-powered trucks as well as from the fleet of propane powered lift trucks. Risks also exist with breakage or spillage of materials during delivery. This is especially problematic because the hazard may not be known at the time and MSDSs not available.
During the Rim years (1988-2000) drivers transported open Gaylord boxes filled with Wollastonite which would blow out of the moving boxes and into drivers' faces.	**Chemical Exposure Risk**: Transport delivering large quantities of chemicals, parts, etc. contain a substantial build-up of contaminants from the shipment of chemicals and other toxic substances likely to off gas during transport. Workers complained of being overcome when opening the trailer doors to unload the transport.
A number of assembly operations were located in the second building creating additional bystander exposures to those working nearby in shipping. Those same assembly workers were bystanders to the contamination linked to shipping activity especially diesel exhaust from waiting trucks, which was a source of continual complaints from assembly workers who were constantly telling drivers to turn off their engines.	**MOL: 288314 17/05/90: Inspection** finds high CO levels: Fork lift truck tested and areas and found to have high levels of CO; sand and trim-35ppm, north shipping=70ppm; shipping clerk desk=5-10ppm. Also filters in sand and trim required (but didn't receive) regular maintenance.
Finished parts produced by Pebra workers would be picked up and taken to the shipping department then loaded onto tractor-trailers. These trailers were parked in an enclosed area, particularly during winter months and kept running, spewing out large quantities of diesel fuel emissions. Contamination was made worse because of the negative air pressure in the building, which caused diesel fumes to be drawn into the shipping department, as well as the rest of the building. Workers often complained about the diesel fumes insisting that bay doors	The lab was open access and allowed pedestrian traffic through the lab. It was located under the cafeteria in the south-east

remain open and engines turned off.	end of the building.
LABORATORY: this was a materials testing laboratory carrying out various tests on the integrity of paints, hardeners, coatings, resins and flame retardants to test durability under environmental, usage, and material stressors. There were three technologists per shift with two shifts. One person was dedicated to paints and the other two were generalists. Tasks involved direct handling of toxic chemicals and materials attempting to inflict damage to materials to test for durability. Technologists would carry out tests in salt baths, blister test ovens, and chip resistance, as well as humidity and adhesion tests. Most test activities were conducted under fume hoods or vented fume enclosures.	**Chemical Exposure Risks**: Materials were cut up, pounded with sharp objects, and heated and torched to measure thermal decomposition by-product emissions and flame resistance. Most chemicals used in the plant were subjected to various types of tests in the lab. The testing process posed a risk of exposure to dusts and fumes during testing of paints, resins, and adhesives. However, most tests were conducted under fume hoods that were viewed by Dr. Roland Wong and judged to be well maintained and appropriate at the time. Conversely, worker informants indicated that odors were present in the lab and that lab personnel had been diagnosed with leukemia and adverse reproductive function. Based on this we can assume that substances could escape capture in fume hoods. As well, frequent pedestrian traffic and opening and closing of doors would likely interfere with efficiency of exhaust ventilation.

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APPENDIX A

EXPOSURE PROFILES FOR THE PLASTICS PROCESSING INDUSTRY

A LITERATURE REVIEW BACKGROUNDER

By

Robert DeMatteo and Dale DeMatteo

For

The Occupational Health Clinics for Ontario Workers
2019

ABSTRACT: This literature review attempts to describe and characterize the extent and nature of worker exposure to various substances used in the production of plastics products and their potential adverse effects on worker health. Of major concern are the endocrine-disrupting properties of several of these substances such as bisphenol A and phthalates as well as substances identified as mammary carcinogens. Indeed, according to a recent study, almost all commercially available plastic products release chemicals having detectable estrogenic activity (Yang, et al., 2011). This review summarizes numerous scientific publications on the extent of worker exposure to these substances as well as numerous studies on their health effects on lab animals and humans. Methods to control exposures utilizing industry best practices based on the hierarchy of hygiene controls are also explored.

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INTRODUCTION

This literature review is an attempt to describe and characterize the extent and nature of worker exposure to various substances used in the production of plastics products and their potential adverse effects on worker health. Of major concern are the endocrine- disrupting properties of several of these substances such as bisphenol A and phthalates as well as substances identified as mammary carcinogens. Indeed, according to a recent study, almost all commercially available plastic products release chemicals having detectable estrogenic activity (Yang, et al., 2011)

This literature review summarizes numerous scientific publications on the extent of worker exposure to these substances as well as numerous studies on their health effects on lab animals and humans. Methods to control exposures utilizing industry best practices based on the hierarchy of hygiene controls are also explored.

To this end, the literature search included scholarly publications and standard texts that described and explained the processes and substances used in the plastics processing industry, industrial hygiene monitoring studies and reviews of occupational exposures in the plastics industry, epidemiological studies that attempted to identify adverse health outcomes associated with worker exposures in the plastics industry and toxicological reports and reviews. Regrettably, there was a paucity of occupational exposure studies that provided details on exposure risk factors. And even fewer addressed the impact of worker exposure to complex mixtures.

The following areas are explored:

1. The materials used in the production of various plastic products;
2. The various processes used to fashion plastic products;
3. The identification of various chemical constituents and by-products that accompany the processing of plastics;
4. The identification of factors that contribute to emissions of these substances during the process of production;
5. The identification of various job tasks and processes associated with the production of plastics production that place workers at risk of exposure.
6. The identification of adverse effects associated with worker exposure to various substances used in plastics processing.
7. Developing effective exposure controls.

PLASTICS INDUSTRY ECONOMIC DEMOGRAPHIC PROFILE

According to Industry Canada (2010), plastics manufacturing generates $20.7 billion annually and employs about 91,000 people, primarily in small and medium sized firms with a low level of unionization. The majority of firms (48%) are located in Ontario where over 51,000 people employed, followed by Quebec (35%), Prairie Provinces (13%) and Atlantic Provinces (3%). The industry is dominated by three major product lines including packaging (34%), construction products (26%) and automotive components (18%). The automotive component, which comprised about 18% of overall industry, dominates plastics manufacturing in Essex County, generally regarded as the automotive capital of Canada. While plastics manufacturing in Canada is on the rise generally, employment in car parts manufacturing has declined from a high of 18,000 in 2003 to 13,000 in 2009 (Industry Canada, 2010). In general, women hold a higher percentage of jobs in the plastics industry when compared to other manufacturing sectors constituting about 37% of the overall plastics workforce. The industry is marked by a high rate of turnover, a reflection of low wages, poor working conditions, and a lack of a commitment to skill upgrading (Industry Canada, Canadian Plastics Products Industry,01/02/2010). Interviews with plastic workers focus groups in Essex County indicated that the female participation rate may be far higher than these reports suggest.

Workers estimated that women participation ranged between 60 and 80 percent in small to medium size plants with 35 to 500 employees.

PLASTICS MATERIALS AND PROCESSES

Plastics are organic materials produced from petrochemicals referred to as polymers. Polymers consist of large chains of molecules. To make the chains, many links are hooked, or polymerized together. To create polymers, petroleum products are heated and broken down into smaller molecules called monomers. Monomers are the building blocks for the creation of polymers. Polymerization is a chemical reaction in which the molecules of a monomer such as styrene, vinyl chloride or ethylene are linked together to form large molecules with a molecular weight that is a multiple of the molecular weight of the original monomer.

While each polymer will have its discrete molecular structure, it is possible that polymers may be contaminated by unreacted monomers or other materials, especially solvents required for polymerization.

Thus in the polymerization process monomers are converted into complex polymers in the form of resins including polystyrene, polyvinyl chloride and polyethylene. At times the terms plastics, resins, polymers are used interchangeably to refer to plastics. These resins in turn are used by downstream industries making plastics products, paints and adhesives; they also include compounders that blend resins with additives to produce concentrates and compounds used by these industries.

The following chart describes the total process from raw materials to finished plastics production as follows (Rosato, 1997):

Starts
With

Petroleum Natural Gas Coal Agricultural

Distilled
Into

Ethane Propane Benzene Naphtha Butene

Converted
Into
Feedstocks
Monomers

Ethylene Styrene Formaldehyde Polyol Adipate Propylene Vinyl Chloride Cumene Acrylic

Polymerized
Into

Plastics

Polyethylene Polystyrene Acetal Polycarbonate Polypropylene Polyvinylchloride Nylon

Fabricated
Into

Plastic Products

Pipe Appliance Packaging Luggage Marine Auto-Parts Toys Fabrics Electrical Medical Tools Siding

CLASSIFICATION OF MONOMERS

Plastics are broadly divided into two categories—thermoplastics (TP) and thermosets (TS).

Thermoplastics are the most commonly used materials in plastics processing. Examples include polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), polyamide (PA) a.k.a. nylon, and polyethylene terephthalate (PET).

Thermoplastics soften on the application of heat and solidify when cooled. This ability to soften and solidify is reversible, making the recycling of thermoplastics relatively straight forward.

Thermosets are also used in some forms of plastic processing, including fiber-reinforced composites, and are most commonly used in formulated products like paints, adhesives and inks. Some examples include: phenol formaldehyde, urea formaldehyde, epoxy, polyurethane, unsaturated polyester, alkyd, and silicone. These chemicals are cured via a chemical reaction which is not reversible. Unlike thermoplastics that can be reprocessed using heat, thermosets undergo decomposition when heated and cannot be recycled.

There are literally hundreds of classes of polymers with about 20 principal classes that are used in production. Various subclasses have been created by various combinations of polymers, additives, fillers, alloying, blending, etc. These developments have resulted in about 17,000 processable plastics worldwide. (Rosato, 1997; Maxwell, 1999).

The five polymers that make up the vast bulk of production globally are the following (BioAuto Council, 2007):

Polyethylene –PE (high density/low density) representing 40% of total plastics production has a wide range of properties and is produced in several forms and densities. High density polyethylene (HDPE) is the harder form used in milk containers, lids, laundry containers, toys, sporting goods and electrical insulation and has relatively high tensile strength and rigidity. Low density polyethylene (LDPE) is a relatively soft form of PE. It is softer and more flexible and possesses higher impact strength than HDPE.

Polyvinyl Chloride—**PVC** (20%) is produced from vinyl chloride monomer in a variety of grades from flexible too rigid -- from rigid piping to thin flexible film by adding plasticizers in the production process.

Polypropylene— PP (19%) is very versatile, produced in many grades and often is combined with many other polymers to form copolymers. It has superior resistance to heat and flexural fatigue. Outside of packaging, PP is used for luggage, molded parts for automobiles and household appliances.

Polystyrene—PS (9%) is produced in many grades, usually combined with other polymers to remedy its brittleness and poor heat resistance. An expanded version of PS is Styrofoam used for take-out containers, fast food tubs, egg cartons and as filler for shipping. A large amount is produced in the form of High Impact Polystyrene by adding rubber to PS. PS is often blended with PE through the addition of mixing agents because of the natural incompatibility of PS and PE.

Polyethylene Terephthalate—PET (6%) is a form of polyester with a broad range of mechanical properties that make it a useful replacement for metals like die-cast aluminum and zinc. Different grades of PET are used in many different processes, e.g., appliances and electronics, but particularly in stretch injection blow molding for plastic beverage bottles and film production. It can be produced in a wide range of properties.

A **polymer** is a pure unadulterated material usually taken as the family name for a group of materials; a polymer is a 'Nothing Else Added To" (NEAT) material. Pure polymers are seldom used on their own. (Rosato, 1997)

Other polymer resins include:

Acrylonitrile Butadiene Styrene—ABS
Acrylic—PMMA
Polycarbonate—PC
Modified Polyphenylene Oxide—PPO
Polyurethane—PU
Ethylene Vinyl Acetate—EVA
Phenol Formaldehyde—PF
Melamine Formaldehyde—MF
Acetyl—POM
Polyamide—PA (Nylon)
Polyester—PET, PBT
Polypropylene Tetra phthalate—PPT
Urea Formaldehyde Foam—UF
Polyphenylene Sulfide—PPS
Styrene-acrylonitrile —SAN

The basic raw materials used in plastics processing and manufacture of plastic products are resins. The resins are produced in chemical plants by combining the chemical element carbon with others such as oxygen, nitrogen and hydrogen. From here chemical plants ship the resins to plastics manufacturing plants in the form of syrup, powder, granules, pellets and other easy-to-use configurations.

COMPOUNDERS AND ADDITIVES

Once the resins are at the plants, workers may add and mix other ingredients. This might involve the compounding of polymers by mixing two or more polymers to form blends. In addition a whole host of additives may be introduced.

Additives are a diverse group of specialty materials. Sometimes they are added by the resin supplier before the formulation is processed and other times added by the processor.

Some additives are **processing aids** such as blowing /foaming agents, organic peroxides, mold release agents, and lubricants. Other additives used to improve the properties of materials include: antimicrobials, antioxidants, antistatic agents, colorants, flame retardants, impact modifiers and UV stabilizers. Some additives, such as plasticizers and heat stabilizers, enhance both the processability of the plastic resin and the properties of the finished products. (Rosato, 1997)

Some of the major additives include (Coaker, 2000):

Stabilizers
Lead, zinc, cadmium, barium, calcium, azodicarbonamide, antimony tris(isooctyl mercaptoacetate).

Plasticizers
There are over 500 known plasticizers that serve to give materials softness and flexibility. These also act as processing aids. Most are in the phthalate family. However, dialkyl ortho-phthalate and terephthalate comprise approximately 70% of all plasticizers used in production.

DOP—di-octyl phthalate
DEHP—di-2ethylhexylphthalate
DHP—dihexyl phthalate
BOP—butyl octyl phthalate
BBP—butyl benzyl phthalate
DUP—di-undecyl phthalate
DOTP—di-2-ethylhexyl terphthalate
Epoxides—epoxy plasticizers
Citrate esters

Impact Modifiers
Impact modifiers are designed to impart extra toughness to plastic material. There are two basic types -- predefined elastomers (PDE) and non-predefined elastomers (NPDE). These may include:

<u>PDE</u>
ACR—Acrylic
MACR—Modified Acrylic
MBS—Methacrylic-butadiene-styrene

ASA—Acrylate-styrene acrylonitrile
ABS—Acrylonitrile butadiene styrene

<u>NPDE</u>
CPE—Chloronated polyethylene
EVA—Ethylene vinyl acetate copolymer
ACRgrafts—PVC on rubber acrylic
PU elastomers
PO elastomers

Flame Retardants

<u>Organic</u>
Phosphate esters
Brominated phthalates

<u>Inorganic</u>
Alumonia trihydrate
Antimony trioxide
Barium metaborate
Huntite
Magnesium hydroxide
Ammonium octamolybate
Mixed metal complexes—Zn, Borate, Zinc hydroxystaminate

Light Stabilizers

Titanium dioxide
2-(2'-hydroxyphenyl) benzotriazoles 2-hydroxybenzophenones

Lubricants

Paraffin waxes
PE waxes
Carboxylic acid
Amide waxes—e.g. ethylene bis-stearamide
Lubricious esters—e.g. metal carboxylates

Fillers

Carbon black
Calcium carbonate

Blowing Agents

Azodicarbonamide 4,4’— oxybisbenzenesulphonohydrazide

Cross-linking Agents

Peroxides

Antioxidants

Phenols (such as 4—methyl—2,6—ter—butylphenol)

Antistatics

Polyethylene glycol alkyl esters

The following is an example of a typical formulation for PVC siding (Coaker, 2000):

PVC (K66)
Hi-tin stabilizer
Calcium stearate
Paraffin wax
Polyethylene wax
Titanium dioxide
Calcium carbonate
Acrylic impact modifier
Processing aid —
Lubricating processing aid

PLASTICS PROCESSING METHODS

There are a variety of methods used to process plastics. Each method has its advantages and disadvantages and is best suited for specific applications and resins types. These methods include: injection molding, blow molding, thermoforming, transfer molding, reaction injection molding, compression molding, casting, extrusion, and fabricating. (Rosato, 1997, Croaker, 2000, Harper, 2006, Harper and Petrie, 2003)

Injection molding

Injection molding is the most widely used method of processing thermoplastics. In this process polymers are placed in a hopper. The hopper then feeds the materials into a heated injection unit where it is melted and vented and then pushed through a long chamber with a reciprocating screw. Here it is then melted into a fluid state.

A nozzle is located at the end of the chamber where the fluid is forced into a cold, closed mold. The halves of the mold are held shut with a system of clamps. When the plastic is cooled and solidified, the halves are opened and the finished product ejected from the press.

This process is used for all thermoplastics. However, thermosets are not usually processed with injection molding.

Steps in the process
(1)Drying, (2) mixing and blending, (3) pouring into hopper, (4) feeding into the heated barrel (5) plasticizing and venting, (6) injecting into a closed mold, (7) cooling, (8) mold releasing and (9) fabricating.

With the exception of drying, mixing and pouring, the plasticizing process is enclosed but volatiles, fumes, gases and water vapor escape through vents in the barrel and the enclosed mold.

There are activities that several processes share in common. These include:

Venting and melt degassing: During injection molding, as in extrusion, melts must be free of gaseous components (e.g. monomers, moisture, plasticizers, additives, etc.), so a vented screw is used to remove these by-products during the melt. This is referred to as melt degassing. The process is similar for extrusion and blow molding.

Compounding: Most plastics undergo compounding which involves the addition of various ingredients needed to process plastics and provide the desired properties to the final product. The methods used for compounding can be either dry blending or melt mixing and mixing can be continuous or in batches. Batching is more labour intensive and less complicated.

Purging and cleaning: Purging is a process of cleaning out colour or other resins from the cylinder in injection molding, blow molding, extrusion machines in order to process different material or colours. This involves forcing these materials out using other resins or special purging agents to mechanically push and scour residues out of the machine.

Final cleaning of the disassembled parts may be done manually in ventilated burnout ovens.

Blow molding
Blow molding is used when the plastic item needs to be hollow. A molten tube is created by using compressed air, which blows up the tube and forces it to conform to the chilled mold. Variations include injection, injection-stretch, and extrusion blow molding.

Injection blow molding uses a perform, which is taken to a blow mold and filled with compressed air to conform to the interior shape of the blow mold.

Continuous extrusion blow molding involves the extrusion of a continuous molten plastic tube which is pinched between two mold halves. A blow pin is then inserted into the tube with compressed air used to force the material to conform to the shape of the mold.

Extrusion

Extrusion is used to make products such as film, continuous sheets, tubes, profile shapes, rods, coat wire, filaments, cords and cables. Similar to injection molding, dry resin in the form of pellets is poured into a hopper and fed into a long heating chamber where it is melted and driven by a reciprocating screw. At the end of the chamber the material is forced out of a die in the shape of the finished product. As the formed plastic exits it is placed on a conveyor and cooled by air or water. This process is similar to a sausage making machine. It can process all thermoplastics especially polyethylene, polystyrene and PVC. The major difference from injection molding is that extrusion processes plastics at a low pressure and is continuous. As well, the extruded product is not enclosed in a mold as it pushes out of the die.

Calendaring

The calendaring process is used to produce plastic films and sheets. The calendar melts the plastic and then passes it through the nips of two or more heated counter-rotating rollers into webs of specific thickness and width. Upstream of the calendar, a mixer blends the raw material, usually in a powdered form, with additives such as plasticizers, fillers, colourants, etc. A wide variety of plastics can be used; about 80% is PVC but others are ABS, PE, PP and styrene. For PVC mix all additives such as plasticizers, stabilizers, etc. must be premixed and then passed on to a blender where the mass is gelled, pressed into a web and then calendared.

Unlike the process of extruding or injection molding, the plastic mass cannot be confined when being calendared. In addition, it is important to note that the sheets and films being calendared have very large surface areas.

Compression molding

Compression molding is the most common process used with thermosetting resins such as melamine, formaldehyde, and phenol formaldehyde with fillers. However, it is not usually used for thermoplastics. Material is squeezed into its desired shape with the help of pressure and heat. Plastic molding powder and other materials are added to the mix in order to create special qualities or to strengthen the product. When the mold is closed and heated, the material goes through a chemical change that causes it to harden into the shape of the mold. Heat, pressure and time depend on the desired outcome of the final product.

Casting

Plastic in liquid form is poured into an open mold. Commonly used for phenol formaldehyde as liquid resin are polymethyl methacrylate and polyurethane.

Foaming

Foaming involves the release of gas into plastic so that it fills with bubbles and forms within a two part mold. This process is used with polystyrene, polyurethane, and PVC to produce products such as packing, sponges, soles, steering wheels, vending cups, insulation and foam furniture.

Rotational molding

Measured amounts of plastic are placed in a mold which is rotated on two axes at low speed in an oven. This is used with low density polyethylene; polypropylene is used when high temperature tolerances are needed. Products such as storage tanks are made using this process.

Thermoforming

Preformed sheets are warmed and then sucked into a mold. Neither high heat nor pressure is required. This process used mostly for thermoplastic sheets in the production of bath tubs, boats, bowls, etc.

Fabrication

Fabrication is a catch-all for a variety of processes including bonding, carving, cutting, stitching, turning, grinding, sanding, and welding.

JOB TASKS IN PLASTIC PROCESSING

Once resins reach the plastics processing plant, workers perform a number of tasks during the production process from preparation to finished product. With some variation these include the following basic tasks:

Step 1: Resins must be prepared and mixed with other ingredients to form a powder. This involves dryer operators, blenders, and oven tenders who mix and supply the molding powder to the molding machine operator.

Step 2: The molding machine operator is responsible for setting the heat and pressure gauges properly and for pouring the powder in the molding machine hopper and monitoring the process.

Step 3: As the powder is heated, it turns into a liquid and flows into a mold or is continuously extruded where it is allowed to cool and harden into its shape.

Step 4: The operator then removes the molded plastic pieces from the mold or the extrusion, inspects them, and places them on a conveyor or on a truck for transportation to the finishing room.

Step 5: In the finishing room, workers using small tools or machines finish the plastic products. Drill press operators, for example, remove excess plastic. Grinders or fillers clean up edges, and buffers smooth them.

Step 6: Painting and decorating: This includes spray painting, electrostatic spraying, dip coating, fill-in marking, screen painting, and roller coating. Several categories of paint are generally used including water-based acrylic paints and lacquers containing solvents and enamels. Depending on the polymer used the following are employed: urethane, epoxy, polyester, acrylic lacquer, acrylic enamel, and water borne acrylics. Some plastics require primers or protective top coats. Preparatory cleaning of surfaces can involve the application of solvents such as acetone, toluene, trichloroethylene, methyl ethyl ketone (MEK), ether and isopropanol. Application of solvents may involve wiping, immersion, spraying or vapour degreasing. Where possible, preparation may include priming the surface with chlorinated polyolefin primers.

Step 7: Plastic re-grinders run machines that grind up scraps of plastic to be recycled. **Step 8**: After passing inspection, the product is ready to be cleaned, packaged and shipped to market. Sometimes parts are shipped to other plants where they are assembled with other parts into a finished product.

Step 8: Purging, cleaning and maintenance.

In addition to molding, other processes might include the production of plastic sheets or film through calendaring. The calendar operator tends to this process. Products are also laminated with plastics which involve coaters who operate machines that soak sheets of paper, fabric or wood with liquid resin. Laminating press operators press plastic-coated sheets in heavy machines.

THE NATURE OF WORKER EXPOSURES TO SUBSTANCES USED AND PRODUCED IN THE PROCESSING OF PLASTICS

The emission of various chemicals used and produced in the processing of plastics is exceptionally complex. It has been widely accepted that the principal workplace contaminants in this process are associated with the residual monomers, polymers, and various additives including plasticizers, stabilizers, pigments/colourants, flame retardants, activators, lubricants and fillers. This also includes various solvents, paints and finishing agents used in the decorative process. Assessing exposures in the plastics industry is not a straight forward endeavor because of the multiplicity of substances and processes used or generated during production. It is difficult to focus on one particular contaminant, since in reality the production process generates a multiplicity of complex chemical mixtures in the work environment.

Factors Affecting Worker Exposures

The extent of worker exposure to these is conditioned by numerous factors during the production processes in which the workers are engaged. The sources of these may start at time of delivery of raw product in the form of bulk powders, granules and liquids from tankers trucks unloading product to the plant. From here the manual handling of drums—opening, pouring, scooping and closing drums is a major source of exposure to chemical dusts. In addition, manual blending and mixing and pouring in preparation for thermal processing in various molding processors is another source of exposures.

The thermal processing is another source of contamination. Here the various formulations are subjected to relatively high temperatures and pressures in order to produce the molded plastics product. This process produces a host of fugitive emissions of gases, vapors and fumes containing a complex mixture of residues and by-products from the thermal degradation of the original resin formulations.

Emission and potential exposure continues on after thermal processing from off-gassing after the product is ejected from the mold or as it leaves the extrusion dies. From here the product is taken for further fabrication that may produce further dust contamination from drilling, grinding, sanding, buffing and stitching plastic fabric.

Further finishing of the product involving decorating, painting, coating and printing adds an additional source of contamination and exposure. Solvents, paints, and coatings add another set of complex mixture.

Finally, the process of cleaning, purging and maintaining the various molding machines will involve the emission of various resin formulations and solvents used.

With respect to what contaminants will be generated in this production process and what workers are exposed very much depends on the various resin formulations and conditions under which they are processed -- that is, the basic polymer or blend of copolymers used and different additives such as plasticizers, stabilizers, pigments, flame retardants, lubricants, release agents and fillers. In addition, the temperature and pressure applied in the process will influence the extent and types of chemical emission exposures of the primary substances being used as well as by products of thermal degradation. Finally, exposure risk will be influence by the degree to which the process is enclosed, the surface area of processed material and physical state of the substances released.

The essential questions to address are:

What are workers potentially exposed to in the plastics production process?
To what extent are workers exposed to these materials?
What factors influence the extent of worker exposure?
What are the potential health effects from such exposures?

WHAT ARE WORKERS POTENTIALLY EXPOSED TO IN THE PLASTICS PRODUCTION PROCESS?

MONOMERS

Monomers are the building blocks of polymers. Although they should be used up in polymerization, monomer residues may be released during the processing of polymers. In addition, there are occasions where a polymerization step is an integral part of rubber or plastic processing, and on such occasions free monomer is an essential ingredient.
Here are some examples:

E-Caprolactam, CAS: 105-60-2

Caprolactam polymerization provides the route for casting polyamide 6 (nylon 6). The monomer is a low-melting solid releasing fumes and vapour that are irritating to the eyes, nose and throat. Peeling of skin and dermatitis have been reported from chronic exposure.

Methyl Methacrylate, CAS: 80-62-6

MMA is the principle monomer in casting acrylic production. Handling the liquid can lead to allergic dermatitis, while MMA vapour is irritating to skin, eyes and mucous membrane. It can also affect the central nervous system similar to some organic solvents (e.g. headaches, fatigue, etc.)

STYRENE, CAS: 100-42-5

Styrene is the most common monomer in unsaturated polyester formulations. Styrene is most commonly released monomer from various styrene based polymers such as ABS, polystyrene, etc. Styrene is an irritant to eyes, skin and mucous membrane.

Health Effects of Styrene

Occupational exposure can lead to neurological effects and effects on hearing. Styrene is classified as a Group 2B carcinogen by IARC. Styrene is identified as a substance shown to cause mammary gland tumors in animal studies (Rudel, et al. 2007) and as an endocrine disrupting substance (Brody and Rudel, 2003).

Several studies show chromosomal aberration in styrene exposed workers. Chromosomal aberrations were positively correlated with urinary concentrations of styrene in exposed workers compared to unexposed controls. (Meretoja, et al., 1978; Hogstedt et al., 1979; Anderson et al., 1980; Duverger et al., 1981; IARC 1982b; Camurri et al., 1983; Yager et al., 1990; Maki-Paakkanen e al., 1991; Tomanin et al., 1992; Tates et al., 1993; Anwar, et al., 1995)

A hematological study of styrene exposed workers found a direct effect of styrene exposure on blood disorders identified. The authors' suggest that studies showing no effect may be explained by the low level of exposures in such studies (0 to 20 ppm). (Stengel, et al., 1990)

Extent of Exposure to Styrene

Exposure to styrene at work in the processing of plastics makes a significant contribution to the body burden of styrene compared to a normal population. Styrene concentrations in the reinforced plastics industry ranges between 20 to over 200 ppm, depending on the operations concerned (Crandall and Hartle 1985; Lemasters et al., 1985). In France, 45% of samples from the reinforced plastics industry had styrene levels above 50 ppm (Meyer-Bish and Protois, 1986 cited in Stengel, et al., 1990).

Brugnone, et al., did a comparison of blood-styrene concentrations in exposed workers vs. the "normal" population, identifying blood-styrene concentrations in exposed workers that were 5.5 times higher in exposed workers. The "normal" population had blood- styrene concentration of 221 μg/l while exposed workers had average levels of 1211ug/l confirming that styrene can accumulate in the body. It also showed that styrene uptake was directly proportional to the level work effort (Brugnone, et al. 1993).

In another study of urinary styrene levels in exposed workers in Emilia Romagna, Italy, researchers found that job tasks were the most important predictor of styrene exposure. ***The range of exposure was directly proportional to the level of manual handling of materials.*** It also showed that while ventilation resulted in lower exposure, the differences in average values were not very wide. Finally, while exposure to styrene declined between 1978 and 1990, the study found that 15% of participants had styrene exposures in excess of the biological limit value for this particular region of Italy (Galassi, et al., 1993).

In their study of styrene exposures in 12 categories of the reinforced plastics industry, Lemasters and colleagues found significant differences for styrene exposure levels between closed mold process and open mold process. Average exposure to styrene in open-mold companies (24-82 ppm) was generally 2-3 times the exposure in press-mold companies (11-26 ppm). As well, the researchers found considerable overlap among job titles classified as directly exposed. For example, those classified as directly exposed in press molding (closed) were similar in exposure to those classified as indirect in open mold operations. Indirect exposure classification was based on work that involved less than 50% direct contact with wet resins, while direct exposure was based on work involving more than 50% direct contact with wet resin containing styrene. Indirect exposure included assemblers, inspectors, dispatchers, shippers packers located in the same vicinity as those in direct contact. It is assumed that these indirect exposure groups could be exposed to ambient concentrations of styrene. In auto and truck parts manufacturing, mixers had an average exposure of 26 ppm while press operators had an average exposure of 30 ppm (Lemasters, et al., 1985).

In a large-scale study of worker exposures to styrene through an analysis of air samples taken by the Danish Labour Inspectorate between 1955 and 1988, Jensen et al. found average concentrations in the order of 265 mg/m3 ranging between 714 mg/m3 (1955-70) and 172 mg/m3 between 1981-88 (Jensen, et al., 1990).

These same researchers also found that styrene emissions are usually accompanied by a number of co-contaminants. These included: Acetone at 131mg/m2; dichloromethane at 51mg/m3; xylene at 49 mg/m3; toluene at 113 mg/m3; perchlorehtylene, trichloroethylene, and isododecane at 7, 5 and 4 mg/m3 respectively.

VINYL CHLORIDE MONOMER, CAS: 75-01-4 AND POLYVINYL CHLORIDE,

Health Effects of VCM/PVC

Vinyl Chloride Monomer (VCM) is the basic building block in the production of polyvinyl Chloride PVC. VCM has been identified as a human carcinogen by health agencies around the world. It was first identified as the agent responsible for the development of a rare cancer angiosarcoma in PVC production workers in the early 70s. It has since been linked to a number of other cancers, in addition to other serious health effects, in exposed workers. While VCM concentrations have been reduced over the years with the establishment of stringent exposure standards and process controls as well as improved formulations containing smaller amounts of VCM, residual VCM is still present in PVC and has been shown to be released in low concentrations in thermoplastic processing (Karstadt, 1976).

Early epidemiological studies in the 1970s suggested that VCM might exert a mutagenic effect on sperm cells of PVC production workers, leading to an increase in fetal deaths among pregnancies of workers' wives (Infante, 1976). This study was consistent with earlier findings that demonstrated chromosome aberrations in PVC production workers (Ducatman, et al., 1975) and work showing that VCM is mutagenic in a Salmonella test system (McCann, et al., 1975).

More recent studies identified: increased risk of testicular cancer with exposure to PVC (Hardell, et al., 1997); increased risk of adverse pregnancy outcomes for women working in PVC processing operations (Ahlborg, et al., 1987); and possible association of male breast cancer and employment in the rubber and plastics industries (Ewertz, et al., 2001).

A number of case reports and epidemiological studies continue to find angiosarcoma and increase cancer morbidity among PVC processing workers. These included: a case report of 2 cases of angiosarcoma among PVC extruders producing PVC bags and other containers (Maltoni, et al., 1984); a Swedish cohort study showing an increase in cancer morbidity at a PVC processing plant (Hagmar et al., 1990); and a cohort study of workers at three PVC processing plants (Lundberg et al., 1993) where cancer mortality was close to expected, but a 3 fold increase in malignant melanoma was identified. In the later study, VCM concentrations never exceeded 10 ppm before 1975 and were much lower after 1975.

A case control study found an excess risk of pancreatic cancers among workers assigned to process PVC and polyethylene resins. Researchers found a sevenfold statistically significant increase in risk for those who worked more than 16 years in vinyl and polyethylene processing. The authors concluded, however, that the excess risk was likely associated with vinyl processing (Selenskas, et al., 1995).

Vinyl Chloride has also been identified as a mammary carcinogen. Vinyl Chloride administered to mice by inhalation was shown to induce tumors at a variety of sites, including liver angiosarcoma at 25 ppm and mammary carcinomas at 25, 10, 5 and 1 ppm (Maltoni, 1977).

Results of a cross-sectional study of mortality among PVC-fabricating workers observed that death from breast cancer significantly exceeded the expected number of breast cancers in the U.S. population. In a follow up case-control study of the 44 breast cancer deaths, the researchers were unable to find a statistically significant increased risk. The authors concluded that the absence of a statistically significant relative risk **does not demonstrate that there is not an excess risk of breast cancer among women exposed to PVC** (Chiazze, et al. 1981).

Extent of Exposure to VCM

Studies conducted by the NIOSH in the 1970s showed RVCM concentrations in plastics fabrication facilities to be less than the 1 ppm PEL and in some cases less than 0.01ppm, the limit of detection. However, certain workstations had values that exceeded the 1 ppm standard (NIOSH, 1974).

Tests conducted in 1975 by the U.S. Environmental Protection Agency of automobile interiors for the presence of VCM found readings as high as 1.2 ppm and as low as 0.05 ppm. These cars were tested one month after assembly. We can reasonably speculate that production workers working in the vehicle would have experienced much higher exposure given that PVC fabrics and parts were just recently molded.

Despite the general lowering of VCM concentrations, continued occurrence of angiosarcoma of the liver in fabrication plant workers points to the possibility of low level exposure being very hazardous.

Assessing the health impact of RVCM is complicated by the fact that polyvinyl chloride resin is a complex mixture of a host of additives. PVC based material may have the following variety of different ingredients:

Stabilizers
- Lead compounds (e.g. carbonate, sulphate, phthalate)
- Cd, Ba, Ca, Tin, Zn salts and soaps
- Organotin compounds

Plasticizers
- Phthalates, Adipates
- Polymeric Plasticizers (e.g. polypropylene adipate)

Extenders (replacing partly more expensive plasticizers)
- Chlorinated paraffin's (waxes and liquids)
- Oil extracts

Lubricants (preventing sticking to processing equipment)
- Al, Mg, Ca and Pb stearates

Fillers
- China clay, Ca carbonates

Pigments

Polymeric processing aids and impact modifiers
- Butadiene based rubbers, ABS materials
- Bisphenol A
- Blowing agents (e.g. Azodicarbonamide)

Exposures During PVC Processing Operations:

PVC is processed by various techniques including extrusion, injection and blow molding. Process conditions such as heat and pressure vary depending on the product and the formulation of the material and equipment. Processing temperatures range from 140-250 C. Cutting and welding PVC will subject the PVC material to elevated temperatures. Under these conditions, a broad range of degradation products are possible, potentially exposing workers to very complex chemical mixtures.

In addition to the degradation temperature and type of processing, the various additives in PVC material greatly affect the composition of the degradation products. The initial decomposition reaction is the release of hydrogen chloride with subsequent release of aromatic hydrocarbons, with benzene being the most abundant at high temperatures.

Additives, such as plasticizers (e.g. phthalates) and blowing agents (e.g. azodicarbonamide) are also emitted. They may react further – for example, di-2- ethylhexylphthalate (DEHP) decomposes into phthalic anhydride. Some examples of degradation products of PVC are shown below:

Table 1: Degradation products from PVC at 170C

Group	Compound
Aliphatic hydrocarbon	C4-, C8-,C11-, C12-, C13- hydrocarbons
Halogenated hydrocarbons	1,1-Dichloroethylene
Aromatic hydrocarbons	Trimethylbenzene
Alcohol	1-Nonanol
	1-Decanol
Alkoxyalcohol	2-(2-butoxyethoxy) ethanol
Aldehyde	Formaldehyde
	Acetaldehyde
	Hexanal
	Nonanal
Ketone	Cyclohexanone
Acid	2-Ethylhexanoic acid
Ester	Diethyl phthalate
	Di-n-butyl phthalate
	Di-2-ethylhexyl phthalate
Hydrogen chloride	

(Andersson, 1988)

Table 2: Concentrations of PVC degradation products in processing at 165-200C Product

	Average ±
Hydrogen chloride	0.07 ± 0.03
Phthalic anhydride	0.001± 0.001
Vinyl chloride	<0.003
Benzene	<0.03
Carbon monoxide	< 1
Aerosols*	0.05±0.1
Di-(ethylhexyl)phthalate	0.3±0.1

* Include phthalate
(Madsen, et al., 1988)

Note: The Madsen study measured degradation products of PVC processed at 165-200C containing 40-59% DEHP.

Table 3: Concentrations of PVC degradation products in various processes

Method	HCL (mg/m3)	DEHP (mg/m3	Phthalic Anhydride (ug/m3)	Temp % (C)	Plasticizer (%)
Extrusion	0.15	0.05		150-200	2.4
Extrusion	0.09	0.30	0.3	150-195	Nk
Calendaring	0.15	0.5	0.2	130-200	6.5-15
Embossing	0.03	0.05		180	Nk
Welding	0.3	0.3	5.0	400	Nk
Injection	0.05	0.02	<0.02	180-190	Nk
Spread coat		*	1.2	160-205	35
Blow mold	0.05	**		150-190	
Compression	0.04	**		150	

Nk=not known
*Diisononylphthalate plasticizer
**Unplasticized PVC
(Vainiotalo, et al., 1990)

ACRYLONITRILE

Health Effects of Acrylonitrile

It must be noted that the Acrylonitrile Peer Review reported below was made up principally of chemical producers including Dow Chemical, Cytec Industries, Exxon Mobile, Proctor and Gamble. The "peer review" was sponsored by industry based "Acrylonitrile Group". This cannot be considered an independent scientific peer review of the literature.

The conclusions of the Acrylonitrile Peer Review Report provide equivocal assessment on the carcinogenic risk of acrylonitrile. The review notes that after a review of the extant evidence on carcinogenicity that: No increased cancer risk has been "consistently observed" in several large scale epidemiological studies. They note that these studies have evaluated tumors of the lung, brain, prostate, and a variety of other organs. The studies have been characterized by lack of consistent findings and lack of a clear dose response relationship for human cancer. The highest human exposures approached or exceeded the lowest exposures found to produce tumors in rats, using some dose measures. The panel concludes that the data from epidemiological studies do not support an association between acrylonitrile and increased cancer in humans, but that such a risk cannot be ruled out.

In contrast the panel noted that acrylonitrile is clearly carcinogenic in rats and mice based on findings of increased tumors at multiple sites in oral and inhalation studies. And based on this animal data, the panel concludes that acrylonitrile is possibly carcinogenic in humans.

Despite these evidential limitations, the International Agency for Research on Cancer (IARC) concluded in 1979 and in 1987 that occupational exposure to acrylonitrile is a human carcinogen.

In addition acrylonitrile is a mammary carcinogen in animals. Oral administration of AN in rats induced and increased incidence of mammary gland carcinomas in both sexes.

Inhalation studies showed that acrylonitrile induced mammary tumors in female rats. (Cited in NTP 11th ROC, 2005).

In a large scale study of clusters of congenital abnormalities(CA) and evidence of mutagenic effects in infants born to populations living in the vicinity of an acrylonitrile producing factory in Hungry, Czeizel, et al., found a clear association with the types of CA, the timing of these clusters and proximity to the factory. While there was no attempt to ascertain the level of exposures, the researchers found a negative correlation between the distance from the plant and the incidence of CAs.

These main findings are important to note because of the light the shed on the nature of exposures and the endocrine disrupting potential for acrylonitrile.

- There was a significant absence of certain baseline expected CA's;
- There were significant time and space clusters of CAs. These included: a cluster of 40 cases of pectus excavatum reported in 1990-92 was 77 fold higher than expected and this particular CA is usually inherited in autosomal dominant mode; two cluster of undescended testis between 1981-83 and 1981 was a 9 fold higher than expected: After technological improvement in the plant which reduced emissions there was no instance of boys born with undescended testis. The researchers also found that there was a decreasing risk of undescended testis with increasing distance from the plant. The occurrence of hypospadias showed a similar trend.
- This finding is of particular interest in relation to the effects of endocrine disrupting

chemicals on male genital organs. In this regard the potential for increase estrogen during pregnancy and male genital abnormalities and its implications for breast cancer is important to note.

In another study of worker exposure to acrylonitrile and dimethylformamide in a viscose rayon plant, Major, et al. 1998 found that air concentration for both substances exceeded occupational limits and urine AN and DMF concentrations were doubled at end of shift. The exposure worker showed increase lymphocyte counts and severe liver damage. The exposed workers showed increased chromatid and chromosome exchange aberrations.

The authors conclude that occupational exposures to AN and DMF induce considerable genotoxic consequences and may increase the cancer risk in the exposed human populations.

In a large case control study conducted in seven European countries, Scelo et al. 2004, found a statistically significant increase risk of lung cancer among workers exposed to acrylonitrile. The researchers also found an indication of a dose-response relationship. The researchers used exposure assessment methodology employed by Siemiatycki, et al. 1987 with cut off points for acrylonitrile at 0.9 ppm and 4.6 ppm, vinyl chloride at 5 and 25 ppm and styrene at 5 and 55ppm. Exposure to the 3 agents in this study occurred mainly in the manufacture of rubber and plastics products.

Extent of Worker Exposure to Acrylonitrile

As can be seen from the emission studies reported above, the monomer acrylonitrile is present during normal plastics thermos -processing. Most, however, show low concentrations. There are few systematic studies of worker exposures to acrylonitrile. Where these have been conducted, the studies indicate that workers are chronically exposed and biologically take up acrylonitrile through inhalation, absorption and ingestion.

Of particular significance was a biological monitoring study conducted among Danish plastics workers by Houthuijs, et al. in 1982. This study of excretion patterns of acrylonitrile in urine of exposed plastics workers, found that:

- Exposed workers had higher concentration of AN(U) on their days off than in non-exposed workers, and even higher concentrations during their days at work;
- Mean post-shift AN(U) concentrations of 39 ug/l corresponding with a mean AN concentration of 0.13 ppm which were found to be positively correlated;
- Comparison within the exposed group showed that there are significant differences in AN(U) and AN(A) concentrations between job categories, e.g. reactor workers had significantly higher concentrations than panel operators (42.9 and 5.4 ug/g AN(U) respectively);
- Peak concentration of AN(A) occurred during maintenance work resulting in a substantial fluctuation from 0.3ppm to 1.8ppm in acrylonitrile concentrations in air;
- Exposed workers continued to have significantly higher AN(U) concentrations on

their second day off than those of controls, indicating that AN bio-accumulates and is released more slowly than originally thought;

- Surprisingly, the levels of AN(U) on days that protective devices were used were higher than on days without the use of protective devices—researchers attribute this to poor quality of protection, bad work practices, or insufficient fit.

Similar biological monitoring studies were carried out by Sakurai, et al. in 1978 among Japanese acrylic factory workers using a different analytical method. In this study they found AN(A) concentrations of 4.2 ppm among highest exposed workers with a mean AN(U) concentration of 360 ug/l. The lowest exposed group had AN(A) concentration of 0.1 ppm and corresponding AN(U) concentrations of 3.9ug/l.

In a study to investigate the genotoxic effects of occupational exposure to acrylonitrile (AN) and dimethylformamide (DMF) researchers identified air concentrations of AN and DMF over the maximum allowable limits at the time of investigation. They found that urine concentrations of both substances were almost double at the end of the work shifts (Major, et al. 1998).

Health Hazard Evaluations undertaken by the U.S. National Institute for Occupational Safety and Health (NIOSH) in 1979 and 1980 of injection molding operations found: (1) average air concentrations of : butadiene 22 mg/m3, styrene 420 mg/m3, acrylonitrile 70 mg/m3, MEK 590 mg/3, MBK 410 mg/m3 and benzene 30 mg/m3 in an injection molding operation producing visors helmets; and (2) average air concentrations of : acrylonitrile 45 mg/m3, styrene 420 mg/m3, and 1,3-butadiene 2, 200 mg/m3 in an injection molding operation.

PHTHALATES

Health Effects of Phthalates

Animal toxicology of several phthalates have been studied with questions raised about the relevance of animal findings to humans (Doull, et al., 1999; Ema, et al., 1993). In the early 1990s, some authorities removed DEHP from lists of human carcinogens (EU, 1990; IPCS, 1992). However, the U.S. Agency for Toxic Substance and Disease Registry determined that DEHP “may reasonably be anticipated as a carcinogen” based on animal data (ATSDR, 1993). DEHP was identified as a rodent liver carcinogen through a mechanism involving peroxisome proliferation (David, et al., 1999) .In 2000, IARC reclassified DEHP to Class C (not classifiable as to carcinogenicity to humans).

In addition to findings of liver carcinogenesis, Moore (Moore 1996, as cited in Keml, 1999) found increased incidence of mononuclear cell leukemia above that normally found at background levels in the strain of rat used in the experiment.

Several phthalates, DEHP, DBP and DzBP, are teratogenic in animals (Ema, et al., 1993; Shiota, et al., 1980; Foster, et al., 1980). DBP is toxic to testes, possibly via its metabolite monobutyl phthalate (MBP) (Heindel, et al., 1992; Gray, et al., 1984). Other phthalate metabolites, MBzP and MEHP, are Sertolit cell toxicants and teratogenic in animals (Ema, et al., 1996; Gray, et al., 1999).

In addition, DBP and DEHP were found to interfere with normal fetal development in male offspring (Pirkle, et al., 1995). Several other studies found similar developmental and reproductive effects as a result of phthalate exposure (Gray, et al., 1986; Singh, et al., 1974; Srivastava, et al., 1990). Based on an interpretation of the foregoing research findings, phthalates vary in potency with regard to reproductive and developmental effects. In this regard, DEHP is most potent followed by DBP and BzBP (Blount, et al., 2000).

In addition, phthalates have been found to be estrogenic (Joblin, et al., 1995). In this regard, there are two additional studies of importance. This includes Ewertz and colleagues (2001) finding of a strong association between male breast cancer and employment in the rubber and plastics industries; and Hardell and colleagues (1997) finding of an elevated risk of testicular cancer and exposure to PVC (OR of 6.6 [CI: 1.4- 32]. When cases with risk factors such as cryptorchidism or orchitic were excluded the risk for testicular cancer increased further. The authors found no such increased risk with exposure to other types of plastics.

In this latter regard, the authors speculate that the mechanism for increased testicular cancer risk may be the estrogenic action of the phthalates contained in PVC, since most other plastics do not contain them, referencing a study of adverse pregnancy outcomes showing increased risk to mothers' exposure to PVC (but not other plastics) in pregnancy (Ahlborg, et al., 1987 cited in Hardell, et al., 1997).

In a study of air impurities in the PVC processing, Vainiotalo and Pfaffli (1990) found that in addition to hydrogen chloride, thermoprocessing of PVC released the plasticizer DEHP and its degradation production, phthalic anhydride PA. The highest single value for DEHP was 1.1 mg/m3 in calendaring processing. DEHP was found in 8 plants studied and PA was found in 5 of 6 plants.

Processes that produced higher concentrations were calendaring, extrusion and welding. This may be explained by the following: All three processes occur at higher temperatures and are relatively more open process compared to injection molding operations.

While concentrations were below the current standard, with the highest value measuring 20% of the TLV, the authors note that the release of DEHP during PVC processing caused considerably higher inhalation exposure than encountered in urban air atmosphere measured at 5-132 ng/m3. ACGIH TLVs for DEHP and PA are 5mg/m3 and 6 mg/m3 respectively.

The authors observed that PA will always be present when DEHP is detected. In addition, it is important to note that the highest concentrations were found during higher heat operations such as welding where temperatures reached 400C. In effect, while the levels discovered in this study reflect fair agreement with other studies, higher levels can be expected as temperatures rise during process disturbances, since 40 to 60% of plasticizers volatilize at 300C.

Phthalates (phthalate acid esters PAE) are extensively and almost exclusively used in PVC processing and workers are exposed mainly by inhalation and skin absorption. Industrial exposure levels of PAE up to 66mg/m3 have been reported in earlier studies in the 1970s

(Milkov, et al., 1973; Gilloli, et al., 1975; Theiss, et al., 1978).

In a health study of workers exposed to PAE during the processing of PVC resins plasticized with dibutyl phthalate (DBP), DAP-789, dioctyl phthalate (DOP), diisooctyl phthalate (Diop) and benzyl butyl phthalate (BBP), Milkov and colleagues identified ambient levels of vapors or aerosols of plasticizers (mixed esters) at the working zone of primers that ranged from 10 to 66mg/m3. Similar results were found at work stations for mill operators and calendar operators. Levels of between 1.7 and 40 mg/m3 were obtained in the mixture preparation section of the plant. (Milkov, et al., 1973)

Vinyl chloride monomer, carbon monoxide and hydrogen chloride were found but were below maximum allowable concentration. The major contaminants were the phthalate plasticizers.

A 1985 Dutch study by Nielsen and colleagues evaluating PAE concentration in air and urine among workers processing PVC is instructive with respect to job tasks and extent of exposure. The study was performed in two film production departments. Thin film was calendared from PVC stabilized with zinc and barium and plasticized with diiodecyl phthalate (DIDP), DEHP and butylbenzyl phthalate (BBP). Thick film PVC was calendared mainly with DEHP and aliphatic hydrocarbons as plasticizers. PVC was calendared at a maximum of 180C and both operations had local exhaust ventilation.

The researcher team found that calendar operators suffered the highest exposures at 2 mg/m3 (40% of the TLV of 5 mg/m3), an exposure 5 times higher than other job categories (machine attendants- 0.2-0.4mg/m3: repair men- 0.3 mg/m3; mixers-0.2 mg/m3; reserves 0.1 mg/m3). The average concentration of PA metabolite in urine of exposed workers was 23 umol/L compared to 17 umol/L in unexposed controls.

The authors' note that the lower levels found in their study may be due to the fact that earlier studies focused mainly on dibutyl phthalate (DBP) which has a higher vapour pressure than DEHP and DIDP. Additionally, the absence of clear-cut peripheral neuropathy may be due to the absence of DBP exposures (Nielsen, et al., 1985).

Similarly, Liss and colleagues found significant uptake of DEHP, phthalic anhydride and 2-ethylhexanol in workers exposed during the manufacture of DEHP. They found significant differences in post-shift concentrations and in the pre- and post-shift changes in total urinary phthalate concentrations between workers in jobs considered to be at high risk of exposure to DEHP and PA vs. those not at risk of such exposure. In comparing urinary concentrations to phthalate in air concentrations the researchers found a correlation between air concentration exposures and phthalate uptake as determined by analysis of urinary phthalate metabolites. The heavily exposed workers had the highest post-shift urinary phthalate concentrations and the greatest pre- and post-shift increase.

In addition, they identified instances in which workers in some job categories considered to be at high risk of exposure to PA and DEHP had increases in pre- and post-shift urinary concentrations but no detectable exposure to airborne PA on the day of urinary sampling. The authors suggest that these workers may have had exposures below the detection limit or absorbed phthalates from a pathway other than inhalation, perhaps percutaneously or orally (Liss, et al., 1985).

In a study of metabolites of DEHP in urine from workers exposed while processing PVC in a boot factory and cable factory, Dirven and associates confirmed the uptake of DEHP through workplace exposure. They found that the uptake of DEHP was 1.2-2.3-fold greater after an 8 hour shift than before the start of work in the boot factory, and 1.2-4.5- fold greater after shift than before for workers in the cable factory. They found that the before shift levels for exposed workers was higher than the level for the non-exposed group. In this regard, the authors speculate that the half-life of DEHP may be longer than 12 hours, and continuous exposure to DEHP might result in higher levels of DEHP metabolite in slow-releasing areas of the body such as adipose tissue.

Factors affecting exposure include the heating of materials, closed vs open processes, the amount of DEHP used in the process. These variations in conditions and procedures were reflected in the variation of both urinary metabolite levels and ambient air concentrations of DEHP. For example, in the boot factory the mixing operation had higher air concentrations than during extrusion. In the case of mixing, the product is warmed and mixed in a semi-open “papenheimer” at 160C. In the cable factory, workers assigned to mixing remained in a sound proof booth most of the time, while the extrusion process for coating cables took place in a semi open process at 200C (Dirven, et al., 1993).

In a similar biomarker study of workers exposed to DEHP while processing PVC, Gaudin and colleagues (2008) identified that exposed workers had much higher concentrations of DEHP metabolite in urine than was found in unexposed controls. They also found significantly higher concentrations in exposed workers at the end of shifts when pre- and post-shift levels were (16.1, 58.9 ug/l respectively) compared, with no such difference found for controls. The authors noted that the levels found in controls were in accord with levels found in a human reference population by both Koch et al.,(2003b) and Preuss et al. (2005) at 10.3-9.8 ug/l (Gaudin, et al., 2008).

In a study of workers representing a cross section of industries using urinary biomarkers for phthalate exposure, Hines and colleagues found strong evidence of occupational exposure to a range of phthalates including diethyl phthalate (DEP), di-n-butyl phthalate (DBP), di(2) ethylhexyl phthalate (DEHP), Dimethylphthalate (DMP), benzylbutyl phthalate (BzBP), di-isobutyl phthalate and di-isononyl phthalate.

Across industries the research team compared end-shift metabolite concentrations to the U.S. general population as obtained through the National Health and Nutrition Examination Survey (NHANES 2001-2002) and found:

- Levels of DEP and DMP in phthalate manufacturing exceeded general population levels by 4- and >1000-fold respectively;

- Levels of DBP in rubber gasket, phthalate manufacturing and rubber hose production exceeded general population levels by 26-, 25-, and 10-fold respectively;
- DEHP in PVC film, compounding and rubber boot production exceeded general population levels by 8-, 6-, 3- fold, respectively.
- Some sectors had concentrations above the general population levels even when the parent phthalate had not been reported. This was the case for MBzP in rubber gasket 5.8-fold; rubber boot 3.4-fold; and vehicle filters 1.4-fold.

The authors noted that factors affecting exposure include: Vapour pressure of the substance; working on or near processes with either applied heat or heated materials with large surface areas.

Other studies involving sampling results in PVC processing industries (Nielsen, et al., 1985; Vianiotalo and pfaffli, 1990; Dirven, et al., 1993) and in phthalate manufacturing (Liss, et al., 1985) have shown elevated process temperatures and large surface areas were associated with the most exposed workers. The authors observed few opportunities for dermal contact except when liquid phthalate or plastisol was handled.

The Hines et al. study (2009) identified tasks that may place workers at risk of exposure. In this regard they note the following based on their assessment of the cross-industry work processes:

Phthalate manufacturing of DMP, DEP, DBP and DEHP occurred in batches or continuous processes in presence of a catalyst. Operators could be exposed while taking or analyzing samples or while performing maintenance.

PVC compounding produced pellets using DEHP and DiNP. Phthalate related processes included mixing, extrusion and milling.

PVC film production using DEHP and DiNP involved compounding, mixing, paste preparation, extrusion, milling and calendaring. In vehicle filter production, exposure could occur while dispensing plastisol containing DEHP.

In rubber products, exposure could occur during compounding, mixing, milling, calendaring and curing. In rubber hose, exposure could occur during compression molding, stripping and extrusion. In rubber boot, exposure could occur during extrusion, injection bolding, buffing, boot making and stripping.

It is interesting to note that in metabolite studies that were combined with air sampling, urinary phthalate levels were several orders of magnitude above levels found in general populations even though air sampling showed levels that were far below exposure standards and in trace amounts.

Health Effects of BPA

The levels of BPA measured in human serum, urine and other tissues are within the range shown to cause effects in laboratory animals, and impact cell function in mechanistic studies in cell culture. Therefore, it is plausible and even likely that these levels are biologically active in humans, with obvious potential to cause disease or dysfunction. At the same time, the increased concentrations observed in workers who are occupationally exposed in addition to general population's exposures may place these workers at greater risk of adverse health effects.

Recent animal studies show that low dose BPA exposures in rats stimulates mammary gland development, and that prenatal exposure increases breast tissue sensitivity to estrogen and cancer-causing chemicals. BPA also increases ductal density in laboratory animals. Both conditions are risk factors for breast cancer in women (Munoz-de-Toro, et al., 2005; Markey, et al., 2001; Durando, et al., 2006).

Several animal studies show that low dose BPA exposures in male rats reduce daily sperm counts. This was also replicated male mice exposed to low doses of BPA. That altered hormone levels may be associated with reduced sperm production, two animal studies showed that reduced hormone levels in rats and mice followed low dose BPA exposures. (Chitra, et al., 2003; Al-Hyasat, et al., 2002; Sakaue, et al., 2001; vom Saal, et al., 1998; Akingbemi, et al., 2004; Kawai, et al., 2003).

BPA levels in blood have been associated with a variety of conditions in women including obesity, endometrial hyperplasia, recurrent miscarriages, abnormal karyotypes and polycystic ovarian syndrome. Two studies found that women with PCOS had higher serum levels of BPA than women without PCOS and that levels of BPA were positively correlated with circulating androgen levels (Takeuchi, et al. 2002; Takeuchi, et al. 2004).

A negative correlation between BPA and FSH was found among men in the study of epoxy resin workers described above (Hanaoka, et al. 2002) however, the epoxy resin workers were also exposed to organic solvents. Due to the cross-sectional design of these studies, it cannot be determined whether BPA increases androgen levels or if androgen levels affect metabolism of BPA.

Three studies found higher BPA exposure for health-related outcomes that are 12 associated with chromosomal abnormalities. One study found higher maternal serum BPA among women carrying fetuses with an abnormal karyotype compared to women carrying fetuses with a normal karyotype (Yamada, et al. 2002).

Maternal age, an important potential confounder was not controlled in this study. In another epidemiology study, an association between serum BPA levels and recurrent miscarriage was reported (Sugiura-Ogasawara, et al. 2005); mean BPA levels were more than three times as high in 45 women with a history of three or more consecutive first- trimester miscarriages compared to 32 nonparous women without fertility problems.

Additionally, among 35 women that then became pregnant, there was some evidence of lower BPA among the women who subsequently had a successful pregnancy as compared to those that miscarried again.

The effects of BPA on the endocrine system have been reported. Its estrogen receptor binding capacity has been observed in earlier studies (Nagel, et al. 1997; Krishnan, et al. 1993). With respect to genital function in males, vom Saal, et al. observed decreased sperm production, and Takao, et al. 1999 observed decreased free testosterone and LH in male mice exposed to BPA. In men, LH and FSH are involved in sperm production and androgen synthesis

In addition, sister chromatid exchange measured in peripheral lymphocytes was positively associated with urinary BPA levels in adults (Yang, et al. 2006). These are coupled with the clear findings of cell transformation (Tsutsui, et al. 1998, 2000) and carcinogenicity (NTP, 1982; Huff, 2001; 2002). Cell transformation has long been considered predictive for mammalian carcinogenicity (Barrett, 1985).

Extent of Worker Exposure to BPA

BPA has been measured in human urine from several populations around the world (Table 2). These studies confirm widespread human exposure to BPA, as suspected from the studies of BPA in blood. Most BPA in urine is in its conjugated form, i.e. BPA-glucuronide or BPA-sulfate. Therefore, most researchers use enzymatic (e.g. glucuronidase and/or sulfatase) treatments to measure total (free/unconjugated plus 9 conjugated) BPA in urine. Many also test untreated urine to determine levels of free BPA alone.

The recent study conducted by the US Centers for Disease Control and Prevention (CDC) detected BPA in 95% of urine samples from a reference population of 394 American adults using isotope dilution GC-MS. (Calafat, et al., 2005). This study reported average levels of total BPA in male and female urine of 1.63 and 1.12 ng/ml, respectively.

Similar results were also obtained in a study of 90 young girls; BPA was detected in 94% of samples (Wolff, et al. 2007).

Another study also examined sex differences in urinary BPA levels in 30 Korean adults by HPLC with fluorescence detection. This study found no sex differences in total BPA measures (average in 15 men and 15 women, 2.82 and 2.76 ng/ml, respectively). Interestingly, however, men had significantly higher levels of BPAglucuronide (2.34 vs 1.00 ng/ml) while women had significantly higher levels of BPAsulfate (1.20 vs 0.49 ng/ml) (Kim Y-H, et al., 2003).

In another study of interest, BPA was measured in the urine of male workers who apply epoxy resins containing bisphenol A diglycidyl ether (BADGE). Urinary BPA levels were significantly higher in 42 men exposed occupationally than in 42 non-exposed workers. They found a significant difference in bisphenol A concentrations between exposed (1.06 umol/mol creatinine) unexposed controls (0.52 umol/mol creatinine. The researchers also note that most of the general populations (in Japan) have concentrations similar to those of the controls in their study. In their view, the increase concentrations observed in exposed workers was generated by their exposures to bisphenol A in the materials used in production (Hanoaka, et al. 2002).

The consistent finding that BPA is detected in almost all individuals in developed nations implies that humans are exposed to BPA continuously. Because of the rapid metabolic clearance of BPA, and the measurable levels of BPA that have been detected in human blood and urine, Welshons and colleagues have identified two potential issues: 1) BPA intake may be actually much higher than has been suggested, and/or 2) long-term, daily intake leads to bioaccumulation of BPA, leading to steady-state levels that are not represented by any of the current models for BPA metabolism based on single, acute administration (Welshons, 2006).

METALS: EXPOSURE DURING THERMOPLASTIC PROCESSING

Various metal compounds are used in the thermoplastics processing industry. These may be used as heat stabilizers, particularly in the processing of PVC, and colourants in all polymers. Heat stabilizers might include inorganic lead compounds, organic tin compounds, barium, calcium, zinc carboxylates, antimony compounds, etc.

There are few studies of metal exposures in thermoplastics processing. We summarize some worthy to note with respect to potential levels of exposure and work activities that put workers at risk during the production of plastics products.

Organic Tin

In a study of workers exposure to organic tin compounds used as stabilizers in PVC processing, Boraiko et al. (2005) found that mean organic tin exposures were less than 10% of the TLV. Included were two cases where the results were considerably higher (e.g. >50% of the TLV= 0.10 mg/m3) and one case that was slightly higher (0.102 mg/m3). For these cases, the authors identified that the workers performed multiple tasks and manual handling, as opposed to those involving more automated handling and engineering controls. These manual operations involved operators opening drums and pouring stabilizers into containers to be added manually.

They noted that many operators conducted a variety of different tasks in a work shift, resulting in different exposure levels reported for similar tasks. Tasks that put workers at greater risk of exposure included:

- Opening and closing drums of tin stabilizer and connecting and disconnecting pumps to these drums;
- Pouring of tin stabilizer into containers to be added to a batch of PVC to be compounded;
- Cleaning up small residuals form drum tops or dip pipe;
- Sampling of stabilizer at time of delivery;
- Connecting and disconnecting hoses at time of bulk delivery and cleaning up residuals;
- Cleaning mixing vessels or continuous lines after PVC compounding.

The authors reported the following maximum levels of exposure for each operation:

Blending—0.102 mg/m3

Extrusion—0.034 mg/m3
Injection molding—0.007 mg/m3
Milling—0.064 mg/m3
Pelletizing—0.006 mg/3

The authors conclude that workers may experience exposure to organic tin compounds during PVC processing.

The health effects associated with organic tin compounds exposure include: adverse effects on the liver, kidneys and urinary tract. The current TLV of 0.1 mg/m3 is based on changes in the liver, kidney, lung, heart, nervous and reproductive systems in rodents (ACGIH, 1991)

Lead Compounds
Similarly, Coyle, et al., found that workers processing PVC were exposed to lead sulfate stabilizers. In this investigation three plastics compounders were found to have severe lead poisoning as a result of the uncontrolled use of powdered lead sulfate. Blood lead concentrations for the three workers at time of diagnosis were 159, 114 and 108 ug/dl. Follow up investigation of 6 co-workers identified levels ranging from 4 to 48 ug/dl. For comparison purposes the geometric mean BLL for the U.S. general population and working aged adults is less than 2 ug/dll (CDC, 2003). Further follow-up of workers' children identified one child with elevated BLL of 10 ug/dl.

Air monitoring conducted several weeks after the index case was identified showed personal air lead level of 460-1,100 ug/m3. Air lead levels a year later and after the employer switched to pellet formulation were still excessive at 20-400 ug/m3. Even after the employers' further efforts to switch to a pre-packaged stabilizer lead, air levels remained excessive (3-210 ug/m3). While the source for continuing high lead air levels was unclear, the authors' noted that white powder was visible on the floor and surfaces though out the shop, likely kicked up during dry sweeping. The powder, they speculate, may have been lead sulfate left over from the original process.

The authors note that even engineering controls, such as switching to a pre-packaged stabilizer, may not be sufficient to control lead exposures.

Health effects of lead compounds include toxicity to the nervous system, blood and kidneys. Reproductive effects can occur in men and woman. Some effects include: numbness, tremors, impaired hearing, memory loss, anemia, renal failure and infertility. Lead compounds as used in PVC stabilization are classified by IARC as Group 2B carcinogens.

Cadmium Compounds
In a very limited study of air concentrations of cadmium compound used as pigments in various thermoplastics, Bonilla, et al. (1994) found that cadmium concentrations did not exceed the OSHA action level of 2.5ug/m3. However, the authors noted that their study focused entirely on fumes generated by injection molding, and did not include potential exposure from inhalation of dust resulting from secondary operations involving sanding, sawing, and regrinding that may

generate airborne concentrations of cadmium dust.

FLAME RETARDANTS

There are two general categories of flame retardants with a diversity of chemical types and functions: Inorganic flame retardant include metal oxides, hydroxide and basic carbonates and function by the release of an inert gas or by undergoing highly endothermic decomposition. Organic flame retardants include phosphate esters and halogenated materials-especially organobromine which function by intercepting the active species in the chemical process.

The primary flame retardants used in plastics production are organohalogen-and organophosrus-containing compounds (Green, in Katz, et al., 1987).

Polybrominated biphenyls (PBB) include a class of substances that have been shown to be strongly estrogenic and in some instances have been classified as Group 2B chemicals. Carcinogens including hexabromobiphenyl which has proved to be a liver carcinogen in animal tests (IARC). Many vivo and in vitro studies show that polybrominated biphenyls interrupt thyroid function and are potently estrogenic. Such substances as polybrominated diphenyl ethers (PBDE), hydroxylated PBDE's, peta bromophenol (PBP), tetrabromobisphenol A (TBBPA) and polybrominated bisphenol A compounds showed marked estrogenic potencies in vitro. (Meerts, et al., 2000; Meerts, et al. 2001; Brouwer, et al. 1998, Ucan-Marin, et al. 2009; Crump, et al. 2008; Shao, et al. 2008; Dang, et al. 2007, Reistad, et al. 2007; vandeVen, et al. 2006; Kudo, et al. 2006; Hamers, et al. 2006; Schauer, et al. 2006;Canton, et al. 2005; Kitamura, et al. 2002).

Phosphororoganic compounds (POC) include a number of compounds used as retardants in plastics production. Some of the more common are trybutylphosphate, tris (chloroethyl) phosphate, tris (chloropropyl) phosphate, tris (dichloropropyl) phosphate, tris (2-butoxyethyl) phosphate, tris (2-ethylhexyl) phosphate, triphenylphosphate, tricresylphosphate, tris (2,3-dibromopropyl) phosphate. These are shown to be mutagenic in vitro (Brum and Ames, 1977; van Beerendonk, et al. 1994; Hudec, et al. 1981; Ames, 1979; Gold, et al., 1978; Prival, et al. 1977).

Occupational and Environmental Exposures to Flame Retardants

There are very few occupational hygiene studies of occupational exposures to flame retardants. Of those studies undertaken the focuses was on exposure to halogenated flame retardants and were not directly related to plastics processing. In two studies, one in Norway and one in Sweden, researchers biologically monitored uptake of halogenated flame retardants in workers. The Norwegian study focused on measured uptake in electronic dismantling workers, printed circuit board production workers and laboratory personnel (Thomsen, et al. 2001). The Swedish study measured uptake in electronic dismantling workers, computer screen workers and a comparative group of hospital cleaners (Sjodin, et al. 1999). In both studies, levels of bromonated flame retardants in workers were higher than in the general populations and referent group. In addition, the levels were much higher in the electronic dismantling group than in other occupations.

These studies indicate that while general populations are exposed to several bromonated flame retardants, the elevated levels in dismantling workers suggests that these workers received additional occupational exposure.

Similarly, a study of workers manufacturing, or handling, rubber containing the flame retardant decabromodiphenyl ether found that rubber workers had elevated levels of brominated flame retardant that were 2.5 to 11 times higher than a referent group of non-exposed workers (Thureson, et al. 2005).

In their review of plastics additives in the indoor environment, Wensing, et al. (2005) found significant concentrations of POC in automobiles when interiors were heated to 65C. In this regard concentrations of TCPP and TDCPP reached 11.1 and 8.4 ug/m3 respectively. They also found that new cars give off significantly higher concentrations than vehicles that are 9 months older. The highest concentration at room temperature was 0.48 ug/m3. These levels give some idea of what levels might be like during the thermoplastic processing where temperatures are even higher and the product is newly produced.

COMPLEX MIXTURES

Emissions from Processing Thermoplastics

Up to this point we have only considered the emission, exposure and health effects of various known ingredients, i.e., the chemicals known to be involved in the process. We now turn to an even more complex process in which new species of ingredients are created by the chemical reactions taking place during the thermoplastic process -- in addition to those identified in the original formulations. The result is a complex mix of products that are released into the work environment.

Several studies have been conducted to identify these chemicals and evaluate the extent of emission during various thermoplastic processes.

One of the few comprehensive studies of this kind was conducted in 1995 by M.J. Forrest and colleagues. While a number of studies had attempted to characterize the various substances produced when thermoplastic materials are heated in the laboratory, few had tried to collect data from actual workplace situations.

Forrest, et al. (1995) investigated the processing of ABS, HIPS, PVC, LDPE, HDPE, PP, PAM, SAN during injection molding and extrusion processes. The research took both personal samples and area samples for each process.

They detected a wide range of chemical species in each process work environment. In some instances they were able to detect relevant monomers. The concentrations of species detected ranged between 0-2 mg/m3 under standard processing conditions and up to approximately 10mg/m3 during purging operations. At no time were concentrations above the current exposure limits. Generally their data show that a higher level of fumes is generated during extrusion-based processes than during injecting molding.

Some specific results:

ABS: A wide range of species at various concentrations. Concentrations were higher during purging. Unexpectedly, however, the researchers noted relatively high concentrations of many species in the background, e.g. the differences between the background levels and those obtained close to the injection molder were quite small.

The monomers acrylonitrile and styrene and a modifier methyl styrene were detected.

The following quite extensive list of compounds was detected:

Acrylonitrile
Hydrocarbons (c3-c7)
Trichloromethane
111 trichloroethane
Benzene
Trichloroethane
Alcohol
Toluene
Xylene isomer
Styrene
Hydrocarbons (c10-c11)
Benzene, methyl, ethyl isomers
Benzene, proyl isomer
Benzene, trimethyl isomers
Alpha methyl styrene
Benzene, ethyl, methyl isomers, benzene, dichloroiomer
Acetophenon
Benzene, diethyl isomer
Hydrocarbons (c12-c14)
Benzene, ethyl, dimethlyl isomers
Benzene, methyl, diethyl isomers
Naphthalene, tetrahydro isomer
Benzene, ethyl, methylethyl isomer
Siloxane
Naphthalene, tetrahydo, methyl isomers
BHT

HIPS: During sheet extrusion processes. The species produced were primarily aromatic in nature with styrene the most prominent at 1.48mg/m3. Acrylonitrile was noted in lower concentrations. These results illustrated that location could influence concentrations. Concentrations were higher where the process was located adjacent to a side wall as opposed to machines located in an open area. In addition to the monomers, a host of aromatics and hydrocarbons were identified.

HIPS: During injection molding. A wide range of species were produced at significantly higher concentrations than for sheet extrusion. Background levels were not much lower than concentrations found next to the process and purging produced significantly higher concentrations. The monomer styrene was detected in addition to a complex mixture of aromatics and hydrocarbons.

HDPE: During blow molding operations. A few species were produced at low concentrations, in particular, simple hydrocarbons and toluene.

Nylon 6: During extrusion processing. Various chemical species were detected at relatively high concentrations including background. Background levels were higher than those near the process. This anomaly is explained by the other work activities going on in close proximity. Comparatively high levels of dichlorodifluouromethane as well as hydrocarbons and aromatics were detected during purging.

PP: During tape extrusion of polypropylene. During this process researches took measurement up wind and downwind of a noticeable draft. And background during purging was also measured. This process produced mostly hydrocarbons and some aromatics at comparatively high levels. The level of fumes down wind was higher than up wind concentrations. Relatively high levels of dichloromethane, a-methyl styrene, xylene as well as aromatics and hydrocarbons were detected during purging.

PVC: During injection molding of unplasticized PVC. Comparatively high concentrations were found for a wide variety of chemicals. Background levels were higher than levels close to the process. Monomers found could have originated from additives in PVC compounds being processed nearby. Purging operations enhanced the concentration of species found. Levels for dichloromethane, ethyl acetate, xylene, a- methyl styrene as well as hydrocarbons were detected at high levels during purging.

LDPE and LLDPE (low density polyethylene-linear low density): During blow film processing of both compounds. The processing of this blend produced a larger range of chemical species at higher concentrations. Certain monomers—methyl methacrylate and a methyl styrene were found, but could have been from another source. Purging did not increase concentrations in this case.

SAN: Styrene Acrylonitrile was measure only for hydrogen cyanide. None was detected.

What this study demonstrates is that thermoplastic processing produces very complex mixtures of residual chemicals from the basic formulations as well as numerous chemical by-products from chemical reactions occurring under thermoprocessing conditions. It demonstrates that the extent of exposure is conditioned by a number of factors. These include: the type of material, the type of process, ventilation and purging and cleaning processes.

In a study of depolymerization of products in polyacetal POM, polyamide PA 6, and polymethylmethacrylate PMMA during thermoplastics processing at 11 plants, Vainiotalo and Pfaffli (1984) found monomer concentrations of 0.06-0.23 mg/m3 of formaldehyde during POM processing; 0.05-0.14 mg/m3 of e-caprolactam during PA 6 processing; and 0.06-4.6 mg/m3 of methyl methacrylate(MMA) during PMMA processing. Trace amounts of formic acid during POM processing and ammonia during PA6 processing were found. None exceeded current OEL. The rather high level of MMA is of special concern because of its high degree of toxicity and effects on neurochemicals such as acetylcholine esterase activity.

The authors also found that plastic fumes contain small amounts of other substances, e.g., free radicals, aerosols, and additives which may be harmful to human health. All measurements were taken during normal processing. They noted that a rapid rise in temperature as a result of process disturbance could lead to much higher concentrations of monomers. In a previous study of emissions of additives in thermoplastics the same authors found levels of the blowing agent azodicarbonamide ranging from 0.002-17.5 mg/m3. (Vianiotalo and Pfaffli, 1988). In other research on the production of free radicals during the processing of polyethylene and polystyrene plastics Westerberg, et al. (1982) found that plastic processing gives rise to free radicals with lifetimes long enough to reach the breathing zone of workers. The toxicity of free radicals can initiate a process leading to serious cell damage.

Another major contribution to these exposure and risks assessment was the extensive literature review under taken by the Nordic Expert Group for Criteria Documentation of Health Risk of Chemicals. Their assessment involved an evaluation of the literature on degradation products of polyethylene, polypropylene, polystyrene, polyvinylchloride and polytetrafluoroethylene in the processing of plastics as well as a brief review of the health effects literature. (Zitting, 1998)

A brief summary of their review follows:

Polyethylene: Studies included measurements and identification of chemicals during compression molding, injection molding, blow molding and extrusion. Most PE is formed by extrusion processing. Additives may include: carbon black, titanium dioxide, chromic oxide, antimony trioxide, chlorinated compounds, azodicarbonamide, 4,4-oxybisbenzenesulphonohydrazide, polyisobutylene, butyl rubber, peroxides, phenols, polyethylene glycol alkyl esters.

Major degradation products are formaldehyde, formic acid, acetaldehyde, acetic acid. Significant amount of aerosols are formed as well as free radicals. The authors present a long list of 45 compounds identified during thermal processing polyethylene at temperatures ranging from 264 to 289C.

Exposure data from several studies indicate low concentrations of aldehydes, keystones and organic acids as well as a whole host of volatile organic compounds.

The health effects literature reviewed indicated adverse neurological adverse effects and respiratory tract irritation in animals. Human studies indicated dermatitis, irritation of the eyes and upper respiratory tract, bronchial constriction and adverse CNS effects.

Polypropylene: Additives are similar to polyethylene.

Major degradation products include: acetaldehyde, formaldehyde, acetone, acetic acid and methylacrolein along with significant amounts of aerosols resembling paraffin wax fumes.

Again the authors list a long list of chemical compounds in the following categories: hydrocarbons, alcohols, ethers, aldehydes, ketones, acids.

Health effects literature indicated irritation of the upper airways in animals. Human studies showed potential bronchial spasms, as well as some studies indicating possible association between work with PP and colorectal cancer, but authors point out that weight of epidemiological evidence does not support this association.

Polystyrene: Processed through a number of techniques.

Degradation products include alcohols, aldehydes, and ketones. At least 190 compounds have been identified. The most abundant product was styrene. These are accompanied by significant amounts of aerosols and free radicals in PS processing fumes.

Health effects literature indicated adverse liver and lung effects in animals, although the author discounted these effects as not relevant to humans because of the high exposures in the animal studies. Only one human study was reported of adverse pregnancy outcomes among women employed in the plastics industry in Canada (McDonald et al., 1988).

Polyvinylchloride: The authors point to the large number of additives in PVC processing and its use in all processing techniques which greatly affect the composition of degradation products.

Degradation products are complex: The literature indicates that various additives such as phthalates and blowing agents including azodicarbonamide are emitted. These have been shown to react further, e.g. DEHP decomposes to phthalic anhydride.

The authors cite several studies indicating a larger range of chemical species that include: Aliphatic hydrocarbons, halogenated hydrocarbons, aromatic hydrocarbons, alcohol, alkoxyalcohol, aldehydes, ketone, acid, ester, and hydrogen chloride. Exposure values varied widely depending on the process techniques employed and materials used.

The health effects literature indicate respiratory irritation in animals and humans. The authors discount the association between angiosarcoma and PVC degradation products.

Polytetrafluoroethylene: PTFE is made from tetrafluouroethylene and additives are seldom used.

Major degradation products include: hydrogen fluoride, tetrafluoromethane, carbonyl fluoride, tetrafluoroethylene, Hexa fluoroethane, hexafluoropropene, Octafluoropropene, Octa fluoroisobutene, and trifluoroacetyl fluoride.

Health effects literature indicate pulmonary hemorrhage and edema and polymer fume fever in animals. Edema from inhaling fumes produced in welding and grinding and polymer fume fever in humans have been reported and studied.

EPIDEMIOLOGICAL EVIDENCE OF
ADVERSE REPRODUCTIVE EFFECTS AND BREAST CANCER

Adverse Reproductive Outcomes and Infertility Associated with Plastics Production There are several studies that found an association between work in the plastics industry and various forms of adverse reproductive outcomes and infertility. These were identified by Baranski in a comprehensive review of recent literature on adverse effects of occupational factors on fertility and related reproductive outcomes. These include: Spontaneous abortions in viscose rayon and styrene industry (Hemminki, 1984); infertility and delayed conception in plastics industry (Rachootin, 1983); Spontaneous abortion in PVC and styrene plastics workers (Lindbohm, 1985); spontaneous abortions among phthalate plasticizer workers (Aldyreva, 1975); spontaneous abortions among plastics and rubber production workers (Figa-Talamanca, 1984); menstrual disorders and infertility among female workers in synthetic rubber, caprolactum and styrene production (Sanotsky, 1986); spontaneous abortions among women exposed to organic solvents (Lindbohm, 1990); menstrual disorders and spontaneous abortions and polyamide cord production (Gaevaja, 1983); spontaneous abortion and premature delivery among women working in PVC and epoxy plastics production Sachbazjan, 1981); spontaneous abortion among and congenital malformations in offspring of women working in rubber production; spontaneous abortion among women working in rubber tire production; increased odds ratio of adverse reproductive outcomes for women who worked in PVC processing and processing cold plastics(Ahlborg, 1987); Reduced fertility in women exposed to organic solvents(Sallman, 1995); more recently an increased incidence of infertility among women working in plastics industry (Hougaard, 2009).

Breast Cancer Associated with Plastics Production

Early epidemiological evidence showing an association between employment in the plastics industry and breast cancer identified elevated breast cancer mortality among PVC fabricating workers (Chiazze, et al., 1977). However subsequent case-control analysis of the data found a non-significant risk of death from breast cancer. The authors concluded that the absence of statistical significance did not demonstrate lack of excess risk, since the study lacked the statistical power to detect the size of the risk (Chiazze and Ference, 1981).

A more recent study identified excess risk of breast cancer in plastics and rubber industry workers (1.8, 95%CI 1.4-3=2.3) as well as in workers exposed to organic solvents and benzene (Patralia, et al., 1998). Two other studies report a non-significant increased risk among rubber and plastics workers (Bu-Tian Ji, et al. 2008). Adding weight to a connection between breast cancer and employment in the plastics industry is the finding of excess risk of male breast cancer among workers in the rubber and plastics industry (OR=4.5, 95%CI 0.7-2.8) (Ewertz, et al., 2001). Male breast cancer is a rare event and its occurrence may indicate the estrogenic effectiveness of substances used in this industry.

Two other studies may indirectly implicate these substances with increased risk of breast cancer. An Israeli case-control study (Shaham et al., 2006) identified increased risk of breast cancer among women working in textiles and clothing industry (OR=1.8, 95% CI 1.1-3.0). In the absence of specific exposure data, the authors speculate that exposure to various carcinogenic agents and endocrine disrupting substances used in textile manufacturing may play a role in breast cancer risk.

Similarly, Labreche and colleague link excess risk of breast cancer with occupational exposure to synthetic textile fibers, acrylic fibers, (OR 7.0 and nylon fibers (OR 1.99) when exposure occurred before age 36. They found that OR doubled for estrogen/progesterone positive tumors lined to exposure to acrylic and rayon fibers and nonaromatic hydrocarbons. A threefold increase was linked to exposure to PAHs (Lebreche, et al. 2010). It is important to note that modern textiles consist mostly of synthetic fibers made from acrylic, nylon, rayon, polyesters—essentially from plastic resins treated with additives such as plasticizers and flame retardants that are recognized as mammary carcinogens and endocrine disrupters. At the same time, the finding of increased risk with exposures before age 36 is also consistent with what we know about risk factors for breast cancer, all of which are related to life-time exposure to ovarian hormones. Early exposure to xenoestrogens present a window of vulnerability with several possible dimensions for increased risk.

Adding weight to this evidence of a causal connection is the case-control study by Brophy et al. that utilized descriptive data from a qualitative study (Brophy et al., 2012; Keith et al., 2011; DeMatteo et al. 2012). That study found a more-than-doubling of breast cancer risk among women who had worked in automotive plastics manufacturing for 10 years and were assessed as having been highly exposed to EDCs and/or carcinogens (OR=2.68; 95% CI 1.47-4.88). Astonishingly, the risk rose to almost five-fold for premenopausal women (OR=4.76; 95% CI 1.58-14.4). The early onset of breast cancer further substantiated the hypothesis of a causal connection between exposure to EDCs and carcinogens in the plastics production process.

DISCUSSION

This review brought to light some very significant evidence to postulate a probable link between work in the plastics industry and breast cancer as well as other adverse reproductive effects.

Firstly, we were able to demonstrate through a review of a number of monitoring studies that workers sustain a significantly higher body burden of endocrine disrupting substances than that found in the general populations which are already higher that those found to harm animals. Second, these substances have a longer half-life that originally believed and tend to bioaccumulate. These observations were found for a number of endocrine disrupting substances such as bisphenol A, styrene, acrylonitrile and phthalates. For example, levels of BPA detectable in human blood are within or above the range of concentrations demonstrated in vitro to cause changes in the function of human tissue (vom Saal et al. 2007).

Third, several studies indicated that air monitoring can underestimate the true body burden of these substances. While most studies indicated that levels were below current occupational exposure limits, body fluid concentrations were significantly higher than levels found in 'unexposed' referent populations.

In this context, it is important to emphasize that endocrine disrupting substances have disruptive effects at infinitesimal levels. At times, low doses may have more powerful effects that at higher doses. Dose is measured in parts per trillion. To illustrate how small, this is like one drop of substance place in 660 rail tank cars extending along the tracks for 6 miles (Goettlich, 2005). Consequently, these substances may not exhibit the traditional linear dose-response curve, but are more likely to produce an inverted U or U- shaped curve (Diamanti-Kandarakis, et 2009).

Additionally, workers are exposed to a complex mix of compounds that may include endocrine disrupting chemicals and other co-contaminants. The combined effect of different classes of EDs ma exert additive or even synergistic effects. Studies that investigated the link between EDs and breast cancer produced inconsistent results where exposure to a single substance was measured, while those that considered several co- contaminants exposures demonstrated a positive link. In fact, one such study demonstrated that the combined effects of several environmental estrogens as measured by the total effective xenoestrogen burden (TEXB) are a risk factor for breast cancer over and above the risk linked to any single substance (Ibarluzea, et al. 2004).

The other major obstacle is associated with the inherent limitations of epidemiology in demonstrating the link between occupational exposures and disease. The problem lies in the limited statistical power of most studies to actually detect the risk or underlying relationship. In this regard, numerous studies reviewed found non-significant excess risk because there was insufficient statistical to detect a risk of that magnitude. In their review of 115 occupational breast cancer studies, Lebrech and Goldberg identified that the median number of breast cancer cases was 19 with an average of 64 cases. Only five studies had more than 100 cases. They noted that even though 75% of studies had statistical power above 80%, the small number of cases seriously limited the ability to detect risk in subgroups and test for exposure trends. This inherent limitation will tend to underestimate any conclusion about the impact of workplace exposures on the production of disease. Our challenge, as researchers, lies in overcoming the inherent limitations of the dominant scientific paradigm for establishing causation.

CONTROLLING EXPOSURES IN THE PLASTICS PRODUCTION PROCESS DEVELOPING BEST PRACTICES

The Hierarchy of Controls

Effective control measures in the plastics industry must be based on the fundamental principles of control. This embodies a set of principles that are traditionally referred to as the hierarchy of controls. We can conveniently consider these measures on the basis of 'where' the control measure is exerted: At the source; along the path to the worker; at the worker.

Controlling at the Source
Under this hierarchy, the most effective method of controlling hazards is to apply the control at the source of the hazard by eliminating the hazard altogether or isolate it from the worker. It is the best method of control and the only one acceptable for carcinogens. Control at the source is typically accomplished through engineering methods that may include:

Re-designing the Work Process
It may involve the purchase of new equipment, the addition of safety features to existing equipment, or the complete elimination of a hazardous step in the production process.

Substitution
Eliminating the hazard at the source by substituting the hazardous agents with agents that have been tested and proved to be non-toxic. This approach is consistent with various 'toxic use reduction' (TUR) campaigns and programs. There are countless examples of control by substitution, and this should be the first line of attack. At the same time, sometimes a less hazardous substance may not necessarily be safe.

The case for massive substitution of plastic additives shown to be estrogenic active (EA) was made by Yang and colleagues. Applying estrogenic bioassay to various plastics, the researchers found that almost all commercial plastics products release estrogenic chemicals. Because polymerization of monomers is rarely complete and additives are not chemically part of the polymeric structure, chemicals having estrogenic activity can leach or be released from plastics products during production and during normal use by consumers. ***The authors also note that even when using all materials that initially test EA- free, the stresses of manufacturing can change chemical structures or create chemical reactions to convert an EA-free chemical into ones with EA.***

This last observation has important implication for the potential to EA chemicals during the manufacturing process given the physical stresses of heat and pressure employed.

They further note that most of the 500 commercially available plastics products that were sampled, even those that are presumably BPA free, release chemical having detectable EA.

Importantly, the researchers indicate that since it is possible to identify existing, relatively inexpensive monomers and additives that do not exhibit estrogenic activity, even when stressed, then it is possible to produce non-EA plastics having comparable physical properties at minimal additional cost.

Isolation
This approach may employ various measures to isolate the hazard so that the worker cannot come in contact with the offending agent. An example of this involves enclosing the process at every step where exposure would be possible. Several sectors such as the chemical industry employ various process controls to accomplish isolating the hazard.

For example, closed vat systems have reduced exposures to such carcinogens as vinyl chloride and bis chloromethyl ether to minimal levels.

Another method of achieving hazard isolation is to use automated procedures and mechanical devices that can perform simple procedures or employing environmentally controlled cabs or booths. A combination of these three methods used in the Japanese steel industry brought exposures to coke oven emission down to nil.

Controlling Along the Path

Controls along the path can be situated close to the source. For example, local exhaust ventilation is located close to the source to interrupt the flow of hazardous fumes to the worker by extracting before they can reach the worker. Alternatively, controls can be implemented along the entire path. General ventilation is an example of this type of control.

Local exhaust ventilation includes fixed hoods, soldering benches, moveable hoods and ducts in welding operations and spray booths. Properly designed and maintained local exhaust systems can be extremely effective means of controlling exposures because this extracts fumes out of the path of the worker.

General ventilation or dilution ventilation simply allows the toxic substance to become diluted throughout the entire volume of air in the workplace. It is limited to situations where very small amounts of a non-toxic substance are released into a large volume of air. In a toxic environment found in most plastics plants, it is little more than a technical term for the complete absence of controls. For the most part, it results in the spread of the toxic substance throughout the entire workplace.

Portable barriers are another example of control along the path. These barriers or screens may provide some protection from energy hazards such as noise, radiation and electricity.

Finally, general housekeeping measures can be considered controls along the path. They include proper cleaning, the disposal of waste and the clean-up of spills. Utilizing vacuum cleaners instead of brooms or mops is a form of housekeeping methods that remove the substance form the workplace. The use of air hoses to clean machinery should be opposed, because it spreads the hazard.

Wet method can be used to control dust in grinding, drilling and sanding operations is another example of control along the path.

Control at the Worker

Controls applied at the worker through the use of personal protective equipment and administrative controls are the least effective. Examples of controls at the worker include devices such as respirators, ear muffs or plugs, protective gloves, safety glasses or eye shields. These types of controls are the least effective and can be a hazard in themselves and can, in fact, worsen the hazardous conditions.

Because these are cheaper and easier to provide than engineering changes and local ventilation or sound absorption, outfitting workers with this protective gear if all too often the first approach to workplace hazards.

Administrative controls attempt to control the worker rather than the hazard. These include measures such as prescreening workers who may be abnormally susceptible; rotating shifts in hazardous areas; and hiring workers who have been sterilized where there are hazards to reproduction.

The Cost of Controls

There is no question that adequate controls can be costly. Confronted with a choice of installing and maintaining a proper ventilation system or supplying respirators, management will invariably argue for the latter. Not only does it cost a fraction of the cost, but it also shifts the burden of responsibility from the company to the worker.

Companies frequently use traditional cost benefit analysis to justify their position, stressing the cost of controls and predicting plant closures and unemployment if adequate standards are enforced.

While these scare tactics have been effective barrier to more effective controls and more stringent exposure standards, in reality these fears are not well founded.

The regulation of vinyl chloride is a case in point. When it was discovered in 1974 that vinyl chloride was a powerful carcinogen, the US government introduced an emergency standard that reduced the permitted exposure from 500 parts per million to 50 parts per and then to a new standard of 1 part per million.

The chemical industry had been operating at exposure levels of 50 ppm, and it predicted the end of the plastics industry and the loss of 2 million jobs and $65 billion to $90 billion in lost revenue. However, quite to the contrary the industry met the standard with only one plant closure. At the same time, four new plants were built and the price of vinyl chloride at dropped by 10%.

Despite company claims that stricter controls will force them to shut down, various studies in the US have demonstrated that few plants have closed because of the cost of meeting new standards. Those plants that closed were already marginal and would probably have closed even if they had not been required to meet new standards.

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APPENDIX B

MINISTRY OF LABOUR (MOL) REPORTS 1986-1996 and 2004-2018

1986

138009 13/11/86 DSR Vinyl Chloride assessment INJEC MOLD/POST LAM

DSR assessment was ordered for vinyl chloride contained in Geon Vinyl Compound Resin. Based on manufacturer's (B.F. Goodrich) opinion VCM could not be released by temperatures used to melt resin, and DSR not applicable. **AUTHORS'COMMENT:** However, did not consider other toxic chemicals released at these operating temperatures such as phthalates, lead, stabilizers, etc., that are toxic. Also thermal decomposition by-products including VCM can be released during high heat malfunctions as well as during fires—instances which did occur from time to time. Workers manually poured and used directly 28 25kg bags per day. Orders also issued for handling and storage of MEK, acetone and other flammable solvents.

1987

168077 23.04.87 cyclic review by MOL PLANT WIDE

No.6 in assessment review states: Ontario Regulation 654/86 "control of Exposure to biological or chemical agents was discussed and copies left. Toluene, MEK, Acetone, Perchlorethylene and Ethyl Acetate are all included in this regulation. No.7)"The Internal Responsibility System appears to be working well in this work place. Attention should be given to the orders issued in this report." Order Issued {"the flammable material currently stored in open top 5 gallon pails (with no lids) in the Flammable Storage Cabinet shall be stored in properly sealed containers in accordance with section 27 of Regulation 692."

876513EAAV 07.07.87 Health complaints through physician POST LAM

"A letter of complaint received from the director, public health inspection, community health inspection division stating that some workers at Pebra had complained to Dr. Patrick Kilmartin that they had been suffering from headaches, dizziness etc., was discussed with the worker H&S representative. The company produces automotive side moldings. In this process, stainless steel has glue applied to it, then a stainless strip is passed through an induction heater which is ventilated. After strip goes on, then PVC sold strip is added, and the stainless steel strip and PVC strip pass through a press where marriage of the two pieces takes place. Each station where the glues are added has local exhaust ventilation. A request to have the occupational health branch complete testing in the injection area will be forwarded for testing, as soon as possible. "AUTHORS' COMMENT: Ventilation determined to be inadequate to capture dripping from glue dispenser.

876513EAAV 20.07.87 test results from previous report POST LAM

"Testing (chemicals?), indicated that fume levels in these areas would not be above the TWAEV of the chemicals used. At the molding machine where Pebra 5 used readings of 20ppm total combustibles obtained which indicate fume levels below the TWAEV of 50ppm.

PAINT LINE/SLEUSS WAY/SLUDGE ROOM

Letter on Pebra Inc. stationary 18.09.87 critical injury report OUTSIDE PAINT

"re: critical injury report addressed to Mr. Swindell (Inspector MOL): In compliance with section 25 of the Act, I hereby submit this report of a critical injury as defined by……..which occurred on these premises on Tuesday, September 14, 1987. Incident: This worker was beginning her second day in our employ and was assigned to do touch-up work to painted automotive parts. This involved wiping down the part with methyl ethyl ketone (MEK) to remove any excess paint and dirt. This operation was taking place in an open area of the plant but without mechanical ventilation. The resulting inhalation of fumes produced a state of unconsciousness. She was immediately removed to fresh air and again become conscious. She was then transported to St. Joseph's Hospital for medical evaluation. No other workers have experienced any adverse effects in this production area.

Yours truly, Lindsay Reiach, Safety and Environmental Engineer."

MOL report of telephone call 18.09.87 re: critical injury report OUTSIDE PAINT

Details of occurrence:

"1 worker passed out – exposure to MEK. Taken to hospital treated and was OK. Forget about Sect 25 Report."

Action taken: "WCB requested to prepare incident report and provide to Peterborough office including steps taken to prevent recurrence."

138473 13.10.87 hydrochloric acid spill/sewer smells OUTSIDE PAINT

"Concentrated hydrochloric acid is stored outside and when needed is pumped to a 60 gallon day tank at the de-ionizing area. The day tank is equipped with an automatic filling system and has a vent pipe that goes to roof level. On October 8th the lid of the day tank came off while hydrochloric acid was being pumped causing 5-10 gallons to be forced out of the day tank. Hydrochloric acid was also forced up the vent pipe to roof level.

“Prior to the acid spill, “sewer like smells” noted by operators in the Paint Assembly area but not reported. (The next morning) operators complained of not feeling well (dizziness, upset stomachs) in East side of Paint Assembly area. Seven operators went home. During the acid spill investigation and now that management was aware of concerns on “bad” sewer smell, it was established that 4 floor drains in the Paint Assembly area were “dry.” Water was added to these drains to ensure that any associated traps would be functional.”

Orders issued for 1) “sealing of drains in the paint assembly area or ensuring that each drain has a properly functioning trap and that water is present in such traps. “ 2). All pipe systems in the paint facility which contain hazardous materials shall have contents and direction of flow positively identified at valves, fittings, and where pipe passes through a wall or floor, or where circumstances make such contents and direction of flow doubtful. (Several other related orders issued as well).

Advice given: 1. All floor drains be checked to ensure they have properly working traps and that water is present. 2. Consideration should be given to installing local ventilation on all work tables where MEK and IPS used in Paint assembly. 3. Consideration should be given to workers using protective gloves when working with MEK and/or IPA, and in particular, where no local ventilation is present.”

871537NOVB 14.09.87 visit to assist with new H&S program PLANT WIDE

MOL Visit made at company’s request to assist with new H&S program.

“During this visit, a complaint due to possible exposure to solvent vapor at the marker-like pencil used was investigated. “

re: solvents tested vs TLV.

Dimethyl benzene 0-30ppm

Isopropyl alcohol - up to 300ppm (with two workers working it is expected that the concentration may exceed 400ppm the TWAEV).

Advice to management: 1. Respirators need not be worn if exposure to solvent vapors or dust is below the respective TWAEV. However, if worker asks for respirator a NIOSH-approved respirator should be offered and the worker should use it in accordance with manufacturer’s instructions. 2. <u>Where there is more frequent exposure to solvent vapors, portable fans or local exhaust should be considered.</u>

178534 26.10.87 cyclical inspection PLANT WIDE

Orders: (lack of regular JHSC mtgs) 2. For JHSC to meet on, or before, Nov. 15, 1987. 3. The need for formal emergency/evacuation plan with regard to fires and chemical leaks/spills. 4. Compliance with

WHMIS (labeling, MSDSs, training, history, right to know). 6." The internal responsibility system appears to be working fairly well in this work place, however attention should be given to the functioning of the safety committee and to the suggestions given in this report." (e.g., regular meetings, monthly inspections, co-chairs from management/union). AUTHORS' COMMENT: How could the IRS be working well, given these observations?

Advice given not orders: 1. NIOSH rated dust masks, rather than single strap masks should be used in Trim Dept. 2. Consideration of the use of eye protection when polishing/grinding, and use of local ventilation to remove dusts and fumes (from resin, putty, alcohol) 3. All chemicals, and hazardous materials, must be properly identified; containers of MEK not adequately labeled. 4. Manual "top up" of hoppers on Injection Molding Machines. Operators have to climb up onto machine to perform this task. Either permanent platforms with access ladders shall be provided as per section 20 of the Regulations or a portable platform shall be used when topping up, so that operator does not have to climb up onto machine (while carrying pellets).

Letter/Queens U. hygienist 26.10.87 chemical air test report PLANT WIDE

"Airborne levels of HDI and various solvent vapors (MEK, Butyl acetate, BA and Toluene) were determined in conjunction with paint mixing and spray operations. ISO levels were also determined….The available air sampling results (especially in conjunction with the plant's PPE policy) suggest that Pebra workers are not over-exposed to those agents sampled. AUTHORS' COMMENTS:

Contraindications to this conclusion are reflected in the following statements:

"a couple of the HDI samples did not correspond with immediate isocyanate use."

"In another case, production requirements limited the duration of spraying within the sampling interval."

"In view of the limited isocyanate sampling conducted (and e.g., not actually sampling the mixing operation) it would be prudent to repeat this, in conjunction with the assessment of the RIM process, in December."

OTHER/OUTSIDE STORAGE

138213 22.12.87 environmental spill OUTSIDE STORAGE TANK

150 gallons of waste paint/solvents leaked onto ground from lead-in pipe. MOE/fire dept. called and tank was pumped out. (clean-up process is described in detail). Inside of building determined as "safe."

Action to be taken and orders issued: "Some unanswered questions came up regarding the structure of the 5000 gallon storage tank and its suitability for use with flammable liquid. Orders issued for filing of drawing layout and specifications of the tank. 45 gallon drums will be used to store waste until such time as tank storage is resolved."

1988

87L537NOZV 14.01.88 HSSSB Consultant Report PLANT WIDE

Visit at request of the company to assist the new nurse with occupational health program at plant.

Important part of nurse's role in medical surveillance will be to reinforce the workers' knowledge about the substances (isocyanates, PVCs, etc.) with which they are working.

Responsibilities: personal exposure records to be completed; responsibility to report possible industrial illnesses; keeping of records for employees under surveillance.

230114 15.09.88 Review of Isocyanates/chemicals PLANT WIDE

Complete tour of the plant was made ... during a Code 10 inspection (230105 14.09.88) Major areas of concern were related to the use of isocyanate in the Paint Dept and Rim Dept. MOL will initiate additional Air Testing in both the Paint Dept and the RIM.

CONSULTANT REPORT 06/14/15/.88 hygiene survey/plant emission audit PLANT WIDE

(Queens U) Hygiene survey included sampling for airborne contaminants (solvents, Iso, metals, total suspended particles, respirable particulate and nicotine) air quality "comfort" parameters and preliminary study of heat stress and noise evaluation.

Findings and Confounders

"The available air monitoring results show no overexposure to airborne contaminants" although the following confounder was noted:

- **"A skin notation for a substance indicates that absorption through the skin can significantly contribute to a person's overall exposure to that substance. Exposure by skin contact is not detected by air monitoring."**

"Symptoms of headache and nausea have been associated, by some employees, with working at the end of paint tunnel or the final assembly/touch up painting tables. Sampling for the primary solvent components of the primer, basecoats, and clear coat was conducted at the end of paint line. Airborne concentrations of butanols, n-butyl acetate, isopropanol, MEK, methyl isobutyl ketone and xylenes.

Airborne concentrations in the breathing zone of paint line inspection personnel were low or not detected**.**

At the final assembly and touch up painting tables, MEK and isopropyl alcohol are used to clean and finish painted parts. Small amounts of basecoat are used for touch up painting; Two of the three tables in this area have downdraft exhaust ventilation. Workers indicated that the most objectionable solvent odors generally occurred at the non-exhausted table."

- **"However at the time of sampling, "less than normal activity" occurred at this table. On two subsequent visits the non-exhausted table was not in use."**
- **"It is conceivable that heavy use of isopropyl alcohol and MEK at the non-exhausted table could result in airborne mixture levels capable of causing the expressed symptoms of headache and nausea. Isopropyl alcohol may cause irritation and symptoms of headache and drowsiness in a small percentage of susceptible workers at levels below 400ppm** (what about the MEK?). **However there are no reported long-term health effects associated with low level exposure to isopropyl alcohol** (what about MEK?)."
- Recommendation: **"Follow-up sampling to determine "worst-case" (i.e., warm day/heavy solvent use) airborne mixture levels of isopropyl alcohol, MEK and n-butyl acetate at the final assembly/touch up tables is warranted."**

Re Testing of Inside Painters: "Due to inherent difficulties of the isocyanate sampling methods, respirator effectiveness was determined by measuring solvent levels outside and inside the supplied, air respirator suits during a two hour period of clear coat spray painting. Protective factors, determined as the ratio of outside to inside solvent levels for the primary solvent component (HDI), were greater than 265 and 315."

- **"The "inside" solvent level** (undetectable) **determined for (names worker) may not be reliable as the sampler tubing disconnected from the pump at some time during the sampled period (14.06.88). However an inside suit solvent level for this painter was determined on (04.05.88) to also be below the analytical detection limit." Solvent vapor was detected inside the suit of one painter on 04.05.88. This exposure may have occurred before the hood was in place and while the other painter tested his spray gun with several short "blasts."**

"Smoke tube testing of the three paint booths on 14.06.88 demonstrated that while the primer booth was under a slight negative pressure, **the basecoat and clear coat booths were under positive pressure. Therefore airborne contaminants are likely to leak into surrounding areas where workers are unprotected.** This is a particular concern when the contamination may include isocyanate.

"Air sampling for HDI was conducted outside the clear coat booth (adjacent to the west door.

- **However an unpredicted shutdown of the paint line prevented the collection of a representative long term sample. During the 24 minutes sample period, only 12 minutes of clear coat spray painting occurred. "**

RE: total suspended particulates: "Raw materials for the RIM process include polyol, isocyanates and fibreglass. These materials are simultaneously injected into hot, sealed molds where an immediate curing process occurs. The end product is a solid, homogenous blend of polyurethane and fibreglass. **There are no specific toxic effects, associated with polyurethane dust. Therefore it may be reasonably classified as a nuisance particulate**. The time weighted average exposure limit for nuisance particulate is 10mg/m3. **This limit was designed to minimize uncomfortable deposits in the eyes, nose, and ears, to prevent chemical or physical injury of skin and mucous membranes, and to ensure adequate visibility in the workplace.** The effects of short term exposure to fibreglass are similar to those of nuisance dust. Numerous studies have provided evidence of no adverse long-term health effects associated with inhalation of fibrous glass. However, the results of some studies are weakly suggestive of a carcinogenic risk associated with such long-term exposures. **Nevertheless, based on the existing evidence, authorities such as the American Conference of Governmental Industrial Hygienists and the Ontario MOL still cite a limit of 10mg/m3 (consistent with the limit for nuisance particulate).**

Palm sanding of (the products of the above injection process) occurs at tables adjacent to the RIM presses, at the pre-cure table, and in the Sand & trim rework area. Workers may or may not wear disposable dust respirators while sanding. Personal air sampling was conducted on two separate occasions to evaluate worker exposures to TSP. Assuming that these employees sand and trim for seven hours of a workday, their actual time-weighted average exposures would have been 7/8 times the measured values….**These levels are close enough to the TWAEV to warrant some investigation of exposure control options (i.e., an "action level" of half the TWAEV is a generally accepted guideline.** The dust respirators currently **available in the plant should provide an adequate level of protection to those employees who <u>choose to wear them.</u>" There is also evidence that employees working in the vicinity of palm sanders are not exposed to high dust levels (what is that?). Nonetheless, the preferred methods for reducing the exposure of workers to any substance are engineering controls. It is therefore recommended that Pebra consider the purchase of collector equipment for the sanders. (AUTHORS' COMMENTS: Note that dust contained urethane and other chemical residues including fibre glass. The MOL was advised by the assessing physician that these workers were experiencing obstructive lung conditions. Dust was also shown to have been deposited on workers, floors and work surfaces.)**

RE: Air quality "comfort" parameters. Monitoring of air quality "comfort" parameters (temperature, relative humidity, carbon dioxide etc.) can be helpful in further qualifying the indoor environment. Temperature and humidity results fell within the ASHRAE comfort standard 55-81 (large range?). CO2 levels throughout the Pebra plant ranged between 500 and 600ppm. An ideal "maximum" level of 600ppm has been recommended for office buildings by the MOL. (Is this appropriate in active plant environment?). **The total suspended particulate ranging from 0.13 to 0.91 would be excessive in**

an office environment but is considered "positive" for an industrial establishment. The highest were detected in the RIM and Sand and Trim areas where palm sanding occurs.

RE: Heat Stress: "Worker complaints about the "heat" in the Paint Facility prompted a preliminary heat stress evaluation of this area. The WBGT (Wet Bulb Globe Temperature) measured outside the clear coat booth was 27.2C. This index would marginally exceed the TLV of 26.7 for continuous work of moderate workload. However, it would be permissible for light continuous work (TLV=30C). According to Pebra personnel, the paint booths are temperature and humidity controlled at about 80F and 40-45% RH…(Painters) Standing, one arm work…would likely be classified as light work. Therefore the permissible WBGT index for a spray painter dressed in work clothes would be 30C. Clearly the thermal environment within a hooded, supplied air respirator-paint suit ("space suit") is different from that of the clear coat booth alone. However, the WIBGET device cannot quantify heat stress within such a suit. Judging from the observed redness of skin and degree of perspiration, the painters likely experience considerable thermal stress while clear coat spray painting (what about other paint booths?)."

RE: Noise evaluation: "At Pebra, noise levels in excess of 90 dBa were detected in numerous areas, usually associated with specific intermittent operations. These areas include: roll forming (blow off), Post Laminate (cut off) saws and air gun, Sand & Trim (palm sanders), RIM (palm sanders) and the boiler room. (By stander exposures of operators in Roll Form and Post Lam experienced noise levels of 85dBA or greater). Palm sander operators in RIM: exposures to levels averaging between 84-91dBA. The RIIM operator also experienced average level of 85 dBA. It is therefore recommended that palm sander operators, RIM operators, spray painters, Roll formers, and Post Lam personnel (at least west of Arborg Station 6) wear hearing protective devices."

RECOMMENDATIONS: 1. Follow-up air monitoring in the final assembly – touch up painting area on a "worst-case" day is warranted. 2. Periodic evaluations of Iso levels/controls. 3. Dust control options for palm sanders should be considered. 4. Hearing protective devices and a hearing conservation program are recommended at numerous locations.

Exhaust Air Contaminant Audit

"Contaminant concentrations in airstreams discharged from the plant were determined by standard occupational hygiene methods… Typically duplicate samples were collected simultaneously from two different regions of the discharge airstream, and on more than one occasion, although not all samples were analyzed. It must be understood that this air sampling was not conducted in a rigorous manner, and that in many respects it would not meet specific statutory requirements (i.e., MOE testing code). However the intent of this exercise was not to demonstrate strict statutory compliance, but rather by means of an internal audit to determine the relative degree of containment emission. There had been no previous empirical evaluation of emission levels. The results are a good indication of gaseous-phase contaminant (i.e., Iso and solvent vapor) concentration at the time of the sampling although they may not show a truly representative sampling in the case of aerosol (mist) emissions. **Of course with an evaluation such as this, there may be expected to occur a number of mismatches between the requirements for optimal sampling conditions (e.g., Wind direction in the case of re-entrainment assessment) and production scheduling/difficulties). As noted in the results tables, the paint line had stopped running by 1430 hours on the first sampling day whereas 1515 hrs would be "typical" There were no more parts available to be painted the next morning when the paint kitchen was to be monitored. On the second sample day, the Rim department reportedly went to coffee just around the time that the MDI sampling was initiated, whereas information had been that their break should occur at (a different time). On this same day, there was a "gap" in the paint line with respect to parts arriving at the primer booth, around the same time that rooftop HDI sampling was initiated. Therefore 8 minutes of the 38 minute HDI sampling period did not correspond to an interval with expected emissions. Similarly, there would have been "gaps" in the operation of downstream booths… It is notable that those samples collected… (some 30-60 minutes after the paint line had reportedly stopped) were still showing significant Butyl Acetate content (and in fact, because of persisting strong solvent odor at roof-top, it had been assumed that the paint lines were still operating). Clearly solvent vapor concentrations are higher while the paint line is operating, with Butyl Acetate concentrations ranging from 64-413mg/m3. This solvent is not currently regulated under MOE Reg 308 but its proposed "ambient Air Standard" in the Nov. 1987 CAP discussion paper is only 0.6 mg/m3 (one hour average). … If all stacks were emitting an equivalent level, concentration would be approximately 10 times the proposed limit. …and the solvent concentrations at the make-up air intakes on the paint line would be even greater than this, under the appropriate meteorological conditions. Typically, the MOE does not consider industrial makeup air intakes located on the source building (leaving this to the Ministry of Labour). Although this sampling should be considered of a tentative nature (for the various reasons outlined) it has not shown any non-compliance with current emission limits – <u>provided the MOE did not choose to regard the makeup air intakes.</u>**

RIM

Consultant Report 25.02.88 MDI Air Sampling RIM

Air sampling for MDI was conducted by both MOL, CODE Methods ("Marcal" and "Nitro") in the Reinforced-Reactive Injection Molding Process during the production of bottom door panels. Polyol and Isocyanates (at 120F) are injected into the sealed mold (which is at a temperature of 140F). The part sits in the mold for approximately half a minute before it is removed. Sampling trains were suspended from the spot-lamps on either side of the mold and in front of the exhaust hoods which come on in conjunction with the activation of the "mold release" sprayer. Under these conditions no airborne MDI was detectable at the left hand exhaust or the right hand exhaust. **Although MDI is less volatile than many other isocyanates, the elevated mold temperature does create a potential of overexposure, if the exhaust ventilation were ineffective. A saturation vapor concentration of approximately 0.4 ppm has been reported at 140F (AIHAJ 47(4): 227**

88E762EDAV 17.05.88 Inspector requests review of Mold Release RIM

Officer requests review of Battenfeld Clamp Reaction Injection Molding Area where HDI and alcohol based Mold Release are used. Company has done some air testing but results not yet received. MSDS for materials are available. Review of updated assessment/control program for RIM area would be useful.

88I778 03.10.88 ("Priority Order" re: critical injury ISO exposure) RIM

MOL report has "Priority" typed on front and following note: "due to "high Profile" CAW concerns, officer requests Medical Consultant visit to review following:

1. Attached form 7 re: potential Isocyanate exposure claim;

2. Review of medical aspects of Iso Control program,

3. Review of role of "Co-ordinating Physician" and "Choice of Doctor" under Iso regs.

Incident report: An investigation was carried out regarding the accident of (name). The accident occurred on Oct 3, 1988 at about 5:00pm at the automatic glue spray booth. (Name) had just been stirring the Glue Pot (5 gallon pail) alongside the automatic glue spray booth shen she was overcome by the fumes and passed out. The glue pot contains a mixture of toluene, acetone, methyl ethyl ketone, ethyl acetate and cyclohexanone. The blue mixture is prepared in the paint mix room, however the glue holding pot located at the automatic glue spray booth is mixed from time to time and is diluted with methyl ethyl ketone from time to time.

Advice given to employer:

1. The posted procedure in the glue spray area should be updated and should reflect the intent of the orders issued in this report.

2. The glue pot lid should be produced so that it more adequately prevents the spread of fumes from the glue pot.

3. Consideration should be given to installing local ventilation where the glue pot is located in order that needed adjustments and dilution could be made to the glue at that location.

Pebra representative assessment of incident:

"As there were no direct witnesses to this incident, comments have led me to conclude:

1. During operation of this machinery, the glue spray became inconsistent and stringy;

2. (Worker) attempted to rectify the situation by manually stirring the glue pot; this required her to remove the lid;

3. During the process of removing the lid and stirring the glue, she was overcome by the fumes and was unable to reach fresh air or assistance before falling unconscious to the floor.

Although the spray booth mechanical ventilation system was operating and several windows were also open in the area, they did not prevent (worker) from being overcome by the fumes.

Ministry of Labour Report #244546, Order #0225EIR 02604 has initiated procedural changes which will eliminate any possibility of a reoccurrence in the future."

PAINT LINE/SLUICE WAY/SLUDGE ROOM

210589 07.06.88 Solvents in Sludge Room

HSSSB Consultant report 87L524AOBV related to solvent vapors in the sludge room was reviewed and explained. A copy of the report shall be posted in the work place. No orders were required as all testing showed that levels were below the respective TWAEV.

Occ Hygiene Service 03.06.88 Air sampling of Solvents SLUDGE ROOM

Air Sampling was done to measure solvent levels in Sludge Room. In all cases the measured concentrations of airborne solvent vapor were below TWAEVs (MEK, toluene, Methyl isobutyl ketone, and n-butyl acetate). The sludge room is currently operating on a batch water treatment schedule until full production levels are achieved. **While worker exposures in excess of the solvent TWAEVs will not occur under existing conditions, this could change if the production levels of the paint line should increase. It may be desirable to increase the ventilation in this area of the plant at some future date if the production levels increase**. (AUTORS' COMMENTS: Testing carried out under restrictive and unrepresentative conditions).

87L537NOZV 14.01.88 HSSSB Consultant Report PLANT WIDE

Visit at request of the company to assist the new nurse with occ health program at Pebra. Important part of nurse's role in medical surveillance will be to reinforce the workers' knowledge about the substances (isocyanates, PVCs etc.) with which they are working. Responsibilities: personal exposure records to be completed; responsibility to report possible industrial illnesses; keeping of records for employees under surveillance. Tasks: Administration of Iso Surveillance Program; Record keeping of health visits; Administering of First Aid; Anti smoking program; standing orders and medical directives (of Plant Physician); Hearing Conservation Program.

Consultant Report 25.02.88 MDI Air Sampling RIM

Air sampling for MDI was conducted by both MOL, CODE Methods ("Marcal" and "Nitro") in the Reinforced-Reactive Injection Molding Process during the production of bottom door panels. Polyol and Isocyantes (at 120F) are injected into the sealed mold (which is at a temperature of 140F. The part sits in the mold for approximately half a minute before it is removed. Sampling trains were suspended from the spot-lamps on either side of the mold and in front of the exhaust hoods which come on in conjunction with the activation of the "mold release" sprayer. Under these conditions no airborne MDI was detectable at the left hand exhaust or the right hand exhaust. **Although MDI is less volatile than many other isocyanates, the elevated mold temperature does create a potential of overexposure, if the exhaust ventilation were ineffective. A saturation vapor concentration of approximately 0.4 ppm has been reported at 140F (AIHAJ 47(4): 227**

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Officer requests review of Battenfeld Clamp Reaction Injection Molding Area where HDI and alcohol based Mold Release used. Company has done some air testing but results not yet received. MSDS for materials are available. Review of updated assessment/control program for RIM area would be useful

210589 07.06.88 Solvents in Sludge Room PAINT

Health and Safety Special Services Branch (HSSSB) Consultant report 87L524AOBV related to solvent vapors in the sludge room was reviewed and explained. A copy of the report shall be posted in the work place. No orders were required as all testing showed that levels were below the respective TWAEV.

MOL Hyg.R 31/10/88 hygiene assessment over worker complaints POST LAM

A hygiene assessment carried out by Hygienist, Kim Gordon: Post Lam, Paint line, RIM. Findings: Post Lam hot gluing operation inadequate exhaust ventilation; RIM molding operation inadequate exhaust ventilation and isocyanate control program had limited worker coverage; RIM: need immediate attention to ISO leaks: Inside Paint Line found to be blowing paint and solvent vapors into the general work area; hearing conservation program needed; sludge room a confined space not addressed.

244814 30/11/88 Assessment of the Pebra's isocyanate control RIM

The MOL's assessment of the isocyanate control program resulted in orders for the company to provide continuous ventilation during the entire RIM molding process and to include all RIM personnel in the control program. Up to this point, only the mold release spraying process was ventilated and only the molders were included in the process. The ministry noted that there was high probability of vapors during the mold cycle, during part extraction and handling, during spills and leaks as well as sanding and trimming parts that were just 30 to 60 seconds out of the mold and dust that likely contained isocyanates. It was also necessary to train the workers on the hazard and safe handling of isocyanates and provide medical surveillance. It should be noted also that both MSDS and ISO control program material indicates the following physical symptoms indicating over exposure: burning sensation nose, throat, lungs, dry sore throat, wheezing, chest tightness, coughing, reduced lung function, lung irritation. Many of these have been experienced by workers during various incidents and some resulted in hospitalization. In addition to the isocyanate issue it was found that the paint spraying operation was blowing fumes to the general work area, that the confined space entry regulations were not being complied with in the sludge room and leaks were found in the RIM molding hoses.

1989

89A895EAAV23/01/89 Work refusal investigation fibreglass exposure RIM
Worker who shovels fibreglass into a hopper to be mixed with resin twice per day refused to perform this work because he felt fibreglass presented a danger to his health. Even though the hygienist observed the dustiness of this task because the material had to be aggressively disturbed with a pitch fork, the hygienist concluded that "…worker exposure to the fibreglass will not exceed the TWAEV and that the upgraded skin protection is adequate." No measurements were taken and the fibre glass is considered a nuisance dust with a TLV of 10 mg/m3.

244909 30/01/89 investigate union complaint on WHMIS training Plant-wide
Employer refused to consult with workers/union on WHMIS training despite OHSA requirements. MOL advised employer of duty under the act as it was on 14/09/88 report # 230105 about its legal requirement to consult the JHSC.

88E762EOAV10/01/89 Report on ISO measurements to the WCB RIM
WCB request for information regarding a claimants occupational exposure to isocyanates that is claimed to be cause of his illness. Dr. Genesove transmits previous measurement indicating levels of MDI and HDI were below the limit of detection for the analytical methods employed in RIM and Paint Line respectively. Maintain level at lowest practical levels. Other reports are referenced.

244907 12/04/89 Work refusal investigation toluene fumes PAINT-LINE
Workers refused to install a stairway in the inside paint line due to presence of toluene vapors found previously on 10/04/89 that might present a fire and explosion hazard. Fan turned off in the sludge room caused the migration of toluene into the main plant. Four workers were sent home. A combination of factors noted: make up air unit turned off; blower in another area changed air flow in plant from positive to negative, and water levels in sludge room were too high.

89D888EAAV 15/05/89 Investigate of work refusals in the Post Lam POST LAM
An investigation of 44 work refusals in the post lam area due to chemical exposures causing adverse symptoms: headaches, dizziness, eyes, nose and throat irritation and nausea. Hygienist findings include: inadequate exhaust ventilation in the hot glue area of roll form; internal paint line vapors blowing into the general work area; RIM isocyanate control program deficient with respect to coverage of all workers exposed and inadequate ventilation; and failure to comply with confined space entry regulations and eye wash requirements in the sludge room. See also report #288596 reprisal investigation against the refusing workers.

250328 12/10/89 Cyclical inspection: 38 order issued PLANT WIDE
reviewed Isocyanate control program training; availability of MSDSs; WHMIS training; confined space entry; isocyanate leak/spill; paint kitchen respirators; sludge room; WHMIS labelling; compressed case; and several other issues addressed with orders.

293223 03/11/89 Respirator use on the FN-36 (Ford) Pebra 5 POST LAM
Previous work refusal (286154 13/09/89) prompted order for respirators use until air monitoring. Consultation with union and management about restricted use of Pebra 5; and, advice from hygienist that levels don't require respirators.

89I865EAAV 10/11/89 work refusal FN-36 MEK, toluene, ethanol POST LAM
Hygiene report see full treatment below. 2 workers on the fn-36 line complain of solvent levels and intoxication. The glue applicator is vented but the freshly glued parts are stacked on carts without ventilation.

286154 13/09/89 work refusal over glue application-strong fumes POST LAM
Adverse health effects experienced by refusing worker. 5 USG pails of glue (A1104B) were around the glue applicator machine and not appropriately labeled. Glue diluted with MEK and toluene. Applicator was vented but face velocity was 200 fpm. The 5 USG pails used as dipping tanks to clean glue station head. Pails did not have appropriate ventilation and not labeled with no MSDS. Testing noted with following results: MEK=50 ppm; toluene=25 ppm; alcohol=not detected. Inspector: "not likely to endanger." But writes orders that the dipping pails be located in area with adequate ventilation, bonding be properly labeled, and respirators worn.

292916 03/10/89 Hygiene report re: the glue line 286154 refusal POST LAM
Hygiene sampling report (89I865EAAV/10/11/89) indicates: MEK=50 ppm; toluene=25 ppm; ethanol=<10ppm. Hygienist indicates that these levels may not be representative of a full shift

exposure given the brief (10-15 minutes) operating time of the line. Notes also that 5 USG pail of MEK will have made a significant contribution to the solvent concentrations. Hygienist indicates that it is advisable that control measures be implemented to limit solvent exposures on the FN-36 line. (AUTHORS' COMMENTS: It is important to note that as a rule of thumb a concentration of ¼ of the TLV should be taken as a significant exposure. Hygienist recommends the installation of a heated flash-off tunnel with local exhaust ventilation to control vapor concentrations and emissions. Also recommends installing a drip tray under the applicator to contain and prevent accumulation of glue drips and spills that would vaporize and release into the atmosphere. The line uses 15 USG of diluted glue per 8 hour shift. The line runs 24 hours a day 5 days a week. One worker feeds metal strips into the glue applicator and a second stacks the glued strips. A vinyl strip is then bonded to the metal.

89L895N0BR 30/11/89 work refusal investigation use of Pebra 5, MSDS POST LAM
Work refusal over fumes from and no training in handling Pebra 5 and conflicting MSDS information and additional concerns about toxic effects of tetrahydrofuran/perchloroethylene. Hygienist states that exposures to ingredients are negligible. And describes possible exposures when filling the felt tip applicator or replacing the felt pad as possible exposure risks. No discussion of toxicity or concern about chronic/prolonged low level exposures given the toxicity of these chemicals and the possibility that Pebra 5 contains cadmium. Pen holds 15 ml of Pebra 5. Air concentration: tetrahydrofuran 5 ppm; perchloroethylene 2 ppm.

1990

060290V3 19/01/90 work refusal 37 workers after fire FN-36
After a fire occurred on molding machine #6 in the FN-36 line, 37 workers refused to return to work because they were not trained on what proper procedures to carry out to ensure their safety in the event of a fire. Inspector issued order for employer to train workers in the plant fire plan and what precautions to take. Inspector noted that workers had not been given instruction and training on the fire plan.

P90-01-70 22/01/90 paint fumes coming out of tunnel. 2 fires noted PAINT LINE
Inspector request review of air system and references two fires in the paint tunnel at the paint gun.

288460 22/01/90 MOL follow up visit re: ventilation/iso exposures PAINT LINE
MOL inspector notes previous orders not complied with: WHMIS training not completed; paint fumes from paint line still a problem and no action taken to date. Management suggest workers just move out of the way of the fumes which inspector rejects as a solution not in accord with regulation 132.

Other issues noted: JHSC still not doing specific hazard analysis; iso units in tank farm still leaking; cartridge respirators in paint kitchen still not stored separately and still absorbing solvents; sludge room still not provided with life lines and belts; no whmis labels in compressor room; no formal written operating procedures in the sludge room; improper respirators used in sand and trim; still no adequate policies and procedures manual (suggest "WCB Workwell Program; failed to get pre-medicals for iso workers. Failure to conduct a first stage work refusal investigation in accord with Sec. 23 of the Act. Orders issued a second time on this visit. Fires in the paint booth due to electrostatic discharge during use of paint spray gun.

288454 02/02/90 hydraulic fluid/iso leaks at the day tank RIM
Hydraulic fluid (MESAMOLL) from Clamp pistons leaking deemed "not hazardous"; two drip trays below day tanks not cleaned and order issued; iso pumping units are leaking iso and still not fixed; iso evacuation procedures and training as per "control program" still not carried out—orders issued.

SWINDELLS 08/02/90 MOL inspector re: ISO control program PAINT LINE
MOL observes worker entering spray booth without respirators immediately after iso paint spraying; no iso control program training for painters; worker observed entering iso booth with respirator not strapped and fitted properly—orders issued.

293241 14/03/90 MOL ISO control program re-assessed RIM/PAINT
MOL initiated an audit of the ISO control program found deficient on worker coverage under the program. The Grey Putty operator was not formally written into the program and had not been advised that the Grey Putty contained HDI. The product also called "Porenwischfuller 3311" is diluted with clear coat hardener (AP19513), and diacetate alcohol. The control program was found deficient in providing documentation on engineering controls, and air monitoring frequency, and has not adequately identified workers who must be covered by the program and has not adequately developed a proper medical surveillance program and reporting procedure for occupational illness. (See also Hygiene assessment 90A856EOBR).

250328 14/03/90 WHMIS training not completed. PLANT WIDE WHMIS had not yet been completed since ordered in November 1989. Other reports noted 309782, 293237, 288460, 250328

288440 29/03/90 workers develop sensitization from isocyanate SAND/TRIM

288434 11/04/90 ISO sensitization claim wcb PAINT LINE
MOL request medical consultant review. Also, noted problems with the ISO control program and problems with skin exposure and respirator use and training.

288335 25/04/90 Electro static discharge causing fires in paint PAINT LINE
MOL notes the need to balance the ventilation system, and employer has addressed the problem of electrostatic discharge causing fires by replacing appropriate electrical insulation.

90D854EAAV 05/08/90 assessment of solvent/HDI exposures PAINT LINE
Worker exposure to isocyanate (HDI) and MEK possible when loading paint kettles, repairing and flushing system, during malfunctions and manual spraying. Orders issued for skin protection and respiratory protection. Worker observed cleaning equipment parts with MEK without a respirator and no ventilation. Working above the pail of MEK is unpredictable and may cause exposure in excess of TLV. Clean should be carried out in a properly vented area.

288316 09/05/90 work refusal investigation 10 workers FN-36 glue POST LAM
Workers complained of feeling sick from fumes in the FN-36 line-glue line area and heat press area. Butyl acetate, MEK and toluene and ethyl acetate in two glues used. There was a spill of 3 to 4 USG of A1104 glue at the north door of the paint kitchen. Tests showed ethyl acetate at between 25 and 50 ppm, ethyl acetate at <10 ppm and toluene at <50 ppm. Inspector noted to keep fresh glued parts in the flash area for 30 minutes and drip trays for the gluing machine to be cleaned daily. Floors with excess glue should be cleaned daily, keep door to paint kitchen closed. Previously the ventilation was judged to be ineffective. Also report indicates a series of allegations of violations of the act as well as subversion of the IRS.

90E873EABR 25/06/90 MOL assessment of sanding tables ventilation TOUCH UP
MOL hygienist conducted air flow and air monitoring tests for the 12 sanding tables used to smooth out imperfections on RIM molded polyurethane pre-painted parts. Inspector found that exhaust grills on the table are blocked and dust exposure is apparent. The face velocity measurements indicate that exhaust is less than the minimum required to capture the dust generated from sanding. The felt pads on the grill clog with dust and restrict air flow and capture efficiency, and possible that exhaust filters are clogged. Recommend not to use felt pads. Preventive maintenance schedule (PMS) were not available.

90G872MOWY 06/09/90 investigation of worker health problems SLUDGE ROOM
The Workers Compensation Board request the MOL investigate a worker’s illness caused by exposure

to solvent vapors in the FN-36 area when sludge room exhaust fan was not operating. This fan which is associated with the cooling equipment also provides a negative air pressure environment that prevents chemical vapors from solvents and paints from migrating to the general work area including the FN-36 area (Ford Line). It was noted in the investigative report that the fan was not operating and vapors were migrating during this time. The report also note that the water carrying paint overspray and solvents is treated with detack and flocculant. Normally the air flow is from the general production area of the plant into the sludge room, except when the exhaust fan is not connected. Then the air and contaminants from the sludge room will flow to the production areas. (see also MOL Report #s: 90F866MAAAV-C; 87J535EAA; 87L524AOBV/87J535EAA). AUTHORS' COMMENTS: This has been an ongoing problem that has led to many episodes of adverse health effects, complaints, work refusals and MOL investigations. Citing previous solvent exposure measurements in both the FN-36 area and the sludge room, the hygienist concludes: "Solvent vapor, while present, are at levels such that worker exposure will not exceed exposure limits."

288184 13/12/90 work refusal investigation slippery floors PAINT BOOTH
Worker refused after slipping and falling in the paint booth because of slippery grates in the paint booth. In violation of the Act, another worker was assigned to the booth without being advised of the work refusal. Solvents used to clean the grates coated with paint and grease.

288424 22/05/90 investigation ISO leak from day tank RIM
MDI was atomized from a breach in the gasket while still under pressure. The operator was trying to contain leak by applying pressure. Operator was not wearing any protective equipment and regular overalls. Alarm sounded from the monitor and recorded 42 ppb of MDI. Workers were evacuated from the RIM. Order issued to provide appropriate training and PPE when performing any tests on the equipment as part of control program.

288338 15/05/90 inspection to address handling MEK PAINT/SLUDGE ROOM
Inspector orders addressing the use of dip tanks with MEK to clean equipment in paint line and storage, and use of 45 USG of MEK in the sludge room. Orders issued for adequate ventilation, and bonding, to control risk of fire and explosion.

90E859MAAV 14/05/90 obstructive lung disease SAND/TRIM
Inspector advised by company doctor that a considerable number of workers in sand and trim have obstructive airways as indicated in pulmonary testing. Likely due to dust exposure from sanding polyurethane painted parts. Respiratory protection ordered.

325-71-2 03/05/90 investigation of worker complaints PLANT WIDE
Investigation of complaints from union: outdated MSDSs, missing labels, wrong labels, employer not cooperating with JHSC; failure to maintain minutes, not consultation on testing.

90E865EAAV 11/05/90 investigation of 12 work refusals glue/solvent FN-36
Investigation of 12 workers refusing to work on the FN=36 glue line. Two workers sent to hospital. This work refusal is similar to several others on this line.

90D855maav 23/05/90 investigation re worker sensitized to iso PAINT
MOL advised that worker in paint line has been sensitized to isocyanate. Noted, that safe practices and procedures not strictly followed, as required by Iso control program.

288314 17/05/90 inspection finds high CO levels SAND/TRIM
Fork lift truck tested and areas found to have high levels of CO: sand and trim=35 ppm; north shipping= 70 ppm; shipping clerk desk= 5-10 ppm. Also filters in sand and trim regular maintenance required.

90E865EAAV 18/05/90 work refusal investigation glue A-1104B FN-36 POST LAM
Hygiene assessment adverse effects from exposure to glue spill of 3 to 4 USG of A-1104-B located 15' west of the glue line area on May 10, 1990. On May 11, 10 workers refused to work because of vapors that caused adverse physical effects. Consultant notes several previous work refusals for the same reasons. See previous investigations in response to these earlier refusals. Note also that previous reports indicate hygienist recommendations to enhance ventilation and create ventilated flash off area to reduce exposure. Chemicals of concern: MEK, toluene, ethyl acetate, isopropyl alcohol, butyl alcohol. Ethyl acetate levels at 25-50 ppm. Noted also was the drips and accumulation of glue on the table and floor underneath the gluing machine. Need for PM to address leaks and drips noted.

288421 30/05/90 hygiene re: PVC/polyethylene/cyclic amide/MDI INJECTION MOLD
Hygiene visit (90E865EAAV JUNE 19, 1990) over adverse health effects from purging in injection molding using PVC, polyethylene, cyclic amide. Strong fumes and smoke during purging and use of mold cleaner 201B; also thermal decomposition by-products. Molding machines not vented. Also discussion regarding the high level of MOL interventions regarding repeated work refusals on the FN-36 gluing line and workers hospitalized on many occasions. MSDS used in this investigation only had an incomplete document for 201B and no ingredients listed and no MSDS for cyclic amide.

351617 15/06/90 work refusal investigation/glue/solvent FN-36/POST LAM
Work refusal/WCB request for MOL medical consultant re: worker health problems from exposure to solvents and glue in the FN-36 area applying glue. See previous reports identifying major and minor ingredients 90E865EAAV; 90C900MOWV-C.

288315 16/05/90 MOL ordered drawings of paint line extension PAINT LINE

250328 20/06/90 orders issued for WHMIS training see Report # 288263 orders also issued re: MEK/dip tank to clean parts. Training is required on PPE.

228249 20/06/90 investigation several work refusals FN-36/PAINT/RIM
Workers experiencing health problems on the FN-36 glue line. Fumes from the paint kitchen and sluiceway, no log for changes in chemical concentrations in gluing operation, high levels of fumes and smoke during purging of the injection molding machines-Arbourgs and Engels, MSDSs for resin pellets, use of 201-B in RIM, cleaning of spray painters' hood.

288244 15/06/90 Ventilation evaluation ordered/fires in paint PAINT LINE
MOL orders an engineering evaluation of the plant's ventilation system in order to correct the current imbalance between replacement air and exhaust air, which causes a negative pressure environment and the migration of toxic chemicals from other departments to enter the general work area. It was also noted that illegal modification made to the paint spraying system was a cause of several fires in the paint line due to electrical static discharge sparks that ignited the paints/solvents. Ordered to correct and not make changes without consulting the manufacturer of the paint system.

90E859MAAV-C 03/07/90 mol medical consultant re: adv. health/dust SAND/TRIM
Medical consultant assesses workers medical symptom from dust (polyurethane/paint)including difficulty breathing, fatigue, dirt of varying colour in their nose, itchy eyes and dry skin. "Several workers describe symptoms consistent with exposure to a dust." Workers are sanding parts consisting of polyurethane with chopped fibre glass and painted with primer, base paint and clear coat. Two workers were found by the medical department to have breathing problems related to the dust in the area. (occurred prior to them being ordered included in the isocyanate control program.) Use of respirators ordered in response to workers complaints about insufficient exhaust ventilation on the tables. Reported by doctor: "These medical symptoms are consistent with exposure to a fine airborne dust which was apparent, in spite of the exhaust ventilation." But he still concludes that the dust levels are below the TLV. A follow up letter from the doctor dated 22/06/90 expresses a very

contradictory view on the use of respirators e.g. respirators may have stabilized the symptoms, but no need to continue using these. The other issue identified was re: the exhaust from the fork lift

90F866MAAV-C 03/07/90 hygiene assessment glue A-1104B/A-1610B FN-36
Work refusal of 5 workers experiencing nausea, dizziness, sore throat, head ache, burning eyes, fatigue, difficulty breathing and heart palpitations. These workers were hospitalized. Similar health effects on the FN-36 line were previously assessed: 09/89; 11/89. Hygienist suggest that sources of these symptoms is from the solvents coming from the glue, the thinners, the paint kitchen, the sludge room, sluiceway, poor work practices in the paint kitchen and inadequate ventilation. The following chemical breakdown is noted from MSDSs: MEK, toluene, ethanol, butyl alcohol, phenol, isopropyl alcohol, propylene oxide and ethyl acetate. The FN-36 runs 6 days per week, 46 hours per week and three shifts per day. A glue line heat press is in operation where various lengths of steel are coated with a thin strip of glue, which is put in a heat press where a plastic strip is laminated to the steel. After the glue is applied the parts are stacked and allowed to flash on a skid and give off vapors. Inspector does not address the health effects but simply advises the employer and inspector that "worker exposure to the solvents is unlikely to exceed any exposure limit."

90F865EAAV 04/07/90 hygiene report cleaner 201B/resin fumes INJECTIONMOLDING
Workers complained about the smoke and fumes that were intense during the purging operation. Injection molding uses PVC, acrylic and polystyrene resins although the latter two are not used as much. Hygienist notes that during the purging process various thermal decomposition by-products are generated and that the 7 molding machines were not locally ventilated. Purging starts at the beginning of each shift and as well as during the day where necessary. Inspector recommends local exhaust ventilation. Testing for HCL was not detectable near the barrel vent. No measurements were taken by the purge waste dropped on the floor, however. RIM: Workers also complained about the use of mold cleaner Chem-Trend 201B which contains n-methyl-2-pyrrolidone, ethylene glycol, monobutyl ether, solvent blend is applied with a soaked rag and neoprene gloves.

90E845MOWV-C 06/07/90 Medical consultant report re welding POST LAM
Medical assessment to address hygiene report 90D855MAV (MAY 1990) and a request from the WCB regarding an employee who developed medical symptoms attributed to welding fume exposures. Report does not really address the issue of whether the symptoms are caused by the welding fumes. Just attempts to minimize by referring to tarps installed to isolate welding operation, mild steel welding less hazardous and volume of the workplace. AUTHORS' COMMENTS: Ignores substantial welding during cart maintenance to heat dry isocyanate paints and PVC wrap to extremely high temperatures

90F889MOWV-C 09/07/90 medical report re: medical problems BOX AREA/RIM
MOL medical consultant report as requested by WCB regarding worker health problem related to exposure in the Box Areas of RIM used as a loading dock, box assembly and storage. The consultant indicates that in an "upset or spill situation" exposure might be possible but none have occurred. No form 7 indicated to establish date of medical report for worker.

325-71-2 24/08/90 investigation of a 25USG isocyanate spill 07/08/90 RIM
A major spill of 25USG of MDI in the RIM department near Clamp #6. Worker not informed of spill and not wearing respiratory protection. Supervisor was wearing protection, but not worker. Worker told two days later that spill had occurred.

90E873EABR 07/08/90 Hygiene report sanding dust painted parts SAND/TRIM
Dust sampling at sand and trim tables—0.2 to 2.9 mg/m3 in response to worker health complaints about exposure to dust from sanding painted plastic parts. AUTHORS' COMMENTS: Assessed as nuisance dust, regardless of dust containing residues of resin and paint components and possibility of unreacted isocyanate monomer, and other additives in plastics and paints). "Nuisance dust" TLV of 10 mg/m3 applied.

90G845MOWV-C 31/09/90 WCB request worker health problem POST LAM
Worker exposure to Pebra 5 glue contained in glue stick ingredients include Perchloroethylene 20% and Tetrahydrofuran 80%. (Adverse health effects from exposure to these chemicals has been dealt with previously). This hygienist's findings contradict previous MOL investigations concerning the inadequate ventilation and storage. of freshly glued parts. See 90F889mowv-c

90GB63MOWV-C 16/10/90 hygiene monitoring for HDI, MDI RIM/GRAY PUTTY
No detectable levels in RIM molds and Grey Putty (HDI) area. Observes that "comfort" fans were operating in the sand/trim which could possible have interfered with the monitoring. Mondur PF and MDI c-961 used. AUTHORS' COMMENTS: this measure (fan) also spread dust to the general work area affecting other workers.

1991#285955 11.03.91 fiberglass dust/cold air RIM

Call initiated due to 2 concerns: alleged high levels of fiberglass dust in RIM deflash and sanding area and lack of ventilation; Make up air units blowing cold air on night shift workers. Solutions agreed to were that: 1. trial dust collector, currently being used in RIM deflash areas. Consideration of air testing in deflash, but felt it may be better to use money for ventilation system since air testing quotes are in excess of $3000. 2. Supervisors in RIM oven area instructed to leave one or both air make up units on, with some heat, to resolve cold air problem.

901811AOBR 11.02.91.11.03.91 visit re: Iso spill RIM

350 employees working three production shifts, 5 days per week in RIM, and two production shifts in other areas of the plant. On Aug. 7, 1990 outside contract worker doing maintenance set-up work on clamp 6 caused a pressure adjustment bolt that was adjusted too far leading to the bolt coming loose and MDI spraying out of the bolt hole. The worker who was sprayed immediately showered and washed himself with water. Apparently the spill out of the bolt hole extended as far as 20 ft. through a combination of spray and puddling. The contract worker was sprayed onto his shoulder but not onto his face. The MDI would have been 50-60% diphenylmethane diisocyanate and the temperature was probably 31 to 32C….apparently concerns raised regarding the manner and time of advisement of the spill to workers at the other clamps.

31496 28.08.91 heat issue RIM

Work refusal due to heat at clamps. Workers asked to have two additional ten minute breaks, one at 6:50 to 7:00pm, and another at 8:30 to 8:40pm. JHSC have verbally agreed to a hot weather plan, which comes into effect when a temperature of 28 is reached using a WGBT gauge.

Inspector advised there is no heat temperature in the legislation. The policy will be reviewed at next mtg of JHSC.

POST LAM

90H862MOWV-C 20.02.91 WCB case re: solvent exposure POST LAM/FORD LINE

Visit made at request of WCB after a worker's health problem was attributed to solvent vapor exposure while working in the FN36 glue line. The solvent vapors apparently were coming from the FN36 area and paint sludge room. Since the time of the concern the FN36 area has been moved and now removed from the plant. This company has been visited previously by HSSSB on numerous occasions and is considered most recently in report #90I811AOBR. Testing indicated that worker exposure while present was well below any exposure limit.

Comment: Solvent exposures in the old FN36 glue line area were thoroughly investigated and quantified by the HSSSB.

PAINT LINE/SLEUSS WAY/SLUDGE ROOM

28018 23.09.91 strong organic smells PAINT/MIX/SLUDGE

During regular inspection of plant strong organic vapor smells were noted in large paint mixing room and in sludge room. One of the ventilation systems at south end of mix room was not working adequately (very low air flow). Officer requests review of these two areas by hygiene consultant. The company and JHSC team appears to be making good progress and much improvement was noted as compared to previous inspections.

Follow up hygiene report focuses on three chemicals MSDSs: Pebra purge, clean chem 2K-550, Urethane grade retarding thinner a 4th MSDS is included but has no product name.

91I897EAAV 9.12.91 HSSSB air tests PAINT KITCHEN/SLUDGE

All results less than 1.0ppm.

#07170 17.12.91 sleuss way concerns PAINT SLUICE WAY

Concerns as a result of inspection of paint mix room and spill channel drain system and bonding and grounding issues. "At time of inspection, the excess material (water, solvents, and paints) in the floor draw system was being pumped out of the system. The floor drain system is connected to 2 x 5000 gal holding tanks and excess material would normally drain into these holding tanks. Between Dec 20th and end of year during shutdown a complete cleanup of pint kitchen including drain system has been scheduled. It was stressed that periodic cleanup should be scheduled to ensure the drain system is working as intended and does not become (or remain) blocked. The need for upgrading the use of bonding when any flammables are being poured or dispensed or mixed was discussed and left for further review. Order left under section 26(4)b for proper and appropriate bonding and grounding. Since many different types of solvents are used in the paint kitchen it was stressed that the procedures in the msds be followed for spill clean up. …these solvents and paints are generated on a daily basis by cleaning filter units and by backflushing/cleaning paint lines, consequently some day to day processes are needed to ensure the fumes are kept to a minimum.

91I897EAAY 23/10/91 Significant exposure: MEK, Xylene, Acetone PAINT LINE/SLUDGE
Inspector finds "significant risk of exposure to MEK (2-butanone), Xylene (dimethylbenzene), Acetone (2-propanone) paint mixing room and sludge room because of the volume of chemicals used and exposure controls, particularly the lack of training for workers using organic cartridge respirators. Subsequent air sampling did not detect these chemicals.

1992

Event ID 2577 21.01.92 refusal over lack of WHMIS training PLANT

Two work refusals, one worker refused to do janitorial cleaning work because she had not had specific training. This worker was working with WHMIS chemicals at time of refusal. Orders issues under O. REG 644/88 SEC .7(1).Based on work being done at time of work refusal a decision was given that the physical condition of the workplace was not likely to endanger. However it was recognized that both workers (in various jobs in the RIM dept) do require appropriate specific WHMIS training and an order was issued for this to e completed on or before January 29, 1992.

082989 12.02.92 repeat visit re: smoking PLANT WIDE

A meeting was held with manager/worker rep of JHSC to review status of Act in this work place. Reference was made to a similar visit on Dec 11, 1991 regarding smoking in the work place. The safety committee has recommended that the large cafeteria be the DESIGNATED SMOKING AREA and the small cafeteria be non smoking. This clearly would give better separation between the smoking and non-smoking areas. The above recommendation is in the process of being sent to senior management.

92C845EOAV 08.04.92 ISO program PLANT WIDE

510 production workers at plant, of which 350 have taken part in iso program (i.e. pulmonary function testing, chest x-ray, med exam). A variety of ISO containing polymeric hexmethylene di-isocyanate or HDI paints are used in paint kitchen. Advice: "Although control measures are in place, the Isocyanate control program <u>should</u> be documented and a <u>copy of the program provided to JHSC members.</u>

082980 12.05.92 cyclic visit report PLANT WIDE

(16 issues were addressed in report. Those related to housekeeping/chemical issues are included in this summary). (#12) "Fibreglass removal from used tote boxes discussed. PPE appears to be used, however it was recommended that a HEPS vacuum be used rather than regular vacuum in order to ensure that very small fibers of fiberglass are not being forced back into the air." (#13) "Preventative maintenance was discussed with respect to mold machines in RIM where occasional leaks (blow out) and dislodged particles occurred"

(#14) "Cleaning out of filters on buffing machines should be done often enough so that the air flow does not deteriorate. Checks could be done with an air flow velometer." (#15) "Sand and Trim tables in RIM are currently not ventilated (locally) however management is considering local ventilation once the tables are moved to their new locations nearer the mold machines. Meanwhile if operators need respirators for this work they can be obtained." **<u>Order issued</u>**: The ambient air blower on the east external wall of the paint kitchen shall be arranged so that the air used from this unit is drawn from outdoors in an area free of contamination in accordance with section 25(2)h of the Act on or before May 22, 1992. **Order issued:** West Tool Room: Floor area shall be cleared of obstructions and hazards from wood pieces left on floor. **Order issued**: RIM Mold Machines. Materials such as nuts, bolts, rags, flammable containers stored at the entrance of the ventilation system shall be removed in order to allow proper air flow. **Order issued:** Rim Dept. "containers of 201B (a WHMIS product) shall have legible workplace labels attached in accordance with Act. **Order Issued:** RIM dept. "#6 Mold machine mixhead valve shall have electrical connection repaired or replaced in accordance with Act. **Order Issued:** RIM Dept. "Area below (Iso) day tank shall be appropriately cleaned of any isocyanate containing material in accordance with the act. **Order Issued:** Rim Clamps. "Areas of the floors at the back and sides of the clamps shall be cleared of excess plastic debris in accordance with section 12 of Act. **Order Issued:** Polyol storage area: "Leak on floors at N. side of tanks shall be cleaned up and appropriate drip trays used to prevent the spread of the polyol in accordance with Act.

092948 16.07.92 ISO program grievance RIM

re: preliminary discussion due to recent situation in RIM. A RIM dept. worker from Sand and Trim that is included in the Iso Program was concerned due to shortness of breath. As a result the worker was examined by the plant physician and nurse and a pulmonary function test done. Worker and Union were claiming that worker should be paid for visits to 2nd doctor and specialist under section 26 of the Act. Company indicates they will not pay. Grievance is in process.

Event 3474 21.04.92 isometry not working RIM

9 workers refused to work due to isometer not functioning properly because of lack of calibration (RIM DEPT). F.O. notified by phone. Decision: "not likely" to endanger.

PAINT

92A833BOAV 06.01.92 risks in paint kitchen/maintenance PAINT/MAINTENANCE

Hygiene visit: Hygiene consultant reviewed the handling of waste paints and solvents in paint kitchen. 1. Operators should be using appropriate gloves. 2. Operators doing maintenance work or changing filters and cleaning tanks at end of run should be encouraged to use organic vapor cartridge respirators during the work. 3. Air supply for Air supply Unit respirator for the paint kitchen should be connected so that "OUTSIDE AIR" is being used. One means would be to connect to the breathing air supply on the first paint spray booth system. 4. The area under the ISO "day tank" needs appropriate clean up. A schedule of clean up should be established in order to ensure the area is kept reasonably cleaned up at all times. Officer requests review of ISO control program including medical aspects with plant nurse.

132254 01.10.92 refusal due to fibreglass rashes PAINT/CURE

Worker refusal to work on the paint cure fixtures because when he handled the fixtures he was getting rashes from the fibreglass in the fixtures. JHSC held an investigation and offered the following PPE equipment: tyvex coverall suit with long sleeves, respirator, gloves and safety glasses. It was indicated that if appropriate PPE are worn then there should not be any significant skin hazard.

1993

POST LAM/ASSEMBLY

93EO35EAAW 18.05.93 odor/health complaints POST LAM/ASSEMBLY

Hygienist report: 12 employees complain of headaches, dizziness, light headedness, metal taste, acetone-like odor, sick to stomach, one sent to hospital (not a refusee). Trace levels only found in air testing. Inspector advice: "Ongoing efforts to ensure plant ventilation system operates properly throughout the work shifts are appropriate. The use of cooling fans may help to increase worker comfort. Worker exposures to carbon monoxide, carbon dioxide, nitric oxide, nitrogen dioxide, acetone and methyl ethyl ketone, in the areas of concern, are currently within the respective exposure limits."

93EO35EAAW 03.05.93 odors/health complaints POSTLAM/ASSEMBLY

Hygienist report: re: 13 workers refusal. No noticeable odors/air testing done. "It was noted during visit that the company's detector tube pump had a slight leak. Correction action in this regard is appropriate. Workers expressed concern over vapors coming from sludge room. Effluent from a temporary holding tank in sludge room was draining over a mesh basket containing bromocide disinfectant pucks. The effluent was splashing in the nearby work area. Repeated contact may cause skin problems. Appropriate repairs are required for the company's colourimetric detector tube pump. Consideration should be given to ongoing refresher training in the proper use, care and limitations of detector tube sampling."

93E22OMOBR 04.05.93 odors/health complaints POST LAM/STE ASSEMBLY (see above)

OHSB report of above case: On April 27, 1993, several workers complained of "diesel" odors, experiencing light headedness, nausea, eye, nose and throat irritation, headaches, problems breathing and vomiting. Worker sent to nearby hospital. On May 3, 1993 a similar incident occurred.

Reassessment by (hygienist) detected no significant hazard…the cause of these incidents is not known although there may have been a spill of MEK in the paint kitchen and malfunction of the ventilation which is applied to the barrel of the 3000 ton injection molder. Although such exposure can produce uncomfortable and distressing symptoms, it is not likely to result in permanent tissue damage or other serious harm in either short or long term. The affected workers wondered if there were any tests which might detect solvents in common use in this plant like acetone, MEK and xylene. The urine can be examined; such testing should be done at the end of work shift. Acetone: 100 mg/L, MEK: 2 mg/L, xylene: 1.5g/g creatinine. The general ventilation should be assessed by an appropriate consultant to minimize the possibility of recapture of exhaust gases by air intake system. Disposable respirators for use with organic vapors should be available…"

INJECTION MOLD/REGRIND

93E326EAAW 18.05.93 vapors/health concerns INJECTION MOLD/REGRIND

Hygienist report: 4 employees refused work due to health concerns associated with regrinding machine and vapors emitted during regrinding of plastics. "Workers may be exposed to these emissions under current circumstances due to a lack of effective controls. Upgraded controls (e.g., local exhaust) for the regrinding machine are considered reasonable and appropriate. "Dispersion of airborne contaminants produced during use of the regrinding machine into the adjacent work areas is likely under current circumstances. Information from manufacturer indicates volatiles released during heating (550F) of the 1376 resin may include carbon dioxide, water, tetrahydrofuran and styrene. Other emissions may also be released during heating of the resin."

442406 18.05.93 fumes/health concerns INJECTION MOLD/REGRIND

4 persons refused work in injection molding because of fumes coming from Nelmor Grinder. They reported headaches, sick to stomach, dry mouth, dry sore throats, burning lips, fatigue. Scrap TCU was being ground nearby. TPU was also being processed on the line (#1376 and #1103). HSC confirmed the odor. At inspection at 4:25 pm the following was noted: a) a fairly strong plastic odor was present around the grinder. B) The bottom holding tray that catches ground product had been removed and was full of product that was still warm (at 8:00 am the next day it was still warm). C) The section of the grinder that does the grinding/cutting was almost too hot to touch by bare hands. D) the grinder had no local ventilation Order: appropriate engineering controls such as ventilation to ensure that gas fumes or mist generated….is adequately captured and does not enter into the work area and appropriate NIOSH certified dust respirators shall be used by workers handling or transferring ground up TPU.

93E326EAAW 18.05.93 vapors/health concerns INJECTION MOLD/REGRIND

Hygienist report: 4 employees refuse work due to health concerns associated with regrinding machine and vapors emitted during regrinding of plastics. "Workers may be exposed to these emissions under current circumstances due to a lack of effective controls. Upgraded controls (e.g., local exhaust) for the regrinding machine are considered reasonable and appropriate. "Dispersion of airborne contaminants produced during use of the regrinding machine into the adjacent work areas is likely under current circumstances. Information from manufacturer indicates volatiles released during heating (550F) of the 1376 resin may include carbon dioxide, water, tetrahydrofuran and styrene. Other emissions may also be released during heating of the resin."

93D501EAAV 14.04.93 health concerns INJECTION MOLD (TPU)

5 worker concerns associated with the drying of TPU 1376 (Polypur grey). Local exhaust system for drying barrel also services the injector head of the 3000 ton molder (plus two other injection molding machines). Local exhaust system for drying barrel was not locally exhausted on day of refusal. Inspector comments: "during drying of TPU pellets at reported temperature some airborne irritants may be produced…..not likely to be in excess of the relevant exposure limits but they may be sufficient to cause discomfort or irritation. Drying resin pellets at the lowest practical temperature will help to minimize formation of thermal degradation by-products. Advice to management: A potential likely existed for worker discomfort during the initial time of the work refusals due to a lack of effective local exhaust ventilation. Good work practices including use of existing exhaust ventilation as well as preventive maintenance and use of the lowest practical temperature to minimize formation of thermal degradation by-products.

H&S event form 24.02.93 workers sprayed with hydraulic spray INJECTION MOLD

RE: 3000 ton mold in plant making a banging/scraping noise. Mold caused a hydraulic elbow fitting to blow off and spray hydraulic oil onto workers. (Adjustments made by maintenance as well as mtg to discuss issue.

449334 19.03.93 odor and health concerns INJECTION MOLD/ASSEMBLY

5 workers refused to work in assembly because of "odors" believed to be coming from the 3000 ton Injection molding machine adjacent to the assembly area.

Observation: the 3000 ton machine was processing TPU at about 220 degrees (highest in range provided). Dryer unit was in operation but not vented to the outdoors. Local ventilation to the west end of the barrel was working well at time of inspection. At time of visit, management indicated that only about 1 more hour of TPU production was needed to complete the production run. After that it was not expected they would be doing a TPU run for about 2 weeks. It was agreed that a MOL hygienist will be involved in the investigation when the next production run of TPU is made. It was agreed that the refusing workers will not have to work in the area until the extra hour of production run is completed. Temporary ventilation vents will be connected to dryer unit to vent exhaust to outdoors before any further runs of TPU are made. Further suggests, that when purging takes place, the excess hot plastic that falls out of barrel to be directed into pail of cold water. "This should help control the spread of additional purging fumes. "

449329 26.03.93 health concerns INJECTION MOLD/FINISHED PROD

Continuation of work refusal 449334 (see previous page)

"Ventilation had been installed on dry unit of 3000ton mold machine and drying was operating at time of today's inspection. The barrel end of the machine already had local ventilation and this was working today. When purging is done and excess material comes out (1-10 lbs) this material is now put directly into a large pail of water to prevent spread of fumes. Based on advice from hygienist that the dryer unit be vented (which was done) it was felt that adjacent workers are not likely to be endangered." In a note to the hygienist the inspector says: Re: Pebra. (Company) managed to put off decision until TPU is used again, but would like inspector to go in to assist at that time.

PAINT/SLEUSS WAY/KITCHEN/SLUDGE ROOM.

509310 22.12.93 odor/health concerns PAINT/SLUICEWAY

Follow up order to work refusal. Concerns on solvent smell believed originating in sluiceway between paint facility and sludge room. "The sluiceway on the floor outside the last wall of the paint kitchen…shall be sealed or more adequately covered to prevent fumes and vapors from entering the injection molding area and assembly area in accordance with section 25(2)h of the Act. Order complied with at the time of investigation.

"During inspection of the area the following was noted: a) Metal plates placed loosely over sluiceway were not sealed in any way and gaps between adjacent metal plates were as large as 2". b) Filter screens were still left on floor area adjacent to where these filter screens are changed in the sluiceway….Screen filters on the sluiceway are normally changed/cleaned once a day. If an emergency occurs filters would/could also be changed or cleaned. When filter is changed/cleaned, sluiceway has to be opened up and it is likely some organic solvent odors would be released into the area."

Inspector notes: On 21.12.93 a problem occurred in the paint facility. Some carts crashed. The paint line was stopped and the paint spray guns would have been flushed with solvent. The back wash and solvents from the paint facility move through the sluiceway to the sludge room and "it may have been possible that some of the solvent leaked out from the sluiceway as a result."

442316 23.03.93 fumes and health concerns PAINT/SLUDGE PIT

According to employer report, worker assigned to clean screens in sludge room refused. Management offered worker respirator and ambient air supply but he still refused due to fumes, odors from old paint. Inspector compares testing results of area identified from a report on the same area and notes that at 6ppm, “solvent vapor is not likely to endanger worker to enter and work in this area.”

467796 13.12.93 poor air quality PAINT/LOAD/UNLOAD

“15 workers refused to work in NE corner of Paint because of smell and unknown air quality testing: carbon monoxide 5ppm and carbon dioxide 1000ppm (7:00 pm) testing: carbon monoxide 5 ppm and carbon dioxide 1200-1300ppm (10:00pm) Humidity 32%. Gas fired ceiling furnaces recently checked by Consumers Gas at a previous work refusal, 02.12.93. At that time, 5 gas fired ceiling furnaces were logged out of service because they did not have “draft inducers” on them. These are still closed off and out of service. One air make up unit about 40 feet to the west of the refusal area was turned off 1 week ago when another work refusal occurred. It is still closed off until it is serviced. On midnight shift the parts carts were high pressure washed in area just east of paint facility”.

The excess water on the floors was squeegeed into the wash water sump area near by raising the top cover plate…..(it was) still raised at time of this investigation. Plate should be closed properly and remain closed. Since change to winter heating about 4 weeks ago, there have been several air quality type refusals. The heating units have been addressed through Consumers Gas however it is recommended that all appropriate heating units be made operational as soon as possible before the really cold weather comes. It is recommended that a review of the suggestions/ideas to reduce the change of contaminating the air in the assembly area be made as discussed with Pebra by the MOL on May 31, 1993 (attached to report).

467875 15.09.93 air quality PAINT/INSPECTION

14 workers present for discussion and consultation on exhaust fans and make-up air fans which had been the topic of work refusal earlier in the day. Communications between workers and management was discussed and how testing in the areas near doors and fans could be completed as well as how these results could be communicated. The end result was that a better system of communication would be developed. Orders: Employer shall post a copy of the occupational health and safety policy in the workplace in accordance with section 25(2)k of the act. The employee shall ensure that the enclosed workplace shall be at a temperature of not less than 18 C during operational shifts in accordance with section 129(1) lb of the act. (Temperature at the time of inspection was only 15C).

RIM DEPARTMENT:

Report (no author or file no.) on rim air exhaust units June 93ventilation problem RIM

The rim area served by 6 make up air units and exhausted by 16 fans. (Mold Units, MU1-MU6, MU15)

MU1 and MU3 work in conjunction with return fans, MU2 fan was found turned off and started in order to obtain capacity, MU15 is heating unit that operates only in winter.

Conclusion: the area is under a tremendous negative pressure. Although many fans vary from their design capacities, the overall net pressurization is close to the design capacity level.

Management event form 15.09.93 poor air quality RIM

30 workers refused to work complaining about poor air quality, feeling sick/ tired.

467673 15.09.93 air quality RIM

30-35 workers in RIM refused unsafe work because of air quality. Workers stated they had headaches, were getting sleepy and generally felt tired. They believed that the air in the RIM area was the cause of their refusal. Tests were done for carbon monoxide, carbon dioxide, sulfur dioxide, acetone, hydro carbons, hydrogen sulfide, and toluene. Results showed no evidence of overexposure (only high reading 600 for carbon dioxide).

Daily testing for these chemical is to be completed at the beginning of shift and in early afternoon for a two week period to obtain a pattern. Readings are to be posted daily.

Carbon dioxide at 600ppm does nothing more than create a comfort feeling e.g., tired, sleepy, possible headaches as indicated by Dr. Waddell. Decision: " Not likely to endanger."

OTHER/PLANT WIDE

467796 02.12.93 gas smell GENERAL ASSEMBLY

Workers refusing to work because of gas smell in assembly area. Certified JHSC members have done extensive testing over past 2 days. Contractor and Consumers Gas called in.

449329 26/04/93 (5 refusals) due to fumes from PUR pellet dryer INJECTION MOLDING Hygiene visit followed initial work refusal investigation (see 93D501EAAV, 15/04/93). Adverse effects from fumes/vapors from heated polyurethane (i.e. polypur Gray 1376 which contains carbon black) thermoplastic pellets molders and assemblers. Hygienist finds that during the initial day of the work refusal the drying barrel was not locally exhausted. The dried tpu pellets are molded at approximately 400-430 F (204-221C). Hygienist noted that drying TPU pellets at the reported temperatures some airborne irritants may be produced at level below the TLV.

INJECTION MOLD/REGRIND

93D501EAAV 14.04.93 health concerns INJECTION MOLD (TPU)

5 worker concerns associated with the drying of TPU 1376 (Polypur grey). Local exhaust system for drying barrel also services the injector head of the 3000 ton molder (plus two other injection molding machines). Local exhaust system for drying barrel was not locally exhausted on day of refusal. Inspector comments: “during drying of TPU pellets at reported temperature some airborne irritants may be produced….not likely to be in excess of the relevant exposure limits but they may be sufficient to cause discomfort or irritation. Drying resin pellets at the lowest practical temperature will help to minimize formation of thermal degradation by-products. Advice to management: A potential likely existed for worker discomfort during the initial time of the work refusals due to a lack of effective local exhaust ventilation. Good work practices including use of existing exhaust ventilation as well as preventive maintenance and use of the lowest practical temperature to minimize formation of thermal degradation by-products.

442316 23.03.93 fumes and health concerns PAINT/SLUDGE PIT

according to employer report: worker assigned to clean screens in sludge room refused; mgmt. offered helper, respirator, ambient air supply but he still refused due to fumes, odors from old paint. Inspector compares testing results of area identified from a report on the same area and notes that at 6ppm, “solvent vapor is not likely to endanger worker to enter and work in this area.”

RIM

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OTHER/PLANT WIDE

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449329 26/04/93 wk. ref. (5) fumes from PUR pellet dryer INJECTION MOLDING
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442406 18/05/93 fumes/dust Nelmor grinder TPU 110-1376 REGRIND AREA
Investigation of work refusal by 4 workers in the assembly area on May 17,1993 over adverse effects caused by fumes from the grinding operation. Workers experiencing headaches, nausea, fatigue, burning lips, and dry sore throat. Mist and fumes were visible around the re-grind area. Inspector notes: strong plastic resin type odor; ground plastic still warm 2 hours after used; the cutting blades were too hot to touch; no local exhaust ventilation; MSDS indicated that "inhalation of dust may cause lung and throat irritation; fumes may be emitted in the form of oligomers. Local exhaust required." Five orders issued.

1994

PAINT/KITCHEN/SLUDGE ROOM/ SLEUSS WAY

94A143EAAW/449499 12.01.94 odors/health concerns PAINT/LOAD/UNLOAD
Unmaintained propane fork lift truck creating high levels of carbon monoxide fumes; 800 "shots" of release for 2-3 sec per shift – release is 70% methylene chloride and suspected carcinogen, ventilation only during purging. Inspector advice: "A suitable substitute would therefore be desirable"

ID431932 06.01.94 re: fibreglass warning BUFFING/OUTSIDE PAINT

Workers concerned by warning label on polypur that it contains crystalline silica. Do not inhale of swallow dust; Inspector's Advice: ensure ventilation is running and respiratory protection used.

(Ear# 93F018AAAR) 15.11.94 buffing with no vent BUFFING/OUTSIDE PAINT

Workers were concerned about a number of chemicals used in buffing that would be in the dust, as there was no ventilation or respiratory equipment in use. Testing by HSSSB consultants found nothing over TLVs (total dust, flrmaldehyde, phenol). (AUTHORS' COMMENT: In our Advisory Committee meetings several workers described being concerned when they found out the scotchbrite they used to buff with contained nickel and a warning of the presence of nickel was listed on the box the product was contained in).

RIM

ID442438 27.01.94 multiple air quality complaints RIM

Query "purge into plant". AMU tied into ventilation on clamp 1 and 2. If exhaust shut off or flow switch malfunction cause AMU to purge. Ministry called.

509143 07.10.94 lack of labels on hydraulic hoses RIM

522258 07.10.94 poor quality of new gloves/rash RIM

(H&S management: "Gloves were obviously defective and had torn. Claims shin rashes due to penetration of solvent. Concerned temp of mold causes breakdown." Inspector (based on information received from glove manufacturer states "solvex nitro glove will protect the hands from exposure to the mold cleaning solvent." Worker offered barrier cream and special underglove to use with "new" gloves).

94K197EAAW 9.11.09 odors/health concerns RIM

No reason identified for workers concerns. Air sampling was done in plant almost 2 hours later. Inspector's comments: "A variety of solvents used in plant, many of which have relatively low odor thresholds… often well below the exposure limits." He Advises: "Ongoing efforts should be made to investigate sources of unusual odors associated with health effects in the plant as soon as is practical."

467970 21.11.94 odors/health concerns RIM

Workers complained of headaches, dizziness, sore throat and one sick to stomach/nose bleed sent to hospital. No trained person available to conduct air sampling at the time, done later by JASC with no findings. Inspector decision: "ventilation will be improved, no hazardous ingredients in mold release."

OTHER/WASHROOM/PLANT WIDE

568519 19.10.94 INSPECTOR NOTES INADEQUACIES IN H&S PROGRAM

"Union Rep states (H&S rep was tested in flow rate testing but not told what the flow rate "should be". Inspector further notes: "During visits to this workplace, I saw numerous contraventions and hazardous conditions that the certified members and other JHSC members did not notice. (Names company H&S rep) also noted that supervisors need training in how to discharge their duties under the act."

431932 27/05/94 phenol/formaldehyde + dust build-up BUFFING AREA

There are four buffing units in the buffing area producing a large amount of dust from the materials being buffed e.g. freshly made plastic and isocyanate painted parts as well as dust from the buffing disks composed of various grits and phenol formaldehyde adhesives/resins. There was a large accumulation of dust on floors and in the air. While the buffing station was equipped with local exhaust the size of the wheel blocked the flow of air and caused dispersal in the atmosphere. Worker's comments paraphrased by inspector followed by commentary"…the air in the plant is often not fit to breath; despite the fact that numerous air quality test do not support this belief".

1995

INJECTION MOLD

522864 19.10.95 vapors (E702) mold machine INJECT MOLDING

HSCS rep requested visit re vapors coming off mold machines. Mold Release E702 or "rocket release" giving off mist. Testing to be done internally and report from Inspector Burke later. It was observed that (workers) were not wearing the provided respirators. Other workers on other machines were wearing the respirators. Workers are required as per OHS Act, Sec 25-1-d the employer shall ensure that protective devices provided are used!"

95J235EOAR 06.11.95 concerns re: E702rocket release INJECT MOLDING

(TPU machine applies 150-300 applications per shift)."There is visible overspray and is seen as mist at top of IM enclosure. According to MSDS, product contains a halogenated hydrocarbon/ether blend. INFORMATION SUBSEQUENTLY OBTAINED FROM SUPPLIER (not on MSDS) indicates this blend contains dichlorofluoroethan and dimethyl ether which have suggested WEELS of 500 ppm and 1000ppm respectively. THERE ARE NO EXPOSURE LIMITS ESTABLISHED IN ONTARIO FOR THESE MATERIALS. Based on automated nature of this IM process, the distance of workers from the source, and available information on product, it is unlikely that workers are exposed to either (chemical) in excess of suggested exposure limits. However, the provision of upgraded controls would help to reduce overspray and <u>minimize product wastage</u>. "Workers smoking in wash rooms. Designated smoking area is in cafeteria but management is not strict about it. Complainant has made numerous complaints to JHSC but no action taken."

95B224XAAC 17.02.95 noise level testing INJECTION MOLD/COMPRESSOR

Noise levels noted ranging from 89-94.5DB. Appropriate hearing protection provided and worn. Mold repair is conducted in the compressor room on an intermittent basis. Two men would repair molds for 4-8 hours several times per week. Ongoing efforts to reduce noise exposure through engineering controls are appropriate.

568291 17.02.95 noise level/overhead crane INJECTION MOLDING

Inspector: "All (sound) levels appear to be within acceptable limits. The employer is advised to review the operational procedures in the work area with a view to increasing the level of effective communication between workers when more than one worker is required to move a mold by using the overhead crane system. This officer suggests that the workers in the area could be involved in the process to assist with the review."

PAINT LINE/SLEUSS WAY/SLUDGE ROOM

95B223EAAW 23.02.95 refusal over "finesse" OUTSIDE PAINT/BUFFING

Workers health concerns over use of "Finesse". After sanding, 3M "finesse-It" compounds are applied by squeeze bottle. Up to several drops may be applied per occasion. Pneumatic polisher used to buff the part with the compound. MSDS – compound contains 50% water as well as Stoddard solvent, and 13084 an isoparaffinic hydrocarbon and lesser amounts of other petroleum derivatives (20%) and less than 1% morpholine. Repeated/prolonged contact with skin should be avoided. Some splattering may occur." Advice to employer: Provision of a guard or alternate work station design would be of benefit. "…….unlikely to exceed relevant exposure limits (even though the full ingredient list is missing?).

OTHER/WASHROOM

29671 12.10.95 smoking regulations WASHROOMS

Event Report 03.04.96 smoking WASHROOMS

"Complaints not being resolved"

Request for service 03.04.96 refusal re: R-602 spray RIM CLAMPS

Re: "clamps 1,2,5 "exposure to mist from soap spray"

522910 03.04.96 refusal re: R-602 spray RIM CLAMPS

Re: Refusal due to the alleged exposure to "mist" from R-602. At present only a dust/mist respirator is used on voluntary basis and is not adequate for this application. Sampling is to be conducted. In interim workers advised that they may wear … organic/vapor/particulate pre-filter and further advice is to follow. No decision is given re: work refusal until test results are gathered."

614610 09.04.96 air sample tests re: R-602 RIM CLAMPS

"Four workers in RIM mold area using R602, an alcohol-based soap solution, spraying it on the molds to loosen the product. Workers felt they were being exposed to mist from the R602 chemical as they were wearing incorrect respirators. They experienced nausea, reddening of the eyes and headaches. They established that incorrect respirators were being worn."

594989 29.04.96 refusal re: R-602 spray RIM CLAMPS recommendations from the MOL hygienist mentioned in this report are being complied with. Air sampling taken."

96D068EABR 09.04.96 lab results for R-602 RIM CLAMPS

"Worker exposure to n-propyl alcohol of R-602 soap solution ranged from non-detectable to 16 ppm. Time weighted exposure results (5-11ppm well within current 200pm TLV). (No indication that any consideration of the prevalence of many fans in the area used, and their possible contribution)

Ventra MOL more recent reports for period 2006-2018

FV 5449699 05.10.04 re: orders issued letter to company from Robert Molina P.Eng.

In response to your recent telephone call in reference to orders issued on Sept 29, 2004 the following apply:

1. The industrial regulations are explicit, flammable liquids shall be located in a room equipped with a drain and liquid tight ramped sill. Both your flammable liquid storage room and mixing room currently do not have a drain nor liquid tight ramped sill. Order No. 1 specifically states that Ventra propose a plan to deal with this non-conformance by Oct 13, 2004. You mentioned that you feel you already meet the requirements of this section. If this is the case then propose your argument and rationale under an equivalency approach before Oct 13, 2004 for audit. Having said this, I find it difficult to accept an equivalency for drainage.

2. In response to Order no. 4, according to your voice mail message you believe that the order is complied because the operators inside the mixing room do not require labeling since they are aware of the contents of the pots and totes. If this is the case, then please put your argument in writing as an equivalency, and the issue will be reviewed. Clearly there is currently no pipe labeling inside the mixing room, which is a non-conformance.

FV 5449699 12.11.04 re: orders issued Visit by Robert Molina

Orders Nos. 3 and 4 as detailed in Sept 29, 2004 inspection report are considered complied. The mini-paint kitchen as been installed with a localized ventilation system with two inlets each with a capacity of 100cfm, the system is connected to the paint line exhaust. Labelling on pipes was installed.

Order No. 1 as detailed in the September 29, 2004 report is yet to be completed, an equivalency has been submitted and rejected while another argument has been proposed by the consultant and is currently under review.

17580 (hygienist report) 22.03.06 re: vapors from 3M Adpro 4298UV INJECTION MOLDING

Complaints by operator during trial run of new product of vapors from adpro product. It was discovered that solenoid air valve used in conjunction with Adpro and (emergency stop) discharged air containing vapors into the work area by glue line. Volume estimated to be about 20ml. with emergency stop activated twice per hour. Not believed concentrations exceeded exposure limits in Reg 833/90. Has since been ducted into gluing chamber and seal improved on door where Adpro container located. MSDS lists ingredients to be cyclohexane, xylene, ethylbenzene and ethyl alcohol. MSDS recommends skin protection when handling.

ID 5079018 12.04.06 refusal re: Parco purge PLANT WIDE

Follow up on internal resolution of workplace refusal on April 7, 2006. Once per year, water lines descaled with parco purge A500, which contains from 16-40 percent hydrochloric acid. The acid reacts with scale in the lines to produce carbon dioxide, oxides of sulphur and other gasses. Usually, descaling is conducted after hours, however, this time it was conducted on an operating shift. Though normal precautions were taken, it appears that some of these reaction gasses entered the workplace and some workers could smell these odours. In discussion with Mr. Terry Morgan, it does not appear that any of these fugitive emissions were of any such concentration than normal. Employer stated that the descaling will be conducted “off shift” as had been done in the past. In addition they will be switching to de-ionized water which will reduce scale build up. The employer is advised to consult the MSDS for Parco Purge A500, section 8 where it is listed that the respirator cartridge be ‘acid mist.’ Should the operator work in areas with a number of contaminants then a multi cartridge should be considered.

Event #1080113 10.07.06 re: fumes from cure oven CURE OVEN

Re: Workers working with curing ovens. Employer recently changed ventilation system and plugging leaks. Oven is under positive pressure temporarily instead of negative pressure. Smell of off-gasses in the air. Company has air sampled – results on Friday. Hygienist attended workplace. Suggested workers wear face masks. Or employer will move workers to another work location. Not likely to endanger.”

Hygienist report: #5079062: Ventra Plastics has completed an installation of a thermal oxidizer to control plant emissions resulting in a positive pressure being formed in oven. Oven vapors identified consisting mostly of xylene leaking into plant. Approximately 50 workers detected vapors in the air and some sought medical treatment….It is believed that leaks in oven are in the process of being sealed. In addition, the exhaust flow rate from oven has been increased from 2700CFM to 4350 Cfm. The result of this change is unknown. Employer can provide face respirators to workers provided that they are fit tested and trained to use them. There appears to be no likelihood of over exposure.

Employer critical injury report 18.09.09 re: loss of consciousness PAINT LOADING

While loading, worker went to rack and picked up a 10lb. part. While walking to line, he fainted and fell to the floor. Report concludes worker had pre-condition (blacked out on report).

P/PID 17580 01.10.09 concern re: ventilation GRINDING ROOM

"There are now two grinding machines within this area, and the proposal brought forward is that, the inside door would remain closed (other than to bring in product), and the outside door would be opened at the discretion of the workers in the grinding area to allow cool air into the room. The employer would install a security type gate around the outside door which would prevent unauthorized access or egress from the grinding room area. Phase two of this arrangement would involve new bags are to be introduced to reduce/eliminate dust, and if this does not work, a new extractor fan is to be installed in the outside wall, as well as a fan for replacement warm air on the inside wall. The inside door would then remain closed to reduce the noise level from the grinding room into other areas of the plant.

FV 02756FLZP263 27.06.12 manual spray painting PAINT LINE

Robot from paint booth broke down and to keep line running, manual spraying of Adpro was initiated. Spraying was done outside of (clearcoat) booth.

"If it is desired to place an operator in a robotic cell for whatever reason a risk assessment should be completed and adequate safeguards put in place to ensure the operator can not come within the operating arc of the adjacent robot. Ideally physical barriers should be employed to eliminate the possibility of contact. In addition the operator needs to have access to an emergency stop. The material being used Adpro is highly flammable and has a relatively low explosive limit. With the information available at this time the material being sprayed should only be sprayed inside a spray booth. No information on air movement or air quality exists to demonstrate that spraying outside the booth is not hazardous. Persons painting should be adequately protected. It may be advisable to employ air supplied suits and respirators. In any case, an assessment should be done to ensure the correct suit material is in use and that persons wearing respirators have been fit tested and trained accordingly."

FV 02756FBRP116 13.01.12 worker unconscious NO AREA IDENTIFIED

“The incident is believed to be related to a pre existing medical condition. As a precautionary measure, air sampling for carbon monoxide and carbon dioxide was conducted in the plant today. No unsafe readings were recorded.

FV 03480FBXM019 18.01.12 AIR QUALITY ASSESSMENT PLANT WIDE

Inspection was conducted on January 13, 2012. Measurements were taken with a TSI QTrak IAQ monitor which measures carbon dioxide, carbon monoxide, relative humidity and temperature. The monitor was calibrated in October, 2011.

Carbon dioxide ranged from 570 to 1070 (with spike of 2500 after general ventilation is turned on). Carbon monoxide ranged from 0.8 to 3.6ppm

Worker Complaint to district office 23.2.12 re: Iso exposure

“Caller states that workers had refused work and that the work refusal process was not adhered to because the employer thought that it was a frivolous complaint. Other workers wanted to refuse but all fear for their jobs. An odour that is believed to be isocyanates from the painting that workers do was causing dry throats, scratchy throats, tightening of the throat and general unwellness. Employer had said that workers were faking. This has been on going for near three months. Workers were unsure if all of the MSDS sheets had been provided. Caller indicated that she would like a follow-up with the assigned officer and a copy of the F/” query: 1. Work refusal, 2. Iso control program, 3. Sensitization, 4. Air quality.

FV 02756GQCQ591 29.08.13 re: chemical exposure SLUDGE PIT

Several (contract cleaning) workers sustained chemical burns when exposed to caustic solution while cleaning the paint sludge pit. The solution was dripping from a hose attached on the gratings above them. The pump had been disconnected, however, the solution siphoned through the hose. Order issued to contract company to provide personal protective equipment for cleaner.

A second order issued to Ventra to revise their procedure to ensure that chemicals cannot drip into the pits while workers are in them.

FV 02925KMTP083 13.08.16 heat stress program PLANT WIDE

Complaint received regarding heat stress and current policy of breaks. Caller states that employer has turned the AC off in cafeteria to reduce energy consumption and has not provided cool down alternatives. Temperatures reaching 95-96F and workers experiencing heat stress. Safety talks given to supervisors are to be delivered to workers on Sunday. Several stations have large fans, employer working on getting more for other areas.

FV 00588KVBR024 15.11.16 re: Blast shack rebuild PAINT LINE

Shack constructed of metal cladding with insulation between walls and ceiling. At time of inspection, ceiling was sagging, water dripping from it, rusty metal around light fixtures, rusty at bottom edges at floor level, rusty on cover at tank at back of booth and mould and dirt on the light covering inside the booth. Order issued for rebuild and that it be well maintained.

FV 00588LDZP062 23.02.17 re: ventilation concern PLANT WIDE

Concern that ventilation system was not being maintained and dust on top of general ventilation system in bldg. hazardous to workers health. Source of dust likely combination of plastic dust from rework, dirt dust from fork trucks, dust from grinding room and dust on portable racks. It was stated that "ducting has never been cleaned since it was installed many years ago. Recommends more cleaning on regular basis i.e., racks, metal duct work, extensions, sock venting and other surfaces. Employers could also investigate better filters for the air makeup unit to capture finer particulate.

FV 00588LPMS652 17.08.17 re: training outside cleaners PAINT BOOTHS

Compliance required by Ventra in training contract workers on protection from paint fumes and Isocyanates and use of respirators when cleaning Paint Booths. Employer to ensure that all information re: spray booth hazards are communicated to outside contractor.

FV 00588MJBP278 and281 27 and 30.04.18 Re: diesel fumes shared space SOUTH END BLDG

Problem with diesel fumes entering bldg. when trucks are maintenance. Query changing fan controls to Kenworth side of shared area to control when diesel fumes/grinding are being produced. "Kiddie" (home use) monoxide meters used by Ventra are not suitable for industrial use.

APPENDIX C

CHEMICALS USED IN VENTRA PLASTICS PRODUCTION PROCESSES

*Carcinogenesis; **Adverse Reproductive; ***Mutagenesis; ****ED

ISOCYANATE POLYMER RESINS

Isocyanates Groups having Nitrogen-Carbon-Oxygen (NCO) Methylene bisphenyl diisocyanate (MDI) R-RIM Department

Methyl isocyanate (MIC), toluene 2,4 diisocyanate (TDI)

Polymethylene polyphenyl isocyanate (PAPI)

Naphthalene diisocyanate (NDI)

Hexamethylene diisocyanate (HDI) Paint department/grey putty

Product Name: Mondur PF C-961

Hazardous Ingredients: aromatic isocyanates pre-polymer (polyurethane), monomeric, 4,4 dphenylmethane diisocyanate (MDI) polymericSyn modified diphenylmethane diisocyanate, diphenylmethane diisocyanate (2,2,4)

Decomposition Products: vapor form during No provided

Health Effects/Symptoms/Overexposure: irritating eyes, skin, upper respiratory tract, sensitization, rated as carcinogenic, positive mutagenic and genotoxic.

Product Name: Teflon (polytetrafluoroethylene-PTFE) *

Hazardous Ingredients: Polytetrafluorethylene

Decomposition Products: Hydrogen fluoride, carbonyl fluoride

Health Effects/Symptoms/Overexposure: irritating to eyes and respiratory system-choking, coughing, kidney/liver damage, cancer.

Product Name: Mondur PF

Hazardous Ingredients: MDI

Decomposition Products: CO, Co2, NOx, HCN, MDI

Health Effects/Symptoms/Overexposure: irritation of eyes and upper respiratory tract, sensitization

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Product Name: Cycoloy (resin) MC8800-BK 1005; (Sabic Inc.)

Hazardous Ingredients: Silica*, magnesium oxide, acrylonitrile* butadiene* styrene* (ABS), carbon black*, bisphenol A (BPA), flame retardant*, colourants.

Decomposition Products: acrylonitrile*, styrene*, butadiene*, nitriles, N^x , HCN, benzene*, ethyl benzene*, toluene*

Secondary operations: sanding, grinding, buffing produces dust, smoke, condensates.

Health Effects/Symptoms/Overexposure: Irritation of the eyes, upper respiratory tract, skin, nausea, headaches chills, fever

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Product Name: AS 700 LW-2 (Mylex Polymers Inc.)

Hazardous Ingredients: 1-Octene-ethylene-copolymers, carbon black*, copolymer polypropylene, talc*

Decomposition Products: CO, CO^2, aliphatic aldehydes, formaldehyde*, acrolein*, carboxylic acid, NO, smoke.

Health Effects/Symptoms/Overexposure: irritation of eyes, upper respiratory tract, lungs, ski

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Product Name: AS172L-O2US (Mylex Polymers)

Hazardous Ingredients: carbon black*, copolymer –ethylene butane-1, copolymer Polypropylene, talc*.

Decomposition Products: CO, CO^2, NO^x, smoke, aldehydes*, carboxylic acid, acrolein*.

Health Effects/Symptoms/Overexposure: irritation eyes, upper respiratory tract, skin,

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Product Name: HP-2105 HSE Adhesion Promoter (Rohm-Hass Inc.)

Hazardous Ingredients: xylene*, toluene*, ethyl benzene*, cyclohexanone, carbon black*, chloroform*, MEK***, naphtha, 1,2,4 trimethylhexzene, isobutyl isobutyrate, isobutanol.

Decomposition Products: Not indicated

Health Effects/Symptoms/Overexposure: liver/kidney damage, tetal toxins, pituitary gland, thyroid, testicular cancer.

Product Name: Bayflex 110-50 IMR (Inner Mold Release) component AU-125-A (RIM)

Hazardous Ingredients: diphenyl methane, diisocyanate MDI-prepolymer MDI-modified diphenylmethane diiscyanate, TDI- monomeric MDI positive for Ames test*/***.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritating eyes, respiratory tract, skin, sensitization and cancer.

Product Name: Urethane Hardener

Hazardous Ingredients: alphatic Polyisocyanat, 1, 6-hexamthylene, diisocyanate based adduct, homopolymer of HDI, aromatic 100, butyl acetate, hexamethlene diisocyanate

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of the eyes and upper respiratory tract, cough, tightness in chest, headache, dizziness, and nausea.

POLYMER RESINS (Thermoplastic)

Product Name: Multranol 4050-polyether polyol

Hazardous Ingredients: poly(oxyalkylene) Polyol

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: not provided **Product Name**: TEGOSTAB B 8418

Hazardous Ingredients: Polysiloxane polyether

Decomposition Products: CO, CO2, silicone dioxide, prop 65 chemicals

Health Effects/Symptoms/Overexposures: not provided

Product Name: BLACK (Perro Corp.)

Hazardous Ingredients: carbon black*, polyester polyol

Decomposition Products: CO, CO2, NO, sulfur gases, PAHs*

Health Effects: Carcinogenic, irritating to eyes, skin, respiratory tract.

Product Name: Bayer Mondur xp-743 (MDI)

Hazardous Ingredients: diphenyl methane diisocyanates, polyisocyanate based MDI

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of eyes, skin, lungs, nausea, corrosive, sensitization.

Product Name: Bayer Mondur 1402

Hazardous Ingredients: MDI, higher oligomers, phenyl isocyanate.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to eyes, upper respiratory tract, lung, inflammation, sensitization. Positive Ames test.

Product Name: Mobay NB 358329 (polyoxyalkylene.

Hazardous Ingredients: zinc stearate, diethyltoluenediamine (DETA), Organotin, aliphatic amine, poloxalkylene diamine.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritating to eyes, respiratory system, skin. Adverse blood effects.

Product Name: Polypropylene Copolymer with Talc

Hazardous Ingredients: 1-Propene, polymer with ethane talc

Health Effects: reported as no harmful effects or symptoms

Product Name: K-438-Additive 9438

Hazardous Ingredients: Polyoxyalkleneamine, metallic soap/polyether, polyol-blend.

Decomposition Products: CO, CO^2, NO^x, amine vapors.

Health Effects/Symptoms/Overexposure: irritation eyes, upper respiratory tract, pulmonary edema, skin irritation.

Product Name: BLACK (Perro Corp.)

Hazardous Ingredients: Carbon black*, polyester polyol

Decomposition Products: CO, CO2, NOx, sulfur gases, polycyclic aromatic hydrocarbons (PAH)* compounds.

Health Effects/Symptoms/Overexposure: irritation of eyes and upper respiratory tract and carcinogenic effects.

Product Name: 95120_HC UR 560CAPH Cayenne Red.

Hazardous Ingredients: MEK, isobutyl alcohol, melamine resin, ethyl benzene*, isobutyl acetate, n-amyl acetate, methyl alcohol, MAK, Cyclohexanone, propylene glycol methyl ether acetate, methylated melamine-formaldehyde* resin, aluminum, Formaldehyde*.

Decomposition Products: CO, CO2, acrylic monomers*, formaldehyde*, NO^x.

Health Effects/Symptoms/Overexposure: CNS, dizziness, headaches, loss of coordination, nausea, irritation of eyes, skin and respiratory tract.

Product Name: 67502 Barrier Coat

Hazardous Ingredients: Same as above plus: modified benzotriazole, carbon black, naphtha, xylene**.

Decomposition Products: same as above

Health Effects/Symptoms/Overexposure: Irritation of eyes, upper respiratory tract, skin and CNS effects. Possible carcinogenetic effects

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Product Name: 60230-TP UR 560CAFH

Hazardous Ingredients: Same as above plus: methylpyrrolidone, ethyl-beta-ethoxypropionale amorphous synthetic silica gel.

Decomposition Products: same as above

Health Effects/Symptoms/Overexposure: irritation to eyes, GI, respiratory tract, and CNS effects

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Product Name: HP 21054BHST Adhesion Promoter

Hazardous Ingredients: Xylene**, ethyl benzene*, toluene*, carbon black*, naphtha c8-c10, cyclohexanone,

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to eyes, skin, respiratory tract and CNS effects-dizziness, nausea, headache.

Product Name: Adhesion Promoter 4296T (Scotch Mount) Primer

Hazardous Ingredients: Methyl Isobutyl Ketone, toluene*, N-butyl acetate, alkyd resin, nitrocellulose, ethyl alcohol (ethanol), phosphoric acid, xylene**, isopropyl alcohol.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation eyes, nose, throat upper respiratory tract, skin. CNS effects.

Product Name: HP21054 HSE Adhesion Promoter

Hazardous Ingredients: ethyl benzene*, xylene**, mixed with HC

Decomposition Products:

Health Effects/Symptoms/Overexposure:

Product Name: 3M Adhesion Promoter 4298T

Hazardous Ingredients: Cyclohexane, methyl alcohol, xylene**, ethyl alcohol*, ethyl benzene*, acrylate polymer, 2,5 –furandione, isopropyl alcohol, 4,4-isopropylidendiphenol* (ECH polymer, chlorobenzene, benzene*.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: carcinogenic chemicals, irritation to eyes, upper respiratory tract.

Product Name: A-1104-B (BF Goodrich)

Hazardous Ingredients: MEK**, toluene*, butyl alcohol, ethyl acetate, ethanol, phenol*, Isopropyl alcohol

Decomposition Products: Co, Co2, smoke aliphatics and others.

Health Effects/Symptoms/Overexposure: irritation to eyes, nose and throat, nausea, CNS effects- dizziness, lassitude, brain damage, kidney/liver damage.

Product Name: Solvent Cement

Hazardous Ingredients: Toluene*, MEK**, acetone, ethyl acetate

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of eyes, upper respiratory tract, nausea, headaches, CNS effects dizziness.

Product name: A-1610-B

Hazardous Ingredients: MEK**, Toluene*, ethanol, butyl alcohol, Isopropyl alcohol, propylene-Propylene oxide, phenol*.

Health Effects/Symptoms/Overexposure: same as above irritation and CNS effects.

Product Name: HP21054-4B1 (adhesive)

Hazardous Ingredients: toluene*, xylene**, ethyl benzene*, carbon black, cyclohexanone

Same as above

THINNERS/SOLVENTS/CLEANERS/REDUCERS

Product Name: R 790-T 2K reducer

Hazardous Ingredients: MEK, propylene glycol methyl ether acetate, N-Amyl, isobutyl acetate, 2-ethylhexyl acetate, xylene, butyl acetate-n.

Decomposition Products: Not provided

Health Effects/Symptoms/Overexposure: CNS effects, irritation to eyes, skin and respiratory tract.

Product Name: Hi Sol10(SHI 7000) Petroleum distillate (Morton)

Hazardous Ingredients: Xylene**, Naphtha c8-c10, ethyl benzene*.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to the eyes, skin, respiratory tract, CNS-dizziness, liver/kidney damage, avoid inhalation.

Product Name: 16771 Thinner(Morton)

Hazardous Ingredients: MEK, isobutyl acetate, propylene glycol methyl acetate, ethylhexyl acetate

Decomposition Products: Not provided

Health Effects/Symptoms/Overexposure: CNS-dizziness, headache, etc. Irritation to eyes, skin, respiratory tract, nausea, vomiting.

Product Name: Hisol 10 (AHC) Solvent

Hazardous Ingredients: Naphtha, petroleum

Decomposition Products: Hydro Carbons

Health Effects/Symptoms/Overexposure: irritation to eyes, lung, GI tract –air purified respirator

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Product Name: T16776 thinner (Morton)

Hazardous Ingredients: Isobutyl acetate, propylene glycol ether acetate, dimethyl adapate.

T16776 (continued)

Health Effects/Symptoms/Overexposure: irritation to eyes, skin, respiratory tract, CNS effects-dizziness, head ache nausea, diarrhea.

Product Name: Pebra 5 (S-58) Pebra Inc.

Hazardous Ingredients: Tetrahydrofuran, Perchloroethylene (contains trichloroethylene) and cadmium.

Health Effect/Symptoms/Overexposure: irritation to eye, skin, respiratory tract, CNS effects etc.

Product Name: Baytec 505 c 505

Hazardous Ingredients: Dimethyltoluenediamine (DETA), Benzenediamine, 2,4 diethyltoluenediamine, 2,6 ditto.

Decomposition Products: aromatic amines vapors, CO, CO2.

Health Effects/Symptoms/Overexposure: methoglobenemia, cyanosis, irritating to eyes, skin, respiratory tract, tumors on liver, breast, thyroid, mutagenicity.

Product Name: Swish Strip non-amoronated stripper

Hazardous Ingredients: Sodium carbonate, sodium metasilicate, monoethanolamine, sodium hydroxide, dipropylene glycol methyl ether, nonyl phenol ethoxylate.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritating to eyes, skin and respiratory tract.

Product Name: Indicator 2/and 99

Hazardous Ingredients: isopropanol***,

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: positive mutagenicity irritating to upper respiratory tract.

Product Name: Diacetone Alcohol-2B Union Carbide

Hazardous Ingredients: (ketone) 4-hydroxy-4-methyl-1-2- pentanone

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: kidney damage

Product Name: Xenit Citrus

Hazardous Ingredients: dimethyl carbinol, Citrus distillates

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: eye and upper respiratory irritation, dryness in mouth, numbness on tongue.

Product Name: Solvent Blend

Hazardous Ingredients: MEK**, N-hexane, toluene(benzene*)

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of eyes and upper respiratory tract, CNS effects, neurotoxic.

Product Name: Indo 401 (degreaser)

Product Name: Butyrate Cut SV4280

Hazardous Ingredients: Cellulose Acetate Butanate, Butyl Acetate, Methyl Ethyl Ketone

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Nose and throat irritation; harmful if inhaled; may affect brain or nervous system causing dizziness, headache or nausea. Reports have associated repeated and prolonged overexposure to solvents with permanent brain and nervous system damage. Ingestion may cause nausea, vomiting, headache, dizziness and stupor from irritation of digestive tract. Direct contact with vapors may cause tearing, redness and swelling.

Product Name: Clear Lacquer SV4369

Hazardous Ingredients: 2-Butoxyethanol, 2-Pentanone, 4-Methyl-Toluene, 1 Propanol, 2 Methyl

Decomposition Products: C0 and C02

Health Effects/Symptoms/Overexposure: Irritant: Inhalation: allergic respiratory reaction. Overexposure may cause liver and kidney damage, nose and throat irritation, neurological including dizziness, headache, nausea; Ingestion: may cause toxic encephalopathy, liver/kidney damage, can enter lungs during swallowing or vomiting, can cause lung inflammation and damage. Prolonged exposure to vapors and mists may cause blood disorders, permanent brain and nervous system damage.

Product Name: Elastomeric Clear Base, SV4214

Hazardous Ingredients: Butyl Acetate, Complex organic compound

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Irritation: Inhalation - nose and throat irritation, neurological symptoms including dizziness, headache, nausea. Ingestion – may cause liver and kidney damage. Reports have associated repeated and prolonged overexposure with permanent brain and nervous system damage.

Product Name: Baking Enamel Thinner SV1986

Hazardous Ingredients: Aromatic hydrocarbon Blend

Decomposition Products: C0 and C02

Health Effects/Symptoms/Overexposure: Irritant: Inhalation: may affect brain or nervous system causing dizziness, headache or nausea, in poor ventilation may produce unconsciousness and asphyxiation. May cause tearing, redness and swelling of eyes. Ingestion: nausea, vomiting, headache, dizziness and stupor from irritation of digestive tract. Long term use, brain and nervous system damage.

Product Name: Urethane Grade Thinner SV4305

Hazardous Ingredients: 2-Propanone, Methyl Ethyl Ketone, Aromatic hydrocarbon Blend 1, Aromatic hydrocarbon Blend 2

Decomposition Products: C0 and C02

Health Effects/Symptoms/Overexposure: Irritant: Inhalation: may affect brain and nervous system causing dizziness, headache, or nausea. In poor ventilation may produce unconsciousness and asphyxiation. Eye contact: burning, tearing, redness and swelling. Ingestion: nausea, vomiting, headache, dizziness and stupor from irritation of the digestive tract.

Product Name: SV4239 Red Spot Paint and Varnish Co.

Hazardous Ingredients: Propanol, Methyl

Decomposition Products: C0 and C02

Health Effects/Symptoms/Overexposure: Irritant: Inhalation: may affect brain and nervous system causing dizziness, headache, or nausea. Eye contact: burning, tearing, redness and swelling. Ingestion: no evidence of adverse affects

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Product Name: Med Urethane Grade Thinner SV4167

Hazardous Ingredients: 2-Propanone, Butyl Acetate, Oxo-Decyl Acetate

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Inhalation: may affect brain and nervous system causing dizziness, headache, or nausea. In poor ventilation may produce unconsciousness and asphyxiation. Eye contact: burning, tearing, redness and swelling. Ingestion: nausea, vomiting, headache, dizziness and stupor from irritation of the digestive tract.

Product Name: Methyl n-amyl ketone SV455

Hazardous Ingredients: Methyl n-amyl ketone

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Inhalation: may cause drowsiness, eye irritation

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Product Name: Petroleum Solvent SV1986

Hazardous Ingredients: Solvent Naphtha

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Moderately irritating: low to moderate toxicity

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Product Name: Solvent Blend SV4167

Hazardous Ingredients: N Butyl Acetate, 1 Methyl1-2Pyrrolidone, Acetone, Dimethyl Gluterate, Dimethyl Adipate, Dimethyl Succinate

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Irritant: high vapor concentrations or contact with eyes causes irritation, tearing and burning. Long-term exposure to high vapor may produce vision impairment. Inhalation can cause dizziness, headache, nausea, and vomiting. Poisonous if swallowed causing blindness, narcosis, headache, nausea and vomiting leading to severe illness and perhaps death.

Product Name: T580 Thinner

Hazardous Ingredients: Xylene

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Irritant: Inhalation: nasal and respiratory irritation, dizziness, weakness, fatigue, nausea, headache, possible unconsciousness/asphyxiation. Ingestion: nausea, vomiting and diarrhea, aspiration into lungs can cause chemical pneumonitis which can be fatal; Eye contact can cause irritation, seek medical attention immediately. Special Precautions: Overexposure has been found to cause liver abnormalities, kidney damage, eye damage, anemia in animals and is suggested as cause of cardiac abnormality in humans. State of California lists product under Proposition 65 as possible carcinogen.

Product Name: T65717 Thinner

Hazardous Ingredients: Isobutyl acetate

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: missing data. This chemical listed under California Proposition 65 as possible carcinogen.

Product Name: T16646 Thinner

Hazardous Ingredients: Isobutyl Acetate, Methyl Ethyl Ketone

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: Air supply respirator required. Goggles and gloves. Chemical listed under California Proposition 65 as possible carcinogen.

Product Name: SV4261 Thinner

Hazardous Ingredients: Ethyl 3-Ethoxypropinate

Decomposition Products: C0 and/or C02

Health Effects/Symptoms/Overexposure: no evidence of adverse effects. A developmental toxicity study found slight fetotoxicity in litters of rats at concentrations of 1000 ppm. Reports have associated prolonged overexposure to permanent brain, and nervous system damage.

Product Name: Urethane Grade Retarding Thinner SV4430

Hazardous Ingredients: Aromatic Hydrocarbon Blend, Dimethyl Glutarate, Dimethyl Adipate

Decomposition: C02 and/or C0

Health Effects/Symptoms/Overexposure: If poor ventilation, may produce unconsciousness and asphyxiation. May affect the brain or nervous system causing dizziness, headache or nausea; Ingestion: May cause nausea, vomiting, headache, dizziness and stupor from irritation of digestive tract. Reports have associated prolonged overexposure to permanent brain, and nervous system damage.

Product Name: Urethane Grade Thinner SV4563

Hazardous Ingredients: Acetic Acid

Decomposition: C0 and/or C02

Health Effects/Symptoms/Overexposure: No evidence of adverse exposure affects. Not credible. See below.

Product Name: Urethane Grade Thinner SV 4562

Hazardous Ingredients: Acetic Acid

Decomposition: C0 and/or C02

Health Effects/Symptoms/Overexposure: may cause nose and throat irritation, harmful if inhaled. May affect the brain or nervous system causing dizziness, headache or nausea.

Product Name: T16720 Thinner

Hazardous Ingredients: 2-Ethylenexyl Acetate, 1-Methoxy-2-Propanol Acetate, Xylene

Decomposition: C0 and/or C02

Health Effects/Symptoms/Overexposure: Irritant: Inhalation: dizziness, weakness, fatigue, nausea, headache, possible unconsciousness and asphyxiation. Ingestion: nausea, vomiting diarrhea, aspiration may cause chemical pneumonitis which can be fatal. This chemical listed under California Proposition 65 as possible carcinogen.

Product Name: T740 Thinner

Hazardous Ingredients: 1-Methoxy-2-propanol acetate

Decomposition: C0 and/or C02

Health Effects/Symptoms/Overexposure: Can cause irritation of the eye, respiratory, and digestive systems. Reports have associated repeated and prolonged occupational overexposure with permanent brain and nervous system damage**. This chemical listed under California Proposition 65 as possible carcinogen.**

Product Name: SH16200 Solvent

Hazardous Ingredients: Xylene

Decomposition: C0 and/or C02

Health Effects/Symptoms/Overexposure: Can cause irritation of the eye, respiratory, and digestive systems. Reports have associated repeated and prolonged occupational overexposure with permanent brain and nervous system damage**. This chemical listed under California Proposition 65 as possible carcinogen.**

Product Name: T16703 Thinner

Hazardous Ingredients: Isobutyl Acetate, 1-Methoxy-2-Propanol Acetate

Decomposition: C0 and/or C02

Health Effects/Symptoms/Overexposure: Can cause irritation of the eye, respiratory, and digestive systems. Reports have associated repeated and prolonged occupational overexposure with permanent brain and nervous system damage**. This chemical listed under California Proposition 65 as possible carcinogen.**

PAINT KITCHEN/PAINT LINE

Product Name: Almatex

Hazardous Ingredients: 1,6 hexa methylene, diisocyanate, base aduct aliphatic polyisocyanate, xylene, n-butyl acetate

Decomposition Products: CO, CO2, NOx, HCN, HDI, xylene, butyl acetate

Health Effects/Symptoms/Overexposure: irritating to eyes and upper respiratory tract, lung shortness of breath likely due to xylene, butyl acetate.

Product Name: Histol 10

Hazardous Ingredients: naphtha, petroleum distillates

Decomposition Products: CO, CO2, HCs

Health Effects/Symptoms/Overexposures: irritation to eyes, upper respiratory tract, skin, GI. Local exhaust required.

Product Name: Solvent Based Primer A-1104-B

Hazardous Ingredients: dutyl alcohol, toluene*, MEK**/***, methyl methacrylate, acrylic co-polymer, ethyl acetate, ethanol, isopropyl alcohol, formaldehyde.

Health Effects/Symptoms/Overexposure: irritation of eyes, upper respiratory tract, skin; brain and CNS damage, fetal toxin.

Product Name: Ashland, Xylene** aromatic HC

Health Effects: irritation of eyes, and upper respiratory tract, skin, GI tract; CNS effects, pneumonitis. Fetal toxic.

Product Name: Bayflex 210 Component A, Aromatic Isocyanate polymer

Hazardous Ingredients: Isocyanate

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritating to eyes and upper respiratory tract, skin, runny nose

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Product Name: Base Coat Black

Hazardous Ingredients: butyl acetate, butanol, xylene**, 2-butoxyethylacetate, dipentene

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritating to eyes and upper respiratory tract.

Product Name: Clear Coat

Hazardous Ingredients: butylacetate, Methoxypropylacetat, xylene**.

Product Name: 2K – Pur-Primer

Hazardous Ingredients: N-methyl pyrrolidone, methylisobutylacetate, aromatic HC mixture C9-C12.
Health Effects: not provided

Product Name: Base Coat White Same as above in Black

Product Name: Hardener 2K Primer

Hazardous Ingredients: butyl acetate, methoxypropyl acetate, aromatic HC mixture C9-C12, HDI, polyisocyanate.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation eyes, upper respiratory tract, skin, sensitization

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Product Name: Polyester

Hazardous Ingredients: butyl acetate, methloxypropylacetate, xylene.

Decomposition Products: styrene* and organic peroxides

Health Effects/Symptoms/Overexposure: irritation and burns

Product Name: 2K PUR-Gray Primer

Hazardous Ingredients: Butyl acetate methyloxypropylacetate, xylene**.

Health Effects: irritation eyes, upper respiratory tract.

Product Name: Base Coat Beechwood Metallic

Hazardous Ingredients: butyl acetate, xylene**, butanol, dipentent, butyl glycolate

Health Effects: irritation eyes, upper respiratory tract, skin

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Product Name: 00111287 Reducer

Hazardous Ingredients: butyl acetate

Product Name: Clear Coat Hardener

Hazardous Ingredients: HDI, xylene**, n-butyl acetate

Decomposition Products: CO, CO2, NOx, HCN, HDI.

Health Effects: irritation to eyes, upper respiratory tract, skin, sensitization

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Product Name: Booth Coat:

Hazardous Ingredients: White petrolatum, dye

Decomposition Products: NO, CO, CO2

Health Effects/Symptoms/Overexposure: irritation of eyes, skin, nose, throat and upper respiratory tract. CNS effects- depression

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Product Name: 89238 HC UR white auto coating

Hazardous Ingredients: titanium dioxide *, melamine resin, ethyl benzene*, xylene**, formaldehyde, MEK**, methyl alcohol, n-Ayl acetate

Health Effects/Symptoms/Overexposure: CNS effects, irritating to eyes, skin upper respiratory tract.

Product Name: Tergitol (Dow Chemical) NP-Surfactant (iso spill clean up)

Hazardous Ingredients: 4-nonylphenol branched ethoxylated, poly (ethylene oxide), dinonylphnyl polyoxyethylene**

Health Effects/Symptoms/Overexposure: fetal toxin

Product Name: Butyl Cellosolve

Hazardous Ingredients: 2-butoxyethanal

Decomposition Products: not reported

Health Effects/Symptoms/Overexposure: Kidney and Liver damage

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Product Name: Diacetone Alcohol

Hazardous Ingredients: not provided

Decomposition Products: Acetone, Mesityl oxide, ketones

Health Effects/Symptoms/Overexposure: irritation of the skin, eyes, nose and throat. Kidney damage, red blood cell damage (hemolysis) anemia.

Product Name: DBE Dibasic ester

Hazardous Ingredients: dimethyl glutarate, dimethyl adapate, dimethyl succinate, methanol, hydrogen cyanide

Decomposition Products: methanol released

Health Effects/symptoms/Overexposure: not provided

Product Name: Ektasolve EB Acetate

Hazardous Ingredients: 2-Butoxyethyl acetate

Decomposition Products: peroxides, CO, CO2

Health Effects/Symptoms/Overexposure: blood cell damage, kidney damage

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Product Name: Solvent Blend

Hazardous Ingredients: MEK**, acetone**, toluene*

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to the eyes, burning, tearing

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Product Name: PM Acetate

Hazardous Ingredients: Propylene glycol, Methyl ether acetate

Decomposition Products: CO, CO2, NOx,smoke.

Health Effects/Symptoms/Overexposure: brain and CNS damage

Product Name: Isopropyl alcohol 99 anhyol

Hazardous Ingredients: not provided

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of the eyes, skin, lung and digestive tract.

Product Name: N-methyl-2-pyrrolidone** (Chem-Trend Inc)

Hazardous Ingredients: not provided

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of skin, eyes, lungs and adverse reproductive effects.

Product Name: Mold Cleaner 405/201B used in RIM

Hazardous Ingredients: N-methyl-2-pyrrolidone**, ethylene glycol, monobutyl ether, solvent blend

Decomposition Products: not provided

Health Effects/symptoms/Overexposure: irritation of eyes, upper respiratory tract, skin, chemical pneumonitis. Adverse reproductive effects also noted animals and humans.

Product Name: Hexane (liquid) UN # 1808.

Hazardous Ingredients: naphtha, cyclohexane, n-hexane

Health Effects:/Symptoms/Overexposure: peripheral nervous system, depression, avoid breathing vapors., irritating to eyes, respiratory tract, headache, dizziness, adverse impact on CNS potentiated with exposure to MEK, MIBIC and testicular damage.

Product Name: Arcosolv (PM acetate)

Hazardous Ingredients: 1-methoxy-2- propanol acetate, 2-methoxy-1-propanol acetate.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of skin, eyes, lungs

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SLUDGE ROOM CHEMICALS

Product Name: Vanchem 1208

Hazardous Ingredients: Formaldehyde*

Decomposition Products: Aldehydes

Health Effects/Symptoms/Overexposure: irritation eyes, nose and throat. Carcinogenic risk.

Product Name: Vanchem 1824

Hazardous Ingredients: Aluminum chloride***

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of eyes, nose throat and skin. Positive mutagenic data.

Product Name: Bromocide

Hazardous Ingredients: 1-bromo-3- chloro-5,5 dimethyldantoin

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to eyes, nose and throat, skin

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Product Name: disinfectant flammable #9833

Hazardous Ingredients: ethanol, triethylene, propylene glycol monoethylether, liquid petro gas

Health Effects/Symptoms/Overexposure: irritating to eyes and upper respiratory tract, avoid inhalation.

Product Name: TEXOLP 135 (detactifier)

Hazardous Ingredients: Formaldehyde*

Health Effects/Symptoms/Overexposure: irritation to eyes, skin, respiratory tract. Cancer

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Product Name: Titrating Solution 89

Hazardous Ingredients: Sodium hydroxide (NaOH)

Health Effects/Symptoms/Overexposure: not provided

Product Name: Titrating Solution 61

Hazardous Ingredients: HCL

Product Name: End Bac II

Hazardous Ingredients: isobutene, propane

Product Name: Dustbane

Hazardous Ingredients: crystalline silica

Product Name: Parco Biocide 2426

Hazardous Ingredients: 1 poly coxyethylene-(dimethyl-1-minfo) ethylene(dimethyli-minio) ethylene dichloride.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritant **Product Name**: Parco Purge

Ingredients: May have heavy waste metals

Product Name: Penetrating Oil.

Hazardous Ingredients: 1,1,1 trichloroethane, Petroleum distillates, petroleum lubricants

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: respiratory irritation, unconsciousness, dizziness, headache, CNS damage, liver, lungs and kidney damage, ventricular fibrillation.

Product Name: Lubricating Grease (Shell grease EP 2)

Decomposition Products: CO, CO2, HCL, SO2, SO3, NOx, POx, smoke

Health Effects/Symptoms/Overexposure: upper respiratory irritation, lung fibrosis

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MOLD RELEASES, CLEANERS AND PURGING AGENTS

Product Name: Stoner Rocket Release E-702

Hazardous Ingredients: halogenated HC, ether blend, diichlorofluoroethanedimethylether

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: not provided (150 to 300 applications per shift)

Product Name: Paintable Mold Release

Hazardous Ingredients: TCE*, perchloroethylene*, methyldodeoyl, methyl(2-Phenoxypropyl-siloxane.

Decomposition Products: HCL, silicon dioxide, formaldehyde*-, Phosgene+Chlorine.

Health Effects/Symptoms/Overexposure: Irritation of eyes, nose, throat. CNS effects

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Product Name: Soap Solution R-602 mold release (RIM)

Hazardous Ingredients: N-propyl alcohol

Health Effects/Symptoms/Overexposure: irritant, respiratory protection cartridge respl

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Product Name: Mold Cleaner 201B (RIM)

Hazardous Ingredients: N- Methyl-2-Pyrrolidone**, ethylene glycol, monobutyl ether, solvent blend

Decomposition Products: not provided

Health Effects: irritant, fetal toxin

Product Name: Rapid Purge

Hazardous Ingredients: inert minerals, inorganic salts, organic salts, TPO (thermoplastic Polyolefins)

Decomposition Products: Co2, CO, N, ammonia

Health Effects: not provided

Product Name: Ventra Purge Solvent (Ashland Dist. Co.)

Hazardous Ingredients: Toluene (benzene*), MEK**, MBK, n-hexane, EBK in MEK

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to the eyes, stinging, tearing, swelling, respiratory tract—inhalation and skin absorption, toluene effects on CNS, cardiac arrest, kidney and liver damage. California state legislation requiring report any carcinogenic and reproductive toxins.

- RCTW-2006 mold release (same as mold release No.602

FILLERS/PUTTIES/BUFFING COMPOUNDS

Product Name: Promat Pore filler 3311 PUR filler

Hazardous Ingredients: not provided

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: not provided

Product Name: Finesse 051144-76504*

Hazardous Ingredients: Aluminum Oxide, naphtha, mineral oil, glycerin, morpholine, carbon black*

Decomposition Products: phenol formaldehyde

Health Effects/Symptoms/Overexposure: irritation to eyes, and upper respiratory tract. CNS effects, headaches, dizziness. Warning avoid breathing vapor.

Product Name: Grey Putty- 3M Flexible Paste Putty 5903

Hazardous Ingredients: HDI, isopropyl alcohol, talc, polyurethane, Silica*, toluene (benzene*)

Decomposition Products: not provided

Health Effects/Symptoms/Overexposures: irritating to eyes, skin, respiratory tract, sensitization from HDI (isocyanate)

Product Name: Bayflex Black Paste N

Hazardous Ingredients: carbon black*, polyether

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation of eyes and upper respiratory tract, cancer

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Product Name: Union Carbide-cyclohexanone (ketones)

Hazardous Ingredients: not provided

CATYLISTS/HARDENERS (PAINTS)

Product Name: 86191-CC 2KB (catalyst (silver)

Hazardous Ingredients: MEK**/****, ethyl benzene*, toluene*, MAK Isobutyl acetate, n-amyl acetate, aluminum, naphtha, mineral spirits, xylene**, Propylene glycol methyl ether acetate.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: edc, carcinogens, fetal toxics, liver/kidney damage

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Product Name: DABCO T-12 Catalyst for polyurethanes

Hazardous Products: dibutyltin dilaurate

Decomposition Products: CO, CO2, tin oxides, organic acid vapor,

Health Effects/Symptoms/Overexposure: irritating to eyes, skin, respiratory tract, liver, kidney damage, shortness of breath, CNS effects, decreased fertility.

Product Name: Almax Clear Coat Hardener

Hazardous Ingredients: N-butyl acetate, Methoxy propyl acetate, xylene**, isopolymer.

Decomposition Products: CO, CO2, NOx

Health Effects/Symptoms/Overexposure: irritated eyes, upper respiratory tract.

Product Name: Almatex Hardener for primer.

Hazardous Ingredients: n-butyl, xylene, iso-polymer

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: Brain, CNS damage, irritation of eyes, upper respiratory tract.

Product Name: 10002Kist Reduced Clear Coat/2kist/2KC

Hazardous Ingredients: propylene, glycol, methyl ether acetate, MK MAK, diisobutyl ketone, ethyl benzene*, 2-ethylhexyl acetate.

Decomposition Products: not provided recorded

Health Effects/Symptoms/Overexposure: irritation eye, skin, respiratory tract. Cancer

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Product Name: R-790 2K Clear coat for HC UR560 B/Ss

Hazardous Ingredients: n-amyl acetate, MEK**, propylene glycol ether acetate, xylene**, k Benzotriazole, methyl amyl ketone*.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: CNS effects, irritation of eyes, skin GI and respiratory tract.

Product Name: P-3 Clear Masking 2484*

Hazardous Ingredients: Glycerin, triethanolamine, may produce nitrosamines if mixed with Nitrogen

Decomposition Products: not provided

Health Effects/Symptoms/Overexposures: irritating to eyes, skin, respiratory tract. Glove protection

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Product Name: 2004-C 2KC Catalyst for 2kc (HDI)

Hazardous Ingredients: P(HMDI) hardener, isobutyl acetate, butyl acetate, naphtha, 1,2,4 trimethyl benzene, ethyl benzene*, xylene**. Hexamethylene diisocyanates (HMDI)

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to eyes, skin, upper respiratory tract, sensitization, CNS effects, Kidney, blood forming system reproductive, cancer.

Product Name: Bayflex 110-50 IHR component B (RIM) isocyanate.

Hazardous Ingredients: Poly(oxyalkylene)polyol system, diethyltoluenediamine DETA, organotin, aliphatic amine.

Health Effects/Symptoms/overexposure: irritating to eye, respiratory, skin, sensitization, methemoglobinemia (turn blue) interfere with oxygen in blood.

Product Name: Total

Hazardous Ingredients: sodium metasilicate, n-alkyl dimethylaryl ammonium chlorides, nonylphenoxypolyethoxyethanol.

Health Effects/Symptoms/Overexposure: irritation of the eyes, skin respiratory tract—rubber gloves required

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Product Name: Speed stripper (corrosive)

Hazardous Ingredients: ethylene glycol, monoethyl ether, sodium xylene, monoethanolamine, sodium metasilicate.

Health Effects: not provided

Product Name: Over and Under

Hazardous Ingredients: dipropylene glycol methylether, tributoxyethyl phosphate, diethylene glycol, acrylic polymer.

Health Effects: not provided

Product Name: Encounter 969402

Hazardous Ingredients: Octyl phenol ethoxylate.

Health Effects: not provided

Product Name: MC-15-6000

Hazardous Ingredients: MEK**, Toluene (benzene*), isopropyl alcohol, n-propyl acetate, ethyl acetate, acrylic polymer solids

Health Effects/Symptoms/Over exposure: irritation to eyes, skin GI, Lung, CNS effects, chronic lung disease (COPD.

Product Name: R-185-1 (Flash)**

Hazardous Ingredients: toluene (benzene)*, titanium* dioxide, isopropyl alcohol, xylene**, Methylpyrrolidone, n-isobutyl alcohol, ethyl benzene*, carbon black*.

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: CNS effects, irritation to eyes, GI and respiratory tract. Kidney/liver/lung damage, adverse reproductive effects—testes, birth defects

Product Name: Morton T-16806

Hazardous Ingredients: Isobutyl acetate, MEK**, dibastic ester

Decomposition Products: not provided

Health Effects/Symptoms/Overexposure: irritation to eyes, upper respiratory tract, GI. CNS effects and can potentiate the peripheral nervous system via Methyl N-ketone N-hexane. liver/kidney damage

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Product Name: Di basic ester

Hazardous Ingredients: diethyl gluterate, dimethyl adipate, dimethyl succinate.

Health Effects/Symptoms/Overexposure: irritation to eyes, skin respiratory tract, GI tract

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Product Name: Morton T16776 solvent blend

Hazardous Ingredients: Isobutyl acetate, glycol ether PM acetate

Health Effects/Symptoms/Overexposure: not provided

Product Name: Morton T16796 thinner

Hazardous Ingredients: propylene glycol, methyl ether acetate, diisobutyl ketone, MEK**, 2-ethylhexyl acetate, dimethyl adipate.

Health Effects/Symptoms/Overexposure: irritation of eyes, skin, respiratory tract, kidney liver damage and CNS effects.

APPENDIX D

March 28/2019

To whom this may concern,

Hi my name is Rose Wickman, previously the President of Local 1987, and recently retired 2017.

Due to recent findings, I have become concerned with cancers that were found in Ventra Plastics in Peterborough also formely known as Pembra or JPE going back to the years of 1986-1996 and Dec 1996-Dec 1998.

As a result I reached out to a former Health and Safety Management Representative to investigate Pebra # 5. I was informed that Pebra #5 used in the Peterborough plant was different from the one used in Kitchener Ontario.

The Pebra 5 that was used in Peterborough was protected under a trade secret and comprised of a mixture using Pebra 5, MEK, and Cadmium.

Because of this protected secret, my belief and findings, have now contributed to findings that with this mixture of chemicals there have been a number of prior health issues...examples of cancer and other health problems.

If you have any questions or concerns please feel free to contact me

Rose Wickman 705-778-1869

Rose Wickman

Rose Wickman

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APPENDIX E

WORKER EXPOSURES TO SUBSTANCES PREVALENT IN THE PLASTICS INDUSTRY

TABLE OF RESULTS OF MONITORING STUDIES

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
Styrene:				
Meyer-Bish and Protois, 1986	45% of plants in study had level greater than 50ppm			
Lemasters, et al., 1985	Auto Parts Production Mixers: 11-26 ppm Press Mold: 20-30 ppm			
Crandle and Hartle, 1985	Hull: 35-122 ppm Deck: 37.2-124 ppm Parts: 29.7-97 ppm			
Brugnone, et al., 1993	204ug/l		1590ug/l (end shift) 94ug/l (16hrs after)	0.22ug/l (blood)'normal' 0.006ug/l (air)
Galassi, et al., 1993	227mg/m3 (hand) 134mg/m3 (spray) 85mg/m3 (automated)	682mg/g 404mg/g 243mg/g		186mg/g (non exposed) 50ppm=584mg/g (BEEL) 900mg/g= (BLV)
Crandall, 1985	20-200 ppm			
Apostoli, et al., 1983	361-488 mg/m3	348mg/l 1375mg/l 183mg/l 526mg/l	573ug/l 2575ug/l	TLV(TWA) 215mg/m3= 495mg/l (Umu) 260mg/l (Uphu) 811ug/l (blood)
Styrene: Stengel, et al., 1990	0-100 ppm	15-3740 mg/g (C)	Blood Parameters Affected: MCHC (-)	54.8 mg/g (C)

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
	1-49 ppm 50-99 ppm > 100 ppm	376.7 mg/g 896.1 mg/g 911.2 mg/g	MCV (+) Neutraphils (-) Monocytes (+)	
Anwar and Shamy, 1995		328.44 mg/g (C)	Blood Parameters Affected: Chromosome Aberration (+)	50.09 mg/g (C)
Jensen, et al., 1990	265 mg/m3 (1950-88) 714 mg/m3 (1955-70) 172 mg/m3 (1981-88) **Co-contaminants**: Dichloromethane 51mg/m3 Xylene 49mg/m3 Toluene 113 mg/m3 Perchloroethylene 7 mg/m3 Trichloroethylene 5mg/m3			
Styrene: Kolstad, et al., 2005	< 1970= 738.3 mg/m3 1970-74= 401.3mg/m3 1975-79= 306.4 mg/m3 1980-89= 174.9 mg/m3 1990-96= 84.5 mg/m3 Plastic Processing: 165.9 mg/m3 Hand Lamination:			

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
Hartle, 1978 Schumacher, et al., 1981 Dement, 1973 Crandall, 1981	427 mg/m3 Truck Parts: 9-60 ppm Truck Parts: 9-60 ppm Tub/Shower 40-100 ppm Tub/Shower 40-100 ppm			
Acrylonitrile: Houthuijs, et al., 1982	0.13 ppm	39ug/g Workday concentrations for non smoker: Range10-152 ug/g AN(U) Mean 42.9 ug/g AN(U) Day off concentrations: Mean 12.2 ug/g		Non smoker 2.0 ug/g
Acrylonitrile: Sakurai, et al., 1978 Scelo, et al., 2004	0.1 ppm AN(A) 4.2 ppm AN(A) 0.9-4.6 ppm positive association with lung cancer	3.9 ug/l AN(U) 360 ug/l AN(U)		No AN(U) detected in urine of controls
Phthalates: Vainiotalo and Pfaffli, 1990 Nielsen, et al., 1985	DEHP 1.1mg/m3 DEHP:	25umol/L (PA metabolite)		Environmental: 5-132ng/m3 17umol/L (PA metabolite)

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
Milkov, et al., 1973 Gilloli, et al., 1975 Theiss, et al., 1978 Liss, et al., 1985 Dirven, et al., 1993	2mg/m3 calendaring 0.2-0.4mg/m3 mach.atten 0.3mg/m3 repair 0.2mg/m3 mixer Phthalate Acid Ester: 66mg/m3 PA: 4-203 ug/m3 Boot: Mixing 261ug/m3	23umol/L 6.8-9.9 nmol/ml post shift 4.9-5.6 nmol/ml pre shift Boot: MEHP: 32.7-48.9nmol/ml		5.9 nmol/ml post shift 6.7 nmol/ml pre shift
	Extruder 120 ug/m3 Cable: Mixing 180 ug/m3 Extruder 239 ug/m3	Cable: MEHP:16.2-34.5nmol/ml		
		These are before and after shift values representing a 2.3 and 4.5 fold increase.		
Gaudin, et al., 2008 Koch, et al., 2003b Preuss, et al., 2005 Hines, et al., 2009		MEHP: 25.2 ug/g pre shift 55.9 ug/g post shift Phthalates Manufacture: DMP-1210ug/g(+)ss DEP- 716ug/g(+)ss DBP – 402ug/g(+)ss DiBP -3.59ug/g(+)		MEHP: 13.2 ug/g pre shift 13.5 ug/g post shift Referent populations: 9.8-10.3 ug/g HAINES (2001-2002) DMP-1.0ug/g DEP – 181ug/g DBP -16ug/g DiBP -2.3ug/g

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
		BzBP – 19.8ug/g(+) DnOP- 6/35ug/g(+) DEHP -25.4ug/g(MEHP) <u>PVC Film:</u> DMP-1.29ug/g DEP-60.2ug/g DBP-13.1ug/g DiBP-2.74ug/g BzBp-14.9ug/g DnOP-2.51ug/g DEHP-151ug/g(MEHHP) 84ug/g(MEOHP)		BzBP– 12.0ug/g DnOP– 2.24ug/g DEHP–3.96ug/g(MEHP) 17.2ug/g(MEHHP) 11.4ug/g(MEOHP)
Phthalates: Hines, et al., 2009		<u>Auto Filter Manufacture</u>: DMP-1.43ug/g(max.) DEP-102ug/g DBP-24ug/g DiBP-2.80ug/g BzBP-17.0ug/g DnOP-4.5ug/g DEHP-124ug/g(MECPP) 10.2ug/g(MEHP) 27.ug/g(MEOHP) <u>PVC Compounding:</u> DEP-164ug/g DBP-30.9ug/g DiBP-6.63ug/g BzBP-17.9ug/g DnOP-7.72ugg DEHP-102ug/g(MEHHP) 12.2ug/g(MEHP) 60.8ug/g(MEOHP)		

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
		<u>Rubber Hose:</u> DMP-1.94ug/g DEP-68ug/g DBP-168ug/g DiBP7.52ug/g BzBP-10ug/g DnOP-3.48ug/g DEHP-5.4ug/g 25.2ug/g 15.5ug/g		
Phthalates: Hines, et al., 2009		<u>Rubber Boot</u> DEP-183ug/g DBP36.4ug/g DiBP-9.26ug/g BzBP-40.4ug/g DnOP-3.92ug/g DEHP-5.37ug/g(MEHP) 59.6ug/g(MEHHP) 36.9ug/g(MEOHP) 69.3ug/g(MECPP) <u>Rubber Gasket:</u> DMP-1.12ug/g DEP-143ug/g DBP-418ug/g DiBP7-.42ug/g BzBP-70.1ug/g DnOP-6.62ug/g HEHP-12.1ug/g(MEHP) 54.6ug/g(MEHHP) 33.4ug/g(MEOHP) 69.3ug/g(MECPP)		

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
		Nail Salon: DMP-6.19ug/g DEP-199ug/g DBP-34.2ug/g DiBP-6.26ug/g BzBP-4.59ug/g DnOP-1.33ug/g Nail Salon(contd)		
Phthalates: Hines, et al., 2009		DEHP-19ug/g(MEHP) 34.4ug/g(MEHHP) 17.9ug/g(MEOHP)		
Bisphenol-A Hanoaka, et al., 2002 Calafat, et al., 2005 Kim Y-H, et al., 2003		Epoxy Resin Workers: 1.06umol/mol (C)		Controls: 0.52umol/mol (C) 1.12-.63ng/ml(urine) 2.76-2.82ng/ml(urine) 1.00-2.34ng/ml(urine) (BPAglucuronide) 0.49-1.20ng/ml(urine) (BPAsulfate)
Brominated Flame Retardants Thuresson and Jakobsson, et al., 2005 Thomsen, et al., 2001			Rubber Workers: Polybrominated diphenyl ether (PBDE) 270ng/g l.w (max.) 35ng/g l.w. (median) Electronics Dismantling: BDE-8.8ng/g l.w. TriBP	Referent: 2.49ng/g l.w. (median) Referent/Lab workers: BDE-3.0ng/g l.w.

CHEMICAL USED IN PLASTICS	AIR CONCENTRATION	URINE CONCENTRATION	BLOOD CONCENTRATION	REFERENT/CONTROL POPULATION
			12-81ng/g l.w.	
Heavy Metals: Tin (Organic) Boraiko, et al., 2005	PVC Processing: 0.1-0.102mg/m3 Blending-0.102mg/m3			
Lead Compounds Coyle, et al.,2005 Lead Compounds Coyle, et al., 2005	Extrusion-0.034mg/m3 Injection-0.007mg/m3 Milling-0.064mg/m3 Pelletizing-0.006mg/m3 PVC Processing: 460-1,100ug/m3* 20-400ug/m3** 3-210ug/m3*** *Manual handling of powdered lead sulfate **Manual handling of pellets ***Prepackaged lead stabilizer		PVC Processing: 108-159ug/dl	2ug/dl general population

APPENDIX F

RISK HAZARD ANALYSIS

POST LAM AND ROLLR FORM PRODUCTION RISK HAZARD ANALYSIS			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Roller Forming to shape parts from roll of stainless 5" wide steel stock on a 100' rolling mill	Operator guides material during high heat/pressure wash and degreasing	Fine mist and steam produced during wash contaminated with degreaser and metal coatings	Inhalation/absorption of mist and steam contaminated with solvents, TCE, Toluene, Acetone
Application of glue and attachment of PVC strip	Metal goes through a hot air blow dryer and then passes through an oven for gluing. Strip is attached manually on glued surface and pressed on with opposing rollers.	Application of glue and spills and drips produce vapors from gluing operation. Local exhaust not adequate (MOL). Pebra 5 glue fumes heavy. Soak parts in MEK	In halation and absorption of fumes from Pebra 5 contain: Perchloroethylene, TCE, and Tetrahydrofuran, MEK and cadmium. Exposure risk high
Sheets rough cut to size	Automatic cut with shears. Taken to saw operation	Glue continues to flash, wash sticky hands in MEK	Inhalation of fumes from glue and absorbed MEK
Rough cut sheet cut by saw	Saw operator sets part in jig and dry saws part to exact shape	Saw produces fine particulate of SS, glue, PVC	Inhalation of fine particulate: chromium, perch, tetra, TCE
Parts stack and taken to mold press for PVC overlay; 12 presses	Mold operator trims shavings, applies Pebra5, sets part in press	Fumes from glue flash, PVC process. High volume, no exhaust	Inhalation of PVC and glue fumes going on 12 molds at a time.
Post Lam "Ford Line": FN-36	Parts precut and washed as above	Fine mist with degreaser	Inhalation/ingestion of mist
Application of Glue on precut part 24"x48" And attachment of PVC strip	Glue applied manually with glue applicator filled with Pebra 5 and attachment of PVC strip	Larger volume of glue handled directly and parts stacked to flash, no exhaust ventilation.	Inhalation and absorption of glue for operator and by-standers very high. MOL order to correct.
Part to injection mold for overlay	Glue applied at ends with plugs and placed in injection mold	Fumes from glue flash and heated PVC without exhaust ventilation	High risk Inhalation of heavy fumes from PVC and Pebra 5
Arbourg mold set-up for lamination	Manual pouring of PVC pellet from 25kg bags into hoppers. Applying mold release agents 4 X/SHIFT	Opening and pouring of pellets high PVC dust and mold release vapors. No isolation.	Inhalation of PVC dust and mold release to operator and by-standers high. No exhaust
Purging and cleaning of molds	Pouring purging mix (Rapid Purge) and initiating purging process, purge waste smoldering and smoking. Solvent cleaning	Higher risk of exposure to resin decomposition because formulation and high heat application. Application of solvents on heated surfaces.	Very high risk of inhalation of smoke and fumes from purging process materials and solvents to operator and by-standers
Saw sharpening operation	Sharpened saw teeth with grinding wheel in MWF	Mist and droplets containing grinding wheel grit and epoxy	High risk exposure to MWF droplets with grit, metals, resins

INJECTION MOLDING THERMOPLASTIC OPERATION 1986-1996 FOUR SMALL SIZE 200 TO 300 TON MOLDS RISK HAZARD ANALYSIS			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Loading Resins	Hoppers were filled manually from bags of various resins. PVC, acrylic, polypropylene, styrene, etc. plus many additives	Little or no local exhaust ventilation, lots of dust from opening pellet containers and pouring into hoppers	Risk of inhalation and skin absorption from dust in hot sweaty environment.
Molds cleaned and treated with mold release	Molds sprayed with either Rocket Release or paintable mold release agents on hot mold surfaces 201B cleaner	Applied with propellant lots of overspray of mold releases on hot surface of mold produces heavy fumes and vapor	High risk of inhalation exposure to vapors from heated release agents for mold operator and by-standers from overspray
Handling ejected parts	Material handlers manually handled freshly molded parts	Hot, freshly molded, parts continue to off-gas	Inhalation and absorption from handling parts
Trim and torch	Trim worker handles parts to trim with exacto knifes and uses propane torch to smooth edges	Handling freshly molded with resin and mold release residues and fumes from torching	Inhalation of fumes and vapors from torching, as well as dust from sanding
Molding process	Set temperature and initiate the molding cycle. Resins heated to melting and injected into mold with release of gases	High heating of resin during molding cycle produces fumes and gases containing monomers, additives and variety of by-products with no local exhaust	High inhalation risk of exposure to monomers-VCM, styrene, acrylonitrile, phthalates, heavy metals, flame retardants and release agents.
Purging and Cleaning	Mold operators manually loading purging agents and polymers into the hoppers.	Manually pouring purging resins and solvents. Purged with acrylic resins. Creation of dusts and vapors. Purging at higher temperatures creates more intense fume and smoke and hazardous decomposition products	High risk of inhalation exposure to resin dusts containing various chemical formulations as well as thermal decomposition products such as acrylonitrile from acrylic resins and strong solvents such as toluene, MEK, acetone.
Regrinding Operations: small during this period grinding PVC and polyol. Expanded to several large grinders.	Grinder operator loads and tends grinder with waste plastic-TPU (gray) and TPO (black)	Produces heavy fumes/dusts with hazardous ingredients and by-products. Local exhaust inadequate and disabled	Risk of inhalation of dust and vapor created by the high heat caused by blade friction. VCM, phthalates, FG, silica et al.

REACTION INJECTION MOLDING OPERATION (R-RIM) 1989-2000			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Preparation of components to be injected into molds consist of isocyanate MDI and Polyol mixed in the "Tank Farm" area behind molding area. Polyol and MDI moved separately through heated piping under pressure from 5000USG tanks.	Polyol is mixed semi manually at the "mixing station" with Wollastonite, extenders, surfactants, catalysts, cross linking amines, Inner Mold Release (IMR). IMR drawn from 45 USG drum spigot into open bucket and then poured into mixer.	IMR was poured manually from buckets into mixer; Wollastonite poured in semi open with significant air born fibres; other ingredient also mixed manually. Many leaks and spills of ISO and Polyol noted at valves and pipe joints	Inhalation and dermal absorption risk from manual pouring of IMR with spills. Inhalation risk with the pouring of Wollastonite (tremolite), as well as exposure to MDI from leaky valves and performing maintenance and clean up
RIM injection molding operation with MDI and Polyol ready to be injected into the 8 clamps mixing head and injectors.	Cleaning Mold with clamp open mold operator cleans mold with cleaner 201B with scraper, brush, steel wool and rag with neoprene gloves and eye protection worn..	Application of cleaner on hot mold surface produces fumes and vapors from cleaning rag soaked in cleaner. Upward reach on the top clamp causes 201B to drip down operator's arm. Used after every 2-3 shots (66 times/shift)	Inhalation and absorption risk high given vapor produced when 201B (N-methyl-2-pyrrolidone, ethylene glycol, monobutyl ether) contacts heat surface. And is absorbed dermally when running down operator' arm.
Mold release application	Operator applies mold release R602 on all areas of mold	R602 is applied with a manually operated spray gun with a great deal of overspray and creation of vapors when spray hits heated surface. 180-200 shots/shift	As observed through video account, operator as well as trim table operators have high risk of inhaling the mist and vapors containing N-propyl alcohol with soap.
Molding Process commences	Operator closes clamp from control panel and initiates reaction injection molding	The two components are injected into the mix head and combine to react and expand as soon as they meet to fill the void in mold. Gases and vapors are produced and escape through vents. Exhaust not continuous. Shut off when trigger released on mold release sprayer.	High risk of inhaling chemical by-products and unreacted monomers of ISO and polyol since exhaust is not continuous. Operator as well as trim/sand operator close by shares risk of inhalation. Operator repeats process 180-250/day. Chronic exposure predictable.

REACTION MOLDING OPERATION (CONTINUED)			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Retrieving parts from mold	Operator retrieves part from hot mold and trims gates notches part and places these in the adjacent trim table. And begins to clear clam of remaining gates and materials with an compressed air gun and sprays R602 mold release	Hot part still likely off gassing contaminated residues that have just been formed seconds ago. The parts are then handled by the trim and sand personnel.	High risk of inhalation of vapors and gases from Clamp vents during and after molding. Also from freshly formed parts handled by trim and sand personnel.
Sand and trim process	Sand and trim use palm sander to sand and knifes to trim RIM parts	Sanding operation produces great amount of dust containing urethane and other additives and monomers. Accumulation of dusts on workers and work surfaces. Area very hot. Large fan used to cool disperses dust further.	High risk of inhalation of dust containing urethane, iso, monomers, Wollastonite, fibreglass and other additives. Reports indicate workers with obstructive lung problems from medical pre-screening.
Grey Putty operation	Grey putty operator examines parts and decides whether part needs to be puttied.	Putty is applied in an unventilated area with a foam brush bare handed and without respiratory protections. Contains HDI (ISO) asbestos, silica, MEK	Putty operator at high risk of inhalation and absorption of putty ingredients through skin. Worker not advised it contained HDI, Porenwishfuller 3311 diluted with a clear coat hardener and diacetate alcohol.
Post Cure Ovens 325^{o}F	After Grey Putty application, parts hung on racks on carousel conveyor into the oven for 1.5 hrs. After which operator would remove parts and place on racks for further inspection.	The heat in the cure oven would produce various gases/vapors that would escape from the semi enclosed oven. Strong odors present. A maintenance office and notching process underneath ovens plus a TCE vapor degreasing tank 4X4x2.	High risk of inhalation of vapors and gases containing ISO, HDI, MDI, polyol additives as well as decomposition products N^{x}, benzene, nitrosamines, phenol, styrene, et al. for oven operators and by-standers working underneath the oven.
Touch up area for RIM between paint line and post cure oven	Check for defects and sand, touch up with Grey putty at 12 tables	90% of work involve sanding very dusty and poorly vented	High risk of inhalation of dust with MDI, HDI, silica, asbestos, FG

LARGE INJECTION MOLDING THERMOPLASTIC FOUR LARGER 3000 TO 4000 TON AUTOMATED MOLDS (1993-2000)			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Pellet drying operation	Operator initiates pellet transfer to a 1500 ton dryer where pellets are heated to relatively high temperatures to remove moisture.	Vapors released into general atmosphere. Workers detect strong plastic odors in surrounding areas. Heavy dust when changing filters.	High risk of inhalation of solvent components of resin under moderate heating. Also dust containing resin components additives silica, FG, polymers, monomers. Risk to operators and by-standers.
Pellets transfer from dryer to mold chambers via high vacuum	Operator initiates pellet transfer. Pellets move at high speed with lots of friction.	High speed movement of pellets creates a great deal of dust captured in filters and canisters which must be cleaned frequently	High risk of exposure to resin dusts during filter clean out and maintenance. Dust containing silica, monomers, additives
Preparation of mold for thermal processing	Operators clean mold periodically with 201B and spray Rocket Release over mold surfaces.	Mold cleaner and Rocket Release is applied manually on hot surface produces high level of vapors from cleaner and release agent. 150-300 apps/shift. Also a great deal of overspray.	High risk of inhalation and absorption of cleaners and release agents by operator and by-standers containing TCE and perchloroethylene, formaldehyde, methyldodecyl,
Thermal processing	Operator initiates thermal process of heating resin pellets into liquid state and injecting into mold.	Thermal process produces vapor and gases that have to be release through mold vents connected to exhaust stack not adequate for extraction.	High risk of inhalations to resin decomposition products: Example: Cycoloy resin-silica, magnesium oxide, acrylonitrile, butadiene, styrene, carbon black, BPA, flame retardant, colourants
Retrieving molded parts	Part removal done robotically and then handled by material handlers	Warm part continues to release gases and vapors handled by material handlers. Mold release sprayed for next shot	Risk of inhalation of vapors from freshly molded parts by material handlers also exposed to mold release being sprayed
Trimming and torching parts	Material handlers trim parts with propane torch and knife	Trimming part with propane torch would produce fumes and vapors from torching plastic part. CO, CO^2 also produced	High risk of inhaling fumes and vapors from torched plastic as well as chemicals from mold release and propane torch.

LARGE INJECTION MOLDING OPERATION (CONTINUED)			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Purging injection molds	Set-up operator pours purging mixture and solvent into screw head, or purge mix automatically introduced from control panel	The heated purging materials would produce very heavy smoke and vapors from large mass of thermal plastics smoldering on floor for 20-30 minutes.	Very high risk of inhaling smoke, fumes and gases from purged:: Rapid Purge-- polyol, toluene(benzene) MEK, MBK, n-hexane, formaldehyde, benzene, PAH

SEVERAL THERMOPLASTICS RE-GRINDING OPERATIONS			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Grinding Waste TPO/TPU. As production increased the number of large grinders increased to 4 large grinders and became 24/7 operations for 3 consecutive shifts.	Grinder operators feeds damaged plastics into large grinders to make fine resin particulate to be reused in the thermal plastics operation.	Large grinders produced fine particulate that escaped from the trough because exhaust ventilation clogged or too low capture velocity. Heat from friction created vapors and fumes. MOL	High risk of inhalation of fine particulate, fumes and vapors from grinding operations to operators and by-standers in the general work areas. Particulate contains plastic monomers and additives silica, FG, and solvents

GLUE LINE PRODUCTION PROCESS			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Used to attach mylar, PVC or other materials to the parts on a hanging carousel. There were 8 glue lines that could be shifted from place to place as production demanded.	Glue line operators applied either Pebra 5 to glue and or Adpro Adhesion Promoter as a primer. Approximately 400 parts/shift.	Glues and primer were sprayed on manually from a pressure pot filled in the paint kitchen. Pebra 5 contained Perch, TCE, tetrahydrofuran, cadmium. Adpro-toluene, n-butyl acetate, alkyd resin, ethyl alcohol, xylene, methyl isobutyl, phosphoric acid	High risk of inhaling and absorbing the vapors as glues and coating flash off without local exhaust ventilation. See MOL hygiene report on inadequate ventilation on glue line. General contamination given the number of glue lines.

ASSEMBLY LINES PROCESSES			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
There were numerous assembly lines throughout the plant-touch up, sanding, coating, gluing, painting, installing, attaching on tables with	Sanding, touch up, painting, filling, coating, gluing, installing and attaching. 400 to 500 parts per shift.	High volume handling of glues, ISO paints, coating, solvents (MEK), no exhaust ventilation. Fumes from other areas e.g. paint, sludge, injection, RIM.	High risk inhalation/absorption of chemicals in use: MEK, Pebra 5, Adpro, ISO, putty, et al. Fumes from other departments because of General ventilation

conveyor. 8/shift.			flaws.
PAINT LINE EARLY PERIOD INSIDE/OUTSIDE			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Paint Kitchen: Paint/glue mixing area. All paints and glues mixed and paint pumps controlled and flushed.	During early period paint kitchen operator manually mixed all paints/solvents/catalysts/adhesives by the pail full then poured into 85 gallon paint pressure tanks. Pressure & flow monitored and adjusted. Paint lines (to paint booths) flushed by operator and set-up personnel for product changes.	Direct handling of all paints, thinners, solvents, washes with large quantities with limited PPE. Pouring and mixing with volatile chemicals, MEK, TCE, Toluene, HDI, catalysts, paints, primers and Pebra 5. Clearing and purging paint lines with Ventra Purge. Poor exhaust ventilation and Frequent spills	Paint Kitchen personnel at high risk of inhalation and absorption of Ventra purge ingredients: toluene, benzene, MEK, n-hexane; Also to HDI paints, hardeners, catalysts. Pebra 5 perch, terahydroxyfuran, TCE, Adpro Adhesion Promoters ingredients.
Multistage prep and paint process. Major source of solvent, thinner and isocyanate release-250000 USG & 1.3M lbs VOCs	Early Period: Freshly molded parts loaded onto carts on track, inspected & tack wiped alcohol soaked rags.	Outside paint personnel handling fresh molded parts, wiped down with alcohol. Poor ventilation causes fugitive emissions from paint line and sludge room, mold operations	High risk of inhalation for outside paint assembly workers of vapors from parts and fugitive emission from paint line, sludge room and paint kitchen frequently investigated due to spills/leaks
Prepping and paint spray process in the early period: Pre Wash	Drawn into tunnel for an automated 6 stage plastic chemical washes and rinses containing acids, caustics, Parco Plast at wash stations.	Residues of large variety of caustic and acid washes under high pressure generate mists and vapors.	Possible inhalation and skin contact if isolation and ventilation not functioning properly.
3 isolated paint booths under positive pressure: 1 setup, 3 touch-up per booth, 1 chemical monitor, 2 paint kitchen operator.	Next move through 3 booths: first, 2K primer coat; second, 2K base coat; and third, 2K clear coat. Automated but staffed with 2 touch-up spray painters. ("touch up" included painting backs, ends and places missed)	Touch up painter in booth wearing Tyvek suits and hoods with hose connected to outside ambient air, not air supplied while spraying HDI, hardeners and catalyst with thinners. A great deal of overspray.	High risk of inhalation and absorption (contact) with ISO paints and other coatings because respiratory and skin protection not effective. Ambient air would include contaminants.
Cure oven, inspection and assembly	Inspector at "hard gate" end of oven tunnel, sand, trim, rework & buffing	Fumes from oven leaks and fugitive emissions from positive pressure, dust from sanding and buffing and touch up paint.	High risk inhalation to paint vapors & dust and paint vapor containing HDI, and solvent vapors.

PAINT LINE (CONTINUED) LATER PERIOD POST 1993 AUTOMATED & INOVATED			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Paint line expanded about 1993 to add 2 new booths designed to provide 2 coats of base and 2 coats of clear. One-Oven at 325° F was expanded to accommodate larger parts and lengthen curing process. Second-Full scale Robot sprayers In each booth taking place of touch up painters. Third- Paint formulations changed to BASF & Morton systems with isocyanate HDI in clear coat sprays. Fourth-Flush lines with MEK/Ventra Purge –many skids filled with 45USG drums stored and heavily used.	Mixing paints and thinners from 45 USG drums using 30 pumps. Workers maintain the mixing process and monitor line system to ensure no clogging of lines. Workers monitor the process outside of booths and only enter the booths to adjust or repair robotics. Preparation of glues for assembly and glue lines Flush paint lines for colour change and end of day shift.	Larger volume of production and chemical usage. Larger spills and leaks. Fumes from oven leak. Larger volume of emission in the plant and in the environment as well as in the sluiceway and sludge room. Maintaining and repairing pumps risk of spills and leaks. Glue mixing generates fumes and vapors of MEK, Ad Pro, 4296 and 4298. Flushing and draining lines involved spill that went into Sluiceway/sludge room. And fugitive emission to other areas due to ventilation imbalances.	High risk of inhalation exposure due to poor work practices—spraying outside the clear coat booth when robots went down; entering booths without respirator. Larger volume of production and chemical use increased risk of exposure. Paints contained: MEK, acetone, xylene, HDI Sluiceway became a major source of chemical vapor migration when ventilation went down. Continual spills and fires in the paint line was a major source of exposure to decomposition products. PAHs, Nitrosamines, HDI, benzene, formaldehyde
Chemical Monitoring	Chemical monitor: tested proper mix in wash solutions, monitor sludge water, add chemicals to “kill” paint, remove solids from weir box in sludge tank, change filters, adjust air flow, viscosity, temperatures in booths and line.	Detailed handling a multitude of chemicals, wastes and treatment chemicals up close. Removing sludge from the tanks and weir box.	High risk of inhalation of a combination of toxic fumes monitoring and treating the tanks in the sludge room.
Paint Cart Maintenance: repair, maintain and clean paint carts	Repair broken carts, replace or grease wheel, remove build-up of isocyanate paints. Use grinder, chisels, torches, high pressure water. 30 to 100 carts/shift	To remove paint3/4”: welding torch, grinders, air chisels. Torching PVC shrink wrap produce toxic gases. Welding and grinding breaks create fumes	High risk of inhaling very toxic and irritating welding gases containing heavy metal (cd): VCM torching shrink wrap plus a whole host of welding fumes.

SLEUSSEWAY & SLUDGE ROOM			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Risk Exposures**
The Sluiceway is a water filled moat that winds its way in a continuous loop passing throughout the paint line through all the booths into the sludge pits of the sludge room and again in a continuous loop. The sluiceway serves the purpose of picking up all the excess overspray of paints and solvents and delivering these toxic wastes to the sludge pits for treatment and removal. The two open sludge pits measured 75'x12'x20' where 5 pumps move the water back to the paint booths. And ventilated by two local exhaust fans to maintain negative air pressure.	Two workers and a supervisor were required near the sludge room on day shift. One of which was a chemical supplier representative. As well the Chemical Monitor also monitored and serviced the sludge room pits. These were serviced by adding a series of chemical treatments to address biological contamination another as a detackifier so that paint solids could be removed and delivered to the local waste dump. These chemicals added an additional burden of toxic chemicals to the sludge room mix.	Both the sludge room and the sluiceway were a major source of chemical migration to other areas of the plant particularly when negative pressure in the sludge room was lost. These initial odors that workers describe as literally breath-taking and suffocating. The sluiceway was also a major source of contamination to other areas of the plant when a solvent/paint spill or leak occurred in combination with the sluiceway water being exposed by a missing steel grate. Treatment workers were not wearing respiratory protection and not following confine space regulations.	High risk of inhalation of a large variety of solvents, paints, isocyanates in combination and as peak exposures. These exposures include: MEK, xylene, acetone, methylene chloride, TCE, toluene, nitrosamines, benzene, isocyanates, formaldehyde, biocides, and bacteria and fungus. MOL identified some of these chemical threats. These are a threat to the treating workers, but also those in the general areas of the plant who may be in the path of these fugitive emissions. Especially when there is a loss of negative pressure

ASSEMBLY AND QUALITY CONTROL			
Production Process	**Production Tasks**	**Risk Factors**	**Chemical Exposure Risks**
Assembly / Production Workers were the largest group. There were numerous assembly lines that began with "outside paint". The assembly work force was highly mobile. **Quality control/inspection**	Assembly workers performed a variety of tasks: cleaned with solvents, cut, sawed, sanded, patched with putty, trimmed, buffed, notched & punched, shaved, glued, puttied, filled, ground, boxed and likely other tasks associated with the production of plastic auto trim. **Quality conduct destructive tests**	Large volume of solvent usage on detailed work; applied large volume of glues/adhesives; HDI putty; applying touch up HDI paints; large amount of sanding and buffing produce great amount of dusts & solvent fumes. **Quality assurance handling and performing physical test in proximity to assembly activities**	High risk of inhalation of fumes from solvents, paints and adhesives and dusts containing HDI, urethane, monomers, formaldehyde, additives. See list of chemical ingredients. High risk of inhalation of fugitive emissions from paint line, sludge room, and injection molding. **Quality assurance share risks.**

MAINTENANCE OPERATIONS			
Production Process	**Production Tasks**	**Risks Factors**	**Chemical Exposure Risks**
<u>Maintenance:</u> consisted of a number of skilled trade workers, including millwrights, electricians, and tool and die workers. Individually, they were assigned, weekly, to a department or work area to maintain and repair the various systems in the plant. They were available to respond to emergencies (specific to their trade).	***Millwright***: purging and repairs to the complex pump systems in the plant also involved in clean up and containment of pills and leaks as part of the ERT. Detailed clean and soaking of pump, valves, piping in solvents—MEK, toluene, TCE, acetone. Draining lines of HDI, MDI and hydraulic fluids into open buckets. Using compressed air to blow off dirt and chemicals to clear lines and parts. Detailed close work with parts saturated in solvents for long periods. Cleaning filters and canisters in injection molding machines with compressed air.	Handling large volumes of resins, paints and coatings containing isocyanates, Solvents and other chemicals used for treatments. Detailed work with direct handling of toxic materials. Producing fine mists and dusts with compressed air. Large volumes of paints and resins when containing & cleaning up leaks, spills. Purging lines with paints and resins releases large quantities of these chemicals that are difficult to control. Fine dust from cleaning filters on various machines.	Mill rights: High risk of inhalation and absorption of paints, resins, solvents and other toxic chemicals. Exposures to liquid, mists, vapors and particulate are high, with frequent peak exposures during maintenance operations and emergency responses to spills, fires and leaks.
Tool and Die: Machining and milling of machinery used in production. ***Electrical Maintenance:*** Electrical repair and maintenance and electrical safety	***Tool and Die***: Task dealing with repairs to molds surfaces using grinders, polishers, welding and resurfacing tools. Drilling and tapping for fastenings. This would involve solvents to prep for welding, grinding and polishing with MWF and making parts. Carried out maintenance of electronics on control modules and electrical repair.	The use of solvents in preparation of machining and welding activity produces chemical vapor. Grinding, polishing and machining metals produces very fine particulate contaminated with heavy metals, grinding grit and MWF. These are done close up and without exhaust ventilation. Use of solvents to clean connections and working close to production activity	High risk of inhalation, ingestion and absorption of solvents, fine particulate and MWF. Inhalation risk for welding fumes and metals as well as decomposition by-products during welding and machining. High risk of inhalation of solvent fumes as well as fugitive emission from other production activities.

APPENDIX G

PLANT LAYOUT SEE BELOW