Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Written Submission from Peter Harris

Mémoire de Peter Harris

In the matter of the

À l’égard de la

Mid-term update from BWXT Nuclear Energy Canada Inc. on licensed activities at its Toronto and Peterborough facilities

Mise à jour de mi-parcours sur les activités autorisées de BWXT Nuclear Energy Canada Inc. à ses installations de Toronto et de Peterborough

Commission Meeting

Réunion de la Commission

May 2026

Mai 2026

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Canada

CNSC Intervention BWXT Peterborough - 2026 Midterm Meeting

My name is Peter Harris and I am a resident of Peterborough. My children attended Prince of Wales School where my spouse sat on parent council for eight years.

There are three issues that I would like to ask commission members to consider in BWXT's midterm meeting.

1. The CNSC's Regulatory Responsibility and the Demolition of GE's Peterborough Campus.

According to Regdoc 2.11.2 "Decommissioning", the CNSC is responsible for lifecycle planning of a regulated nuclear facility. Regdoc 2.11.2 requires the licencees to "maintain records" with respect to licensed operations " to ensure safety, security, and environmental protection".

Recently, GE Vernova announced plans to demolish almost all of the buildings associated with its historic manufacturing in Peterborough - amounting to 910,000 square feet. Historically, GE Peterborough was involved in fuel bundle design and manufacture at an early stage of the nuclear industry. In 1955, GE Peterborough was awarded the contract for designing and constructing the CANDU prototype at Rolphston. The first fuel bundles were assembled in Peterborough shortly after this. Given that building 21, where BWXT is currently licensed (and GE/GE-Hitachi previous to BWXT) postdates the assembly by years, it is reasonable to ask where early activity pelleting and fuel bundle assembly occurred.

Contrary to Regdoc 2.11:2, no record of activity predating the construction of building 21 is in the public domain. In the absence of the required documents, the public must rely upon verbal records of GE employees. These employees indicate that processing occurred outside the area that is currently regulated - with buildings 16, 22 and 23 cited as being involved in what should have been regulated activities.

Regdoc 2.11:2 also requires "early engagement with surrounding communities on proposed decommissioning plans". However, the CNSC and/or BWXT has not communicated with the public regarding GE-Vernova's plans. The following is the response from CNSC staff regarding regulated materials being released through demolition;1

"The licensee is legally responsible for the release (if any) of contaminants arising from regulated activities (such as uranium and beryllium) subject to the conditions of the CNSC licence. With respect to hypothetical, non-licensed site matters, should this proposal move ahead, the CNSC would be available to provide its regulatory perspective if needed."

Clearly there is no indication that the CNSC is willing to engage with the community regarding the proposed demolition as required by Regdoc 2.11:2 and the same might be said of GE, GE-Vernova, GE Nuclear, GE-Hitachi and BWXT. **Why has the CNSC not planned for the demolition of buildings involved in regulated activities? What purpose do financial guarantees for decommissioning regulated facilities serve if not to ensure that buildings involved in those regulated activities are removed safely?**

2. The Safety of Beryllium Emissions

In Peterborough, the CNSC licenses a facility that is closer to residential properties and a primary school than any other class I nuclear facility in the world. In spite of this, the CNSC regulates the Peterborough facility as it would any other facility. Instead of seeking the highest standards for safety, the CNSC has instead adopted an industrial standard that does not reflect the proximity of vulnerable populations to this facility.

The problems with this approach are illustrated in how the CNSC regulates beryllium emissions at the Peterborough plant.

Beryllium is classified as a carcinogen and it also induces an immune response upon exposure. Response to exposure is dependent in part upon the genetic composition of the individual exposed. Beryllium is regulated to extremely low levels that reflect the danger that it represents. Ontario's ambient air quality standard for beryllium is .01 $\mu g/m^3$ of air. While airborne beryllium is extremely dangerous, ingested beryllium does not appear to represent a risk.

Commission members should therefore understand that soil levels of beryllium around Peterborough have not been and never have been an issue for community members. What has been of great concern are the year over year increases in beryllium - as measured by the CNSC's own IEMP. These increases represent atmospheric deposition of airborne beryllium.

CNSC members should also understand that there are no studies that indicate safe limits of beryllium exposure in children.

Despite the extreme hazard that beryllium represents and that the point of emission for beryllium lies only 50m from the junior playground of Prince of Wales school, the

CNSC's history of beryllium regulation is embarrassing. The following summarizes what happened prior to and after the March 2020 hearings;

- In 2014 CNSC began its IEMP - Independent Environmental Monitoring Program by analyzing soil
- The CNSC touted "state of the art" analytical facilities to accompany its IEMP
- CNSC chose a non standard analytical technique that is not aligned with MOECP and CCME procedures. The analytical technique had no bearing on what should interest the CNSC - It is the year over year increase of extracted beryllium that is of concern. These increases could only come from atmospheric depositions.
- IEMP results in 2018 and 2019 indicated beryllium rising at an alarming rate. The average results without error bars are shown in figure 1.
- Staff did not recognize that they needed a reference point (control point) until 2019 after alarming increases in beryllium levels at Prince of Wales school necessitated comparison. What should have been plain to CNSC at the outset of the IEMP program in Peterborough - and frankly would have been expected of a high school science student, took staff 5 years to recognize.
- Between 2014 and 2019, the CNSC created only 25 data points in their IEMP beryllium testing.
- Neither the CNSC or BWXT indicated that the huge increases in soil beryllium were out of the ordinary. The facility and its emissions was reported as "protective of health" by CNSC staff.
- A parent of children attending Prince of Wales school - Dr. Julian Aherne, an expert in atmospheric pollution, raised the alarm about dramatic increases and began to question the alarming increases in soil beryllium. Dr. Aherne calculated that atmospheric levels of beryllium likely exceeded safe levels to produce the changes produced by the IEMP results
- Up until Dr. Aherne raised his concerns, no CNSC or BWXT staff informed the public of the alarming increases
- At the 2020 hearing, considerable effort was spent by the CNSC to explain the increases seen in the graph. These included;
    - The small number of samples meant that the increases were statistically irrelevant
    - In 2014 -2019, there was no error reported in IEMP beryllium sampling, however, after Dr. Aherne raised his concerns, CNSC found 40% error which subsequently revised to 80% in the soil sampling that occurred in 2014. CNSC staff went out of its way to discredit its own data. (Linear regression analysis of 2014- 2021 data shows that 2014 data in fact underestimated the change in beryllium values between 2014 and 2018 - see figure 2.)

- CNSC staff blamed sample techniques for error, and yet the same sample techniques were used for uranium soil results, which CNSC staff did not discredit.
- The CNSC accepted BWXT's data before it accepted its own
- Staff continued to allude that total digestion of soil samples contributed to error while lauding its "state of the art" lab

- The response of BWXT to the CNSC IEMP results was to hire the engineering firm "Trinity Consultants". In 2020, Trinity reported "Based on the results of this sampling program, there is no evidence that beryllium used at the BWXT facility has had any impact on Peterborough soils, and no risk has been identified to the public." Again, concern for beryllium is in the year over year increases of beryllium - not the absolute value of beryllium in the soil. Trinity couldn't have found any evidence of impacts because they weren't looking for them.
- The 2020 consultant report also states that 19 of 21 soil samples were non-detect (ND). They were non-detect because the lab's detection limit was 0.5ug/g. On the other hand, the CNSC does not report a detection limit, and has routinely reported sub .5 ug/g data (or .5mg/kg). From a lay person's view, this is like telling your doctor that your diet is working while measuring your mass in tonnes.
- Neither BWXT or the CNSC post results in a manner that shows year over year changes at a given sampling location. Again, it is the year over increases that are of concern.
- Until last year, the CNSC and BWXT reported results in different units from the CNSC.
- BWXT has changed consultants and laboratories, making year over year comparison more difficult- if not impossible.
- In the 2020 CNSC hearing, the Commission ordered staff to work with Dr. Aherne to have "robust solid and independent" monitoring in Peterborough. Yet the CNSC and BWXT have not adopted Dr. Aherne's recommendations, which are for continuous airborne monitoring. This is the only way that a facility that processes very large quantities of beryllium and routinely vaporizes that beryllium in its manufacturing processes.
- The CNSC continues to rely significantly on BWXT for its analysis of beryllium and uranium releases at this facility.

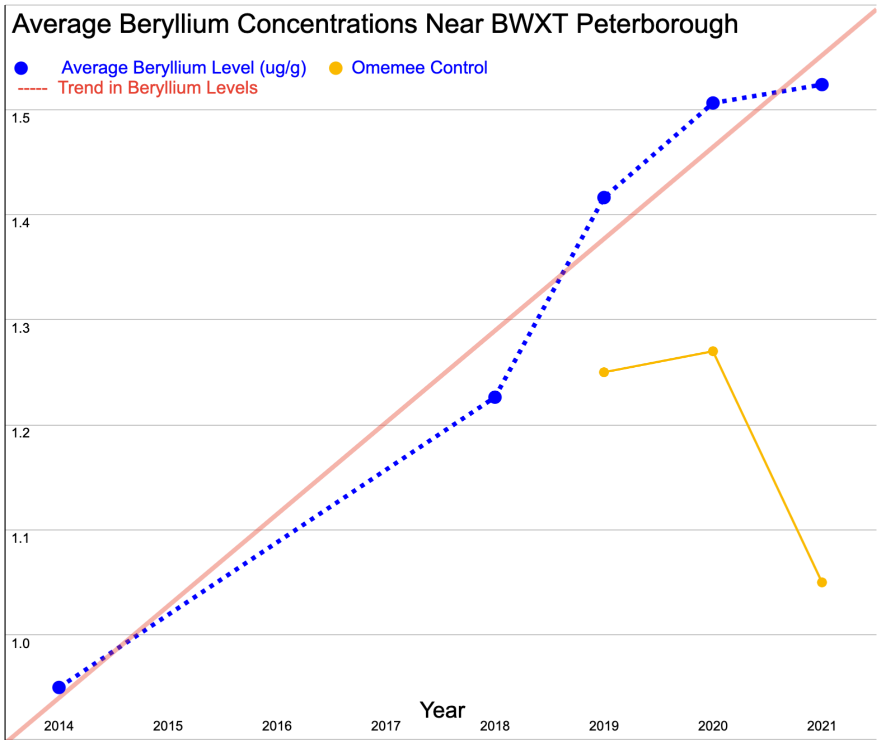

Figure 1

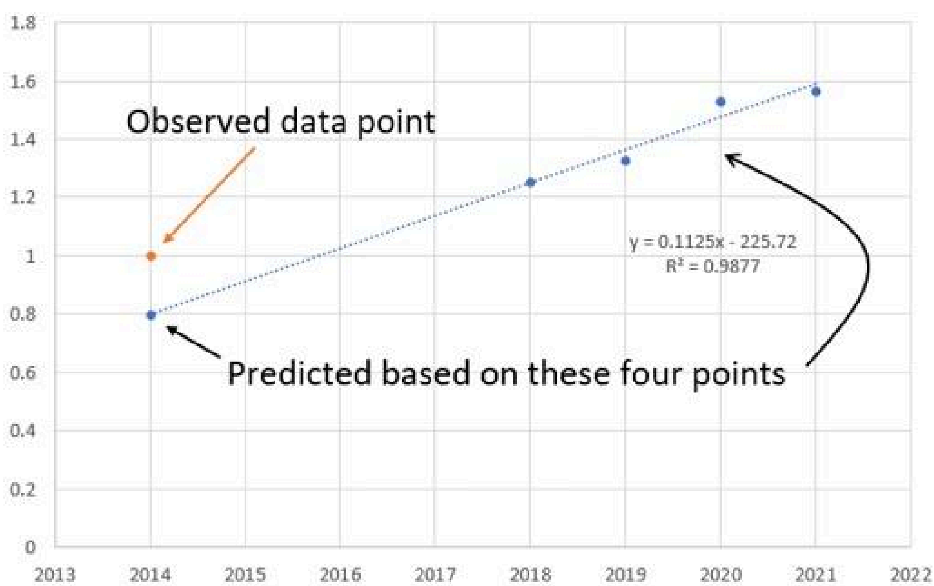

Figure 2

Linear Regression analysis of 2018-2021 data indicating that the 2014 IEMP results underestimates increases in beryllium.

There's no doubt in my mind that were we to encounter the same alarming increases in soil beryllium at Prince of Wales school today, we'd witness the same bumbling process that we saw in 2020. With an IEMP that only samples annually, increases in beryllium might be seen up to a year after they occur. Small sample sizes guarantee that spikes in soil beryllium are permanently statistically irrelevant when the CNSC is challenged by results that don't fit its narrative. This is unacceptable for a facility that operates just 25 metres from a public school.

Walking our dog down our street one evening in the fall of 2020, my wife and I passed through 2 distinct pockets of acrid smelling gas. There is no longer any significant industrial presence other than BWXT in my neighbourhood and certainly not one that operates at night. Other than BWXT, I do not know of any facilities that would be working with chlorinated compounds - which this compound certainly smelled like. While I do not expect CNSC members to believe me, I know what I smelled and I have strong suspicions as to its origins.

More important than what I smelled, were the circumstances under which I smelled it. It was a fall evening, there was a very slight breeze from due south (as measured by the Weather Network), and likely there was a thermal inversion.

Under the CNSC's current IEMP, there's no attempt to recognize that the greatest risk posed to neighbours and children in the Prince of Wales playground is under two coinciding circumstances; when BWXT is actively vaporizing beryllium in its industrial processes and when atmospheric conditions lend themselves to beryllium chloride gas remaining concentrated at ground level. **This is why continuous airborne monitoring was recommended by an eminent expert on airborne emissions and why the CNSC should adopt it as a minimum safety standard.**

The CNSC has chosen to license a facility in an unsafe location. The monitoring of beryllium emissions must reflect the significant danger these emissions pose to neighbours of this facility.

3. The Justification of Radiation Exposure

The principle of justification is one of the three fundamental principles of radiation protection established by the International Commission on Radiological Protection (ICRP). It states that any activity resulting in radiation exposure should do more good than harm—meaning the benefits of the activity must outweigh the radiation risks.

For children, the principle of justification is fundamental to radiation safety because they are biologically and socially more vulnerable: their tissues and developing organs are generally more radiosensitive than adults', and their longer remaining lifespan gives more time for radiation-induced effects (including cancer) to manifest. That raises the threshold for acceptable risk and makes careful assessment of benefits versus harms essential before exposing any child to radiation.

This principle of justification is endorsed by ALL major international radiation protection organizations, incorporated into the International Atomic Energy Agency's Safety Fundamentals, and forms the foundation of radiation protection frameworks worldwide — reflecting scientific consensus that no radiation exposure should occur without a demonstrated net positive benefit.

In the CNSC's 2020 decision regarding BWXT expansion, Commission member Dr. S.J.Demeter applied the ICRP framework (justification, optimisation/ALARA, dose limits) and concluded BWXT had not adequately justified moving pelleting to Peterborough. He argued justification requires demonstrating net benefit that outweighs added exposures, explicitly including social factors and equity; because the proposed change would increase environmental UO_2 releases and public dose and place operations adjacent to an elementary school with vulnerable children, the burden to demonstrate justification was higher.

Demeter treated precautionary and social-trust considerations as integral to the justification/ALARA assessment, contending that even very small dose increases near vulnerable populations were not justified.

The IAEA's IRRS reports on the CNSC reflect Sandor's opinions - criticising the weak, non-systematic treatment of justification in Canada: the initial IRRS mission recommended explicitly embedding "justification" principle in law". The follow-up IAEA 2022 mission found there remains no systematic, documented procedure for justification across practices and urged a formal, documented approach to justification by the CNSC.

In 2022, an appeal launched against the CNSC's Peterborough ruling that allowed BWXT's expansion was heard by the Federal Court of Canada. The federal court dismissed Citizens Against Radioactive Neighbourhoods' (CARN) judicial-review challenge. The Court applied a reasonableness standard of review as this is what is contained within the CNSC's regulatory framework.

Specifically, instead of applying the internationally accepted Principle of Justification, the CNSC determined that t**he risks posed by exposing children to increased levels of radiation** caused by expanding BWXT's license ***were reasonable.*** While it is universally accepted that exposing the vulnerable to any increased levels of radiation without justification is unacceptable, the CNSC, through the Canadian Nuclear Safety and Control Act, is the judge of what is unacceptable. The CNSC is therefore the sole arbiter of what is reasonable and what is unreasonable.

In his ruling, Federal Court Justice Richard Mosley wrote "***While the Court may consider that the wisdom of expanding an industrial operation involving nuclear materials in the immediate vicinity of a primary school is dubious, that is not the question before it to determine"***. What is this statement but a challenge to the CNSC as to what is reasonable?

The principle of justification, as established by the International Commission on Radiological Protection, is a superior standard to the CNSC's "reasonableness" approach used in the Peterborough BWXT decision. Justification requires a comprehensive, evidence-based assessment to demonstrate clear net benefits that outweigh radiation risks, particularly for vulnerable populations like children. In contrast, the CNSC's "reasonableness" standard is more subjective, allowing discretionary decisions that may not align with international best practices for radiation protection. The justification principle shifts the burden of proof to the proponent, considers critical social and equity factors, and provides a consistent, transparent framework recognized worldwide. **Adhering to justification would strengthen the CNSC's regulatory approach and better protect public health and safety compared to the more limited "reasonableness" standard.**

In applying a reasonableness standard, the CNSC ensures that its safety decisions will be capricious. For my community and for the children at Prince of Wales School, I am frightened by the possibility of BWXT expanding the scope of its operations to include pelleting of not just natural uranium but also enriched uranium. Most certainly BWXT wishes to participate in the small nuclear reactor market. It cannot do so without processing enriched uranium.

Some commission members might be surprised to know that this facility was licensed to process enriched uranium in 2010[1]. It appears that even the processing of enriched uranium in a residential area and next to a public school does not cross the threshold of reasonableness for the CNSC.

Despite it being reasonable for the CNSC to do so, it has never recommended to GE, GE-Hitachi or BWXT that they should be looking for a safer location to manufacture fuel pellets and fuel bundles. Instead of promoting safety by locating this facility away from homes, a school and a vulnerable population, the CNSC continues to needlessly expose children to risks from beryllium and uranium by utilizing industrial zoning from the 1800's.

This is unreasonable risk.

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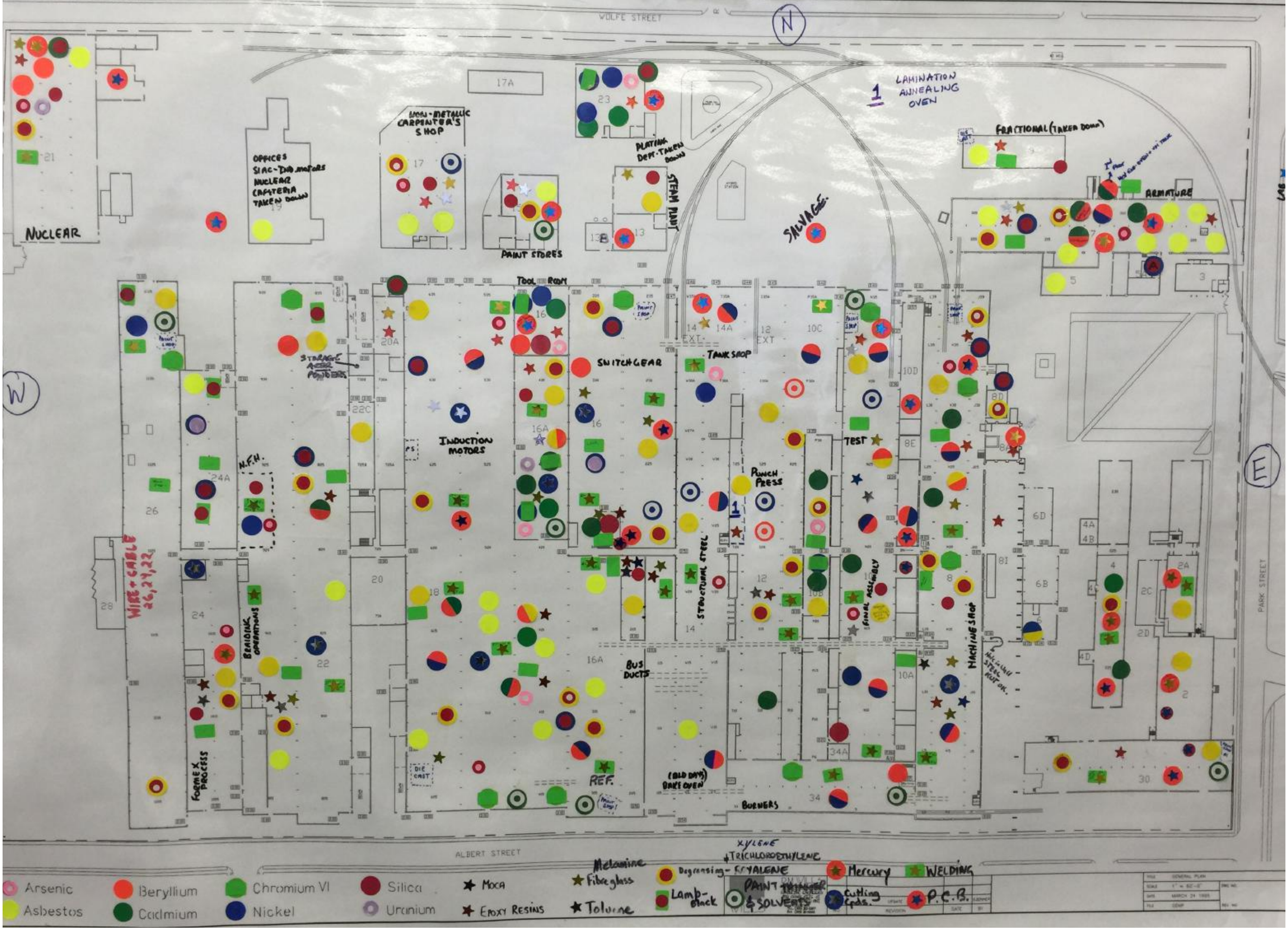
[1] *I ask commission members to review the community participation of the CNSC's 2010 hearing on the processing of enriched with a critical eye. You may begin to understand why community members may be sceptical of the hearing process and the nuclear industry's commitment to safety and community engagement.*

Intake Clinic Hazard Map: 2014



The Report of the Advisory Committee on Retrospective Exposure Profiling of the Production Processes at the GENERAL ELECTRIC PRODUCTION FACILITY in Peterborough, Ontario 1945-2000

Prepared by

Robert DeMatteo, B.A., M.A., D.O.H.S and Dale DeMatteo, B.A., MSc.

with

GE Retiree Members of the Advisory Committee:
John Ball, Linda Brown, Jim Dufresne, Roger Fowler, Marilyn Harding, Sue James, Carl Jenson, Don McConnell, Gordon Terry, Bill Woodbeck, Jim Gill

February 5, 2017

Ms. Sari Sairanen

National Health and Safety Director

UNIFOR

205 Placer Court

Toronto, Ontario

M2H 3H9

Dear Ms. Sairanen:

RE: SUBMISSION OF THE REPORT OF THE ADVISORY COMMITTEE ON RETROSPECTIVE EXPOSURE PROFILING OF THE PRODUCTION PROCESSES AT THE CANADIAN GENERAL ELECTRIC PRODUCTION FACILITY IN PETERBOROUGH, ONTARIO

The Advisory Committee on Retrospective Exposure Profiles is pleased to submit the results of their intensive investigation of exposures to toxic agents at the General Electric plant in Peterborough, Ontario.

It is the consensus of the Committee who worked on this investigation for the last eight months that this report reflects the exposure conditions at GE over the period 1945 to 2000. The insights of the workers who participated in this study were corroborated by government inspection reports, management reports and the minutes of the joint health and safety committee at GE.

We, the undersigned members of the Advisory Committee, understand that UNIFOR, the union, will utilize the contents of this report in support of the many occupational disease claims arising out of diseases caused by toxic exposures while working at GE.

Respectfully Submitted,

Researcher, Robert DeMatteo, DOHS, MA, BA ______ Feb 3, 2017

Researcher, Dale DeMatteo, BA, MSc. ______ Feb 3, 2017

Project Coordinator, Sue James, GE retiree ______ FEB 1, 2017

Member, John Ball, GE retiree ______ Feb 2, 2017

Member, Don McConnell, GE retiree ______

Member, Lynda Brown, GE retiree ______ Feb. 2/17

Member, Marilyn Harding, GE retiree ______ Feb. 2/17

Member, Roger Fowler, GE retiree ______ Feb 2, /17

Member, Jim Dufresne, GE retiree____________________

Member, Carl Jensen, GE retiree____________________

Member, Gord Terry, Unifor Local 524 retiree executive____________________

Member, William Woodbeck, Unifor Local 524 retiree executive____________________

Member, Jim Gill, Unifor retiree____________________

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ABBREVIATIONS:

WSIB- Workplace Safety and Insurance Board

IARC- International Agency for Research on Cancer

MOL-Ministry of Labour (Ontario)

ACGIH-American Conference of Government Industrial Hygienist

TLV-Threshold Limit Values

OEL-Occupational Exposure Limits

NTP-National Toxicological Program

MAC-Maximum Allowable Concentration

EC-European Commission

IARC Carcinogenicity Classifications:

Group 1-Human Carcinogens

2A-Probable Human Carcinogens

2B-Possible Human Carcinogen

Group 3-Not Classified

Group 4-Probably Not Carcinogenic to Humans

February 5, 2017

THE REPORT OF THE ADVISORY COMMITTEE ON RETROSPECTIVE EXPOSURE PROFILING OF THE PRODUCTION PROCESSES AT THE GENERAL ELECTRIC PRODUCTION FACILITY IN PETERBOROUGH, ONTARIO 1945-2000

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John Ball, Linda Brown, Jim Dufresne, Roger Fowler, Marilyn Harding, Sue James, Carl Jenson, Don McConnell, Gordon Terry, Bill Woodbeck, and Jim Gill (retired Unifor National Health and Safety Director)

INTRODUCTION

The purpose of this research project was to develop retrospective exposure profiles of the work processes at the GE electrical production facility in Peterborough, Ontario between 1945 and 2000. As such, it involved a systematic effort to collect and analyze empirical information about how production was carried out in this very complex heavy industrial operation. Historically, this workplace is an example of the intersection of 20th century industrial and chemical "revolutions". 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 GE employees and their families suffered over the years.

The major source of this information came from the workers themselves through a series of intensive focus group and key informant interviews that went on for over 8 months. This information was corroborated by government inspection reports from 1945 to 2000 in addition to joint health and safety committee minutes, internal memoranda, and industrial hygiene literature.

Before proceeding to the substance and findings of the retrospective exposure study, it is important to situate this study in the broader social and scientific context that frames the results and how they may be viewed and used in Ontario's occupational health system.

The study was meant to address employees' concerns that the extent and nature of their exposures and working conditions were being subject to misrepresentation. Indeed, with the exception of a very comprehensive exposure profile study of two departments at GE by industrial hygienist, Sonya Lal of the Occupational Health Clinics for Ontario Worker (OHCOW), there was little systematic empirical study of exposure conditions.

There was an uneasy sense that what was perceived as an extraordinarily high incidence of cancer among GE employees was not being addressed to ascertain whether there was a workplace connection. Given the large number of carcinogenic chemicals used at the plant, their suspicions that there was a connection cannot be viewed as unfounded. It was also their view that the company's efforts to study the problem misrepresented the exposure conditions at the plant, and that such misrepresentation under-mind their disease claims before the Workplace Safety and Insurance Board (WSIB).

Occupational disease remains a largely under-addressed public health problem. Only a small fraction of work-related accepted claims are for occupationally caused diseases. And, an even smaller fraction are for occupationally caused cancers (Yassi 1981; Ison 1989). Yassi estimated in her background study for the Weiler inquiry into occupational disease in Ontario, that a total of 6,000 occupationally related deaths occur annually in Ontario from 3 major sources alone that are related to toxic exposures, but go unreported to the government and the workers compensation system. Some of this is explained by the rather long latency period for cancer to develop…sometimes not appearing until after retirement and therefore missed as work-related.

Over the years several investigators have identified a number of the major obstacles to workplace disease recognition (Yassi 1981; Ison 1989). Some of these include:

- Burden of proof requiring scientific certainty
- "Legalized" Threshold requirements rather than guidelines
- Dismissing patient's doctors' assessment of work-relatedness
- Over-emphasis on claimant's medical history rather than work process interactions
- Lack of exposure data
- Paucity of occupational health research generally
- Lack of occupational health training for physicians

By far, the most influential obstacle to disease recognition and its consequences has been the onerous burden of proof placed on the worker coupled with an outdated view of how diseased is produced by work, one that is out of sync with advances in occupational health and cancer research (Clapp et al. 2008; Hanahan and Weinberg 2011); Hanahan and Weinberg 2000; Welshons et al. 2003; Kortenkamp et al. 2011; Trosko and Upham 2005; Diamanti-Kandarakis et al. 2009; Kortenkamp 2008; Ewertz et al. 2001; Hardell et al. 1997; Senn 1991; Yassi 1981; Ziem and Davidoff 1992) and what the law requires for work-related disease (Supreme Court of Canada [2016] Court file No. 36300; Ison 1989; Law Reform Commission of Canada 1986). This obstacle to disease recognition is imposed by social policy and has its source in the predominant paradigm of "scientific certainty" that requires definitive proof that "X" causes "Y" in a world that by nature is complex and multi-causal. This paradigm is imbedded in current scientific research and standard setting processes and is expressed in our obsession with protecting against "false positives" without thinking about the consequences of "false negatives" (Scott 2005). Unfortunately, this mindset has permeated into administrative tribunals and standard setting bodies, which has produced its own set of detrimental consequences including unjust denial of compensation for diseases caused by work and delayed regulatory action for disease prevention.

With respect to the issue of burden of proof, it is important to note the Supreme Court of Canada's recent ruling rendered on June 24, 2016 regarding a lower court ruling on a breast cancer cluster case among a group of health technologists working at a British Columbia health facility. In this decision, the Supreme Court found that the standard of proof set by laws governing workers' compensations systems do not require a standard of scientific certainty, nor that imposed upon plaintiffs in a civil tort claim (i.e., the balance of probabilities). According to the Supreme Court, these are too stringent a standard of proof, and "… wholly inapplicable to determining causation in the workers' claims…" (Supreme Court of Canada, Docket: 36300, 2016). In essence, in worker compensation law, insufficient evidence is not "no" evidence, and inconclusive evidence may suffice in determining causation in the case of occupational disease claims. In contrast, the current approach extends the presumption of innocence to chemicals and physical agents in the light of scientific uncertainty. The real question is "What do we do in the face of scientific uncertainty?" This is not simply a scientific question, but rather has to do with social values and ethics, and to what extent we value human life.

The current approach to occupational disease recognition results in a distorted view of the extent of occupational disease and its causes. This has led to questionable policy outcomes with respect to long delays in needed regulatory action and the protection of workers from hazardous chemical and physical agents (Watterson 1999; Scott 2005).

BACKGROUND TO THE GE PETERBOROUGH PRODUCTION FACILITY

In contrast to studying industries associated with a single manufacturing process with few chemicals and relatively few job tasks and exposure patterns, the GE plant in Peterborough undertook production on a massive scale with a complex mix of industrial processes utilizing huge quantities of some 3000 chemicals (Lal 2005/6). Some of these industries included: the manufacture of small to massive electric motors and generators; appliance manufacturing; small and large electrical components for urban electrical utilities; and a nuclear facility that produced nuclear fuel bundles for CANDU nuclear reactors. These involved a complex mix of industrial products that included: massive welding operations throughout the plant; plastics and rubber production for wire insulation; production/preparation of copper wire of various sizes and specifications; and machining and pouring molten metals for large motors and turbines to drive locomotives, ships, and large electrical utilities. The size of production is illustrated by the fact that GE Peterborough's PVC production facility used 40,000 pound of lead per week just in the PVC pelletizing operation (Tidey 1968), not to mention massive amounts of epoxy and polyester resins used to coat and insulate nearly every product it produced. GE was "product" driven with new chemicals and work processes introduced regularly. GE Peterborough retirees describe the plant as a changing "industrial mall" with many units independently run and managed.

In these production processes, large amounts of solvents were used as cleaners and degreasers including: toluene, benzene, trichloroethylene (TCE), 1,1,1-Trichloroethane (TCNU), methyl ethyl keytone (MEK), MEK Peroxide, perchloroethylene, acetone, xylene, naphtha gas, carbon tetrachloride, among others. For example, TCE was used in large heated vats that could measure 8'x10'x6' as well as applied by hand by hundreds of workers to wipe down large surfaces with rags soaked in TCE and toluene. Adding to this chemical mix was the generation of large volumes of welding fumes from welding operations going on throughout the Peterborough complex. Many of these products were massive structures that would take weeks to fabricate with 5 to 10 welders working three shifts daily. In addition, machining operations produced large amounts of metal working fluid (MWF) mists and aerosols from heated fluids used to cool and lubricate materials and cutters. The machining involved large 25' and 40' boring machines. Huge volumes of dust, comprised of asbestos, fibreglass, epoxy/polyester resin, and heavy metals, were continually generated from cutting, grinding, sanding and buffing tasks. Peterborough GE admitted to using as much as 500 lbs. of asbestos daily (Rajhans 1971).

Adding to the complex mix of chemicals was a constant off-gassing of volatile organic compounds from the wood block floors (consisting of creosote-impregnated 3" x 4" wooden blocks set on end grain) throughout the building complex. This flooring continually oozed creosotes, especially during periods when ground water would rise through the subfloor. These floors were re-treated periodically and sometimes coated with glyptol paint. Creosotes are highly volatile and classified by the International Agency for Research on Cancer (IARC) as a 2A carcinogen that is 'probably carcinogenic to humans'. As well, because of the floor's structure, various other chemicals spilled, including lead and mercury, became trapped in the crevices between the blocks. Given the widespread use of this flooring in the plant, such spills contributed to the toxic burden experienced by workers.

A significant factor that conditioned production and the safety culture at GE Peterborough was a work organizational approach that included the piece rate system, in operation until 1988, encouraging employees to work to their physical optimum and, often circumvent safe work practices to maintain production rates.

Another variable contributing to GE Peterborough's uniqueness is the physical structure itself. GE motor production was carried out primarily in the century old "Edison" building that is approximately 1,030' by 1,629' with a building area of 38.5 acres occupying more than 50 acres in downtown Peterborough. This is an "open concept" building typical of the time with saw-tooth windows at roof level to maximize sunlight and allow natural ventilation of the intense heat created by the various work processes. As these work processes shifted from the manufacture of lighting products in the Edison era to that of motors and generators during the GE era, this natural source of ventilation was totally inadequate for this enormous production mix. Despite work areas referred to as "buildings" or "departments" they were, in fact, designated areas separated by indoor-vehicle roadways and walking aisles. There were few truly isolated structures, since additions were connected to the main building by huge doorways, to accommodate trucks and cranes. Ceiling heights reached some 60' to 70' high to allow overhead cranes to pass from section to section. In effect, most departments shared the same, mainly natural, ventilation system and thus the same contaminated atmosphere. There was insufficient make-up air, which created an atmosphere of negative pressure throughout the main building. Consequently, what was generated in dusts, fumes, or vapors flowed readily to neighboring departments. In effect, there was major cross contamination between, and within, departments.

Workforce Considerations:

While the GE Peterborough workforce has remained predominantly male, during World War II women replaced men in the GE workforce and production shifted to the war effort. It was during this time that the plant became unionized. As the war ended, men returned and the workforce settled into a relatively stable ratio of 70-75% men and 25-30% women – which has continued to the present. (Older retirees reported that in their early years at the plant there was also a category of work designated "boys work" done by youths, prior to the introduction of child labour legislation).

Until the mid-1990s, women performed what were generally viewed as "women's work" or occupations – with most working in manufacturing production and approximately 1/3 working in office or clerical jobs. Women's work was described as "light" work involving detailed, fine repetitive tasks that required close up, manual work. Some of the major categories of women's jobs included: "winders" who manually wound copper wire for coils, or cores for capacitors; "tapers" who wound insulating tape composed of adhesives and fiber glass/asbestos around coils and other electrical components; spray painters in powder paint operations; hand work that included soldering, brazing, and etching circuit cards and semi-conductors; the assembly and production of electric cords (which involved stripping insulated wire containing asbestos and silver soldering) and work forming plastic/ceramic plugs and sockets. Winding operations in the capacitor department involved exposures to toxic adhesives as well as exposure to PCBs.

Women's jobs were generally performed at work benches with 5 to 10 women involved in manually stripping and degreasing wire in preparation for soldering and brazing (which incurred heavy exposure to asbestos/fiberglass dusts, and lead and solvent fumes). These work areas were poorly or not ventilated. In addition, women could be subject to significant by-stander exposures since many of these tasks were performed on mezzanine levels in departments directly above both intense welding operations and epoxy dipping, baking, and grinding operations where dense fumes, gases, and dusts from these operations would rise to work areas above. This was especially serious in armature (bldg. 7), bus ducts (bldg. 30), and machine shop (bldg. 8). Office and clerical personnel did not fare much better. Toxic dusts generated from many of the manufacturing operations made its way into the offices of clerical workers as evidenced by large accumulations of dusts on workers' desks and other work stations. Focus group participants reported that office workers would find their desks covered in a blanket of dust when they arrived in the morning -- and find another buildup of dust when they came back from lunch.

Problems Estimating Exposures Using GE Records:

In the course of this research, retirees identified serious problems with the information GE Peterborough sent to the WSIB regarding their work histories and work exposures. This included: wrong or incomplete information, missing health reports, and no consideration of overtime in determining work exposures. Focus group discussions identified broader systemic problems related to the fact that employee records were linked to the company's accounting system -- in particular, time and product costing -- rather than specifically to document work histories. Work was recorded by employee (job code) and location (unit/clock#) classifications. There were categories of employees whose work demanded constant movement throughout the plant including: dispatchers, 'chasers', mobile welders, labour gangs, and maintenance workers. With large motor production, workers were required to move to the location of the product thus their unit designation could be in a different building or department from where they actually worked. Employees working in some areas, such as fractional motors, or on final production assembly, could accumulate as many as 40 tickets (i.e. 40 different jobs) performed in a day. The product-driven nature of production required a flexible work force and employees could be: loaned out to different departments to meet production schedules or deadlines; shifted to other departments and jobs during down time; and offered alternative 'clean up' work during plant shutdowns or holidays -- much, or all, of which was not documented in employee work histories. Relying on company documents as the sole source for determining exposures may significantly underestimate the degree and nature of worker exposures.

What GE Knew About Chemical Hazards:

Companies often attempt to excuse themselves from culpability for occupational diseases by claiming that "we just didn't know about the toxic effects" of the substances their workers were exposed to at the time. This oft-repeated defense by GE for not having taken adequate precautions for the protection of its employees is no longer credible given recent historical revelations of just what GE knew about the hazards of the chemicals its employees used without adequate protection.

In the course of our research we came across a book by respected occupational health researcher, Dr. Barry Castleman (2005), identifying the fact that US General Electric knew about the harmful effects of asbestos, lead, and other chemicals used in its production facilities as far back as the 1920s and 1930s. In his book, Castleman documents the work of Dr. Alice Hamilton, renowned occupational health scholar, who conducted numerous health surveys of the working conditions at GE's plants in the U.S from 1922 to 1934 -- including literature reviews on the harmful health effects of industrial chemicals in use. Based on this research she warned Gerard Swope, the president of US GE at the time, of the hazards and health effects of asbestos and other industrial chemicals affecting GE's workforce. Dr. Hamilton continued to personally advise Swope (over a period of 12 years) about chemical risks to workers as well as recommendations for improving health conditions at GE facilities. In one of Hamilton's letters to GE Vice President, CE Eveleth, dated May 9, 1929, she reports meeting a Mr. Dalton of the GE Schenectady Works, who suggested she visit two GE foundry plants in Canada, "all of which, he said, are pretty bad." She then asks Eveleth: "Do you wish me to do this?" (We have found no evidence that Hamilton was given the opportunity to visit GE plants in Canada).

Published letters and reports kept at the GE Museum in Schenectady, New York (Castleman 2005), document that in addition to asbestos, Dr. Hamilton identified the health impact of a number of chemicals used by GE including: oil smoke, gasoline as a solvent, acids, paint spraying, benzene, cyanide, nitrobenzene, aniline, formaldehyde, phenol, numerous silica hazards including sandblasting, mercury, lead compounds, radium, carbon tetrachloride, sulfur dioxide, acetone, kerosene, toluene, hydrogen fluoride, asphalt, x-rays, chromium and nickel plating, welding, soldering, as well as issues related to eye and skin irritants, ventilation, ergonomics, lighting, sanitation and medical service. Hamilton emphasized the importance of substituting harmful chemicals as the first level of controlling harmful exposures.

Importantly, Dr. Hamilton described 'by-stander' hazards to those working near welders and sandblasters without wearing protective equipment. When her book, "Industrial Poisons in the United States," was published in 1925, copies were to be sent to 10 doctors at GE plants around the country. As early as 1929, based on Hamilton's recommendations for controlling lead exposures, one GE plant provided separate lockers for work and street clothes, boots and underwear. Boots were removed before the men left the work area through a washroom for lunch or before leaving at the end of the shift. In describing conditions for workers at the plant, Hamilton said: "It is like a first class men's club house" (Pittsfield, May 1929 in: Castleman 2005). There is tragic irony to this story given the battle Peterborough GE conducted during the 1980s over an inspector's order to institute separate locker and wash facilities for employees working with lead under the designated lead regulation. GE Peterborough appealed, and the order was rescinded.

GE was made aware of the hazards of asbestos by 1930 when Dr. Hamilton described hazardous conditions at GE plants where there was significant airborne contamination and accumulated asbestos fibers on work surfaces (Castleman 2005). US General Electric made attempts to control asbestos exposure through exhaust ventilation and by distributing literature to employees on the safe handling of asbestos in the 1930s and 1940s. Hamilton also noted that GE received advice in the 1970s from asbestos fibre and product suppliers on the hazards of using asbestos in the manufacture of phenolic resins (Castleman 2005). Other investigators have also identified and documented how major corporations have suppressed information about the hazards. (Rosner and Markowitz 2002; Michaels 2008).

Given that GE officials in the U.S. were advised of the known hazards of asbestos in their U.S. operations in the 1920s and 1930s, and that they were aware of the poor conditions in Canadian plants, it is highly likely that GE officials at the Peterborough plant would have been aware of the hazards of asbestos. Yet, testimony from focus group participants and government inspection reports indicate that workers were handling asbestos in a friable state without any respiratory protection, nor were workers warned about the hazards. This was evidenced in various tasks that workers performed including: "plucking the goose" that involved the manual removal of waste asbestos without protection from holding bins in the wire and cable department; the band sawing of asbestos sheets without protection in the armature department; and the dismantling of the asbestos covered compounding tank without protection in coil impregnation, to mention a few. Given these exposure conditions it is highly likely that these contributed significantly to the extent of work-related disease at the GE plant. They also reflect a generalized lax safety culture that would have broad ramification for workers' health.

Exposure to Carcinogens:

A partial-list of chemicals routinely used in GE Peterborough production classified as carcinogens, or strongly suspected of being carcinogenic, include (IARC 2017):

IARC Group 1-Carcinogenic to humans: wood working, welding fumes, asbestos, silica, arsenic, benzene, beryllium, cadmium, chromium VI, 4,4-methylene-bis(2chloroanilene)(a.k.a. MOCA), nickel, trichloroethylene, vinyl chloride, formaldehyde, bis-chloromethylether (a.k.a. BCME), polychlorinated biphenols (PCB), diesel engine exhaust, rubber production, painters, mineral oils, n-ntrosodiethanolamine, inorganic acid mists, uranium, wood dusts, shift work.

IARC Group 2A-Probably Carcinogenic to humans: lead, epichlorohydrin, styrene oxide, tungsten carbide, creosotes, 1,3 butadiene.

IARC Group 2B-Possibley Carcinogenic to humans: Styrene, carbon tetrachloride, tungsten cobalt, diethanolamine, magnetic fields, asphalt fumes, methyl ethyl ketone.

Others, not yet classified as carcinogenic but whose properties disrupt the endocrine system and can mimic the hormone estrogen, include bisphenol-A and phthalates used in the production of plastics and epoxy resins. In the latter case, these are suspected of being breast carcinogens and tumour promoters. (DeMatteo et al. 2012; Keith et al. 2015; vom Saal and Hughs 2005; Diamanti-Kandarakis et a.l 2009; Ibarluzea et al. 2004; Ewertz et al. 2001; Hardell et al. 1997; Crisp et al. 1998; Kortenkamp 2008; Kortenkamp et al. 2011; Welshons et al. 2003)

Many of the chemicals used in GE production processes are subjected to high heat stress resulting in thermal decomposition by-products that are highly toxic and carcinogenic as well.

In summary, the fact that there was a complex mix of various contaminants, and that departments shared the same atmospheric contaminants that involved significant by-stander exposures, presents major challenges for the classification of individual exposures through traditional methods employed in industrial hygiene and epidemiological research. In fact, such approaches to complex exposure situations are largely responsible for the misclassification and/or misrepresentation of exposures that tend to underestimate the extent of exposure (Teschke et al. 2002; dos Santos Silva 1999; Flegal et al. 1986; Greeenland 1982).

METHODS

Qualitative and Participatory Research Methods:

The research team used a qualitative approach to gathering and assessing information necessary to develop rich, detailed, exposure profiles of the industrial processes undertaken at the facility (MacEachen et al. 2016; Institute for Work and Health 2011; Kidd and Parshall 2000; Needleman and Needleman 1996; Lincoln and Guba 1985). 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 (McDonald et al. 2004; Marano et al. 2000; Morgan et al. 1998; Alexander et al. 1996). 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 GE's production system and 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 the workers, themselves.

To address these issues a participatory research approach was employed using qualitative research methods including: focus group sessions and key informant interviews, and reviews of industrial hygiene data, government inspection reports, joint committee minutes, and occupational health literature.

The core research team consisted of 10 retirees from the GE facility, the union's former National Health and Safety Director and two retired researchers with occupational and public health research experience. This group formed **a permanent focus group known as the Advisory Committee on Exposure Profiling at GE**. The activity of this Advisory Committee was coordinated by one of the retirees and facilitated by the two health researchers. Each retiree worked at the GE plant for at least 35 years primarily in the manufacturing sectors. All had worked at the facility between 1945 to 2000 with most starting their work with GE in the early 1960s.

The Advisory Committee played a dual role in this participatory research endeavor. It acted as a permanent focus group consisting of informants with detailed knowledge of the production processes at GE over a period of 35 to 40 years. It also served as an active research team who gathered detailed information and brought in key informants with more specialized information to fill in information gaps or expand the group's knowledge base. In this latter role all members took an active part in leading the interview process with key informants.

The Advisory Committee met twice a week for 4 to 5 hours per session where the Committee documented detailed information about the various productions processes and working conditions department by department. This intense activity went on for over 8 months and the group continues to meet regularly. In the course of their work, the group would seek out and review various documents, locate processes on the hazard maps of the entire complex, and obtain industrial hygiene reports where available. The committee interviewed and documented information from more than 75 former GE employees whose names are recorded in the appendix.

The two researchers along with the coordinator were responsible for documenting the information gathered at meetings providing 3 sets of data notes that were compiled and checked for accuracy and then reworked into the resource template that forms the body of this report. Discussions were guided by a set of both open ended and structured questions (for a list of these questions see the expanded methodology section in ADDENDUM 1 at the end of this report).

The focus group process can be described as a relaxed, egalitarian atmosphere with a sense of shared ownership at meetings reflective of the retirees shared work history at GE. Importantly, the overlap of common work experiences among retirees facilitated a questioning, challenging, confirming, consensus dialogue that was both productive and confirming of the reliability of the information provided. For example, participants would often tell similar stories independent of one another, serving to reinforce confidence in the accuracy of individual recollections. Moreover, the dialogue among the participants and informants involved a consensus building process regarding the accuracy of the information being discussed. This approach was both productive and personally satisfying due to a strongly shared commitment that we do this task well (Kidd and Parshall 2000). Discussions would continue until agreement was reached about the accuracy and completeness of the information. Where agreement was lacking, efforts were made by the committee to track down alternative sources of information including other retirees and industrial hygiene literature reviews.

Risk-Based Approach:

This approach is in line with that of Sonia Lal, industrial hygienist with the Occupational Health Clinics for Ontario Workers, who undertook a very thorough retrospective exposure assessment of the production processes in the Armature and Wire & Cable departments at the GE production facility in Peterborough from 2005 to 2006 (Lal 2005/6). Similar to Lal's (2005/6) work, this current retrospective assessment relies upon a number of qualitative risk factors in assessing exposures, comparative to that used by Marano in the aircraft industry (Marano 2000). In this regard, we assessed the production processes and working conditions with regard to their potential to have significantly exposed workers. The risk factors framework included:

- The physical states of the chemicals (liquid, mist, gas, vapors, solid, dust),
- Route 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 the chemicals,
- Duration of exposure, e.g., use of overtime,
- State of ventilation systems, e.g., effectiveness of general, natural, local exhaust ventilation,
- Provision of make-up (fresh air circulation) air,
- Provision of personal protective equipment (PPE), e.g., respiratory protection, protective clothing (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, impact on safe work practices,
- Workers knowledge of and training re: chemicals used including access to, and understanding of, MSDS precautions.

In addition to relying on qualitative findings based on the above, effort was made to include quantitative measures available including those found in the Ontario Ministry of Labour's GE hygiene reports/investigations, GE Peterborough joint health and safety committee minutes, and worker/union documentation with the employer. Additionally, the Industrial Hygiene literature was reviewed for exposure assessments involving similar industries/processes.

Information Sources and Research Process:

This project relied upon three basic sources of information on industrial processes, working conditions, and the nature and extent of exposures for this retrospective exposure assessment:

Focus Group (Advisory Committee) Information Source:

Focus Group meetings were organized with reference to the industrial processes and working conditions for each department with attention to details on: chemicals, equipment and 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 experiences, and adverse health symptoms. Additional information was generated by members of the focus group through phone calls, informal discussions, and sharing primary/historical documents among the group.

The dynamic associated with focus group methods is one that lends itself to both enriching and challenging the veracity of information collected and providing in-depth understanding of the complex work environment at the GE facility. Throughout the research team applied the "constant comparative" method associated with qualitative research, where information collected is constantly contrasted and compared for consistency and reliability.

Supportive Documentation:

Additional documentation of exposure conditions at GE Peterborough was obtained from 1) the Ontario Ministry of Labour (MOL) Inspectorate reports/investigations 1945-2000; 2) Joint Health and Safety Committee (JHSC) minutes/reports, 3) union or employee/employer correspondence, all of which provided a cross check on the reliability and validity of focus-group generated information about the industrial processes and exposure conditions at CGE; 4) Other information sources, including: The previous hazard mapping of GE carried out by Gary Lane and OCHOW, historical documents, GE product materials, worker medical reports and documents, local newspaper articles, GE Peterborough newsletters, motor production process videos, and broad ranging literature and internet searches.

Industrial Hygiene, Occupational Health, and other Literature Reviews:

Additional documentation was sought 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.

In this way, we were able to corroborate the description of work processes and exposure conditions through the process of "triangulation" (Lincoln and Guba 1985; Needleman and Needleman 1996; Patton 1990), a major validation technique used in qualitative analysis. A sense of informational reliability was achieved through this use of different approaches to information gathering including 1) The richness and dynamic of focus group-based discussion and consensus; 2) A review of official government (MOL) reports, JHSC minutes, and employer documents; and 3) A review of industrial hygiene, occupational health, and other literatures.

LIMITATIONS OF THE SCIENCE

In considering the retrospective exposure profiles, some perspective is in order with regard to current interpretations attached to numerical exposure levels to various chemicals as well as results of epidemiological studies. Firstly, there is the assumption that no harm should have come to workers if exposure levels were below the regulated occupational exposure limits or Threshold Limit Values set by the American Conference of Government Industrial Hygienist (ACGIH). Secondly, there is the interpretation of negative epidemiological studies as indicating that there is no association between the disease and the chemical exposures studied.

In response to these assumptions it is important to recognize that the validity of these approaches is being challenged by a large and growing number of researchers in the field of occupational and environmental medicine. In the case of exposure standards, these research efforts have provided evidence that exposure standards are not health-based limits. Researchers have shown that the standard setting process and science upon which these are based are significantly compromised by industry influence. Further, they show that the "science" upon which these limits are based is, itself, seriously flawed. At best, these limits are what industry has determined to be economically and technically feasible rather than protective of workers' health.

Importantly, the misuses of the science of epidemiology and the misrepresentation of epidemiological study results have come under increasing critical scrutiny that can no longer be ignored. Here again a growing body of critical investigation has uncovered the questionable manipulation of data and analysis as well as serious flaws in research design shown to be the result of industry influence on the researchers. Many epidemiological studies suffer from inherent limitations such as poor design, misclassification of exposures, and insufficient statistical power to detect an elevated risk to health. The classic example involves concluding that there is no association between disease and exposures when the study did not have the statistical power, due to small sample size, to detect a risk that may be present. These unacknowledged limitations of science have serious consequence for the protection of occupational and public health.

For a fuller treatment of these limitations and detailed citations, please see ADDENDUM 2 - LIMITATIONS OF THE SCIENCE.

BRIEF OUTLINE OF RESEARCH FINDINGS

Information was gathered on the production processes and extent and nature of exposures for 22 departments/buildings. Numerous departments or processes went through changes in location over the years and some were discontinued as a result of outsourcing products, being moved to other areas, or being closed down due to toxic contamination. In total, 22 GE Peterborough departments are reviewed in the detailed exposure profiles that represent the body of this report including:

- Building #4: Capacitors
- Building #5: Coil Impregnation
- Building #7: Armature
- Building #8: Machine Shop
- Building #9: Fractional Horse Power Motors
- Building #10: Generator Assembly/Babbitt
- Building #12: Punch Press
- Building # 14A: Tank Shop
- Building # 14: Structural Steel
- Building # 16: Switch Gear
- Building # 16A: Transportation Equipment
- Building # 17: Non-Metallic Machine Shop (aka Carpentry)
- Building # 18: Induction Motors
- Building # 20: Drive Systems
- Building # 21: Nuclear
- Building # 22: Wire & Cable (until 1980)
- Building # 24: Wire & Cable (Formex until 1980)
- Building # 26: Wire & Cable (until 1980)
- Building # 22: Traction Motors (1994-2004)
- Building # 23: Plating Department
- Building # 30: Bus Ducts
- Building # 34: Steel Cutting

It is impossible to summarize all that is contained in the detailed exposure profiles. However, it is useful to identify some of the general conditions, and the nature and extent of exposures shared by most employees. The following are major working-condition features, commonly experienced throughout the plant, that raise the level of risk for significant chemical exposures.

These common conditions were also confirmed by the independent multiple source of documentation the researchers reviewed e.g. MOL, JHSC reports, etc. In addition to supporting the reliability of the focus group-based data, the multiple sources of documentation exposed a pattern of recalcitrance on the part of GE towards making necessary improvements and repairs to protect worker health and, often, outright refusal to adhere to the law with regard to providing workers and their union with information they requested and to which they were entitled. There was also evidence of an unclear relationship between the Ontario Ministry of Labour inspectorate and a very powerful multinational corporation, one with widespread influence both locally and internationally. What else could explain the inspectorate's seeming reluctance to issue orders preferring instead to give "advice to management" or issue unenforceable "recommendations" -- rather than write "orders" where compliance is mandatory.

Common Physical and Work Conditions:

1. The GE facility had little in the way of effective local exhaust ventilation. Most ventilation was by natural means and there was not enough make-up (fresh) air provided. There were locations in which contaminated exhausted air would re-enter the building atmosphere because of the location of exhaust and intake ports.
2. The lack of adequate replacement air resulted in negative air pressure throughout the building leading to the migration of air contaminants within and among departments (Kyselka 1979).
3. Asbestos for insulations on electrical wires and motor parts was used universally throughout the plant. The large size of products required large amounts of asbestos in various forms. Much work with asbestos was done by hand and in confined spaces. Asbestos was drilled, cut with a band saw, and milled by hand, resulting in the dispersal of asbestos fibres/dust. Overhead piping throughout the plant was covered with friable asbestos insulation, contributing to asbostos air contamination. It is documented that GE employed over 500 lbs. of asbestos per day (Rajhan 1971).
4. In addition to chemical exposures associated with industrial work processes, workers were exposed to diesel, propane, and gas fumes as well as dust from transportation vehicles within and outside the plant. Often vehicles were left idling for hours during loading and unloading. Numerous complaints about these fumes are contained in MOL and JHSC reports. Creasote impregnated wood block floors throughout the building were also a common source of chemical exposure for workers.
5. The absence, and poor quality, of hygiene and housekeeping practices within the GE plant are documented including: lack of showers and lockers, the use of recycled rather than potable water, non-functioning water fountains, inadequate lunch room facilities, poor containment and handling of dust, dirt, spills, fumes, vapors, and workers required to provide their own work clothes. Retirees reported that it was once discovered that soft drink and coffee machines had been hooked up to a recycled water source rather than potable drinking water.
6. Nearly every department or area had a curing oven and/or heated resin or solvent tank resulting in employees working under high heat stress and exposed to heavy solvent and resin vapors. Retirees made reference to the “GE smell” which referred to a distinct odor carried on workers’ bodies and clothing that family, friends and health professionals detected.
7. The large size and surface areas of materials being fabricated required the use of large volumes of solvents, paints, and resins as well as extensive welding which took place in open areas. This translated into higher levels of vapors and fumes associated with these processes.
8. The large size of products fabricated resulted in employees working with chemicals for prolonged periods of time in close proximity and confined spaces, for example while degreasing and welding. Some parts were over 40 feet in diameter. At peak, these operations demanded higher use of overtime. Some pieces took weeks, sometimes months, to complete.

The following constellation of risk factors was identified as contributing to significant exposure of workers to a wide spectrum of toxic and carcinogenic chemicals:

- Working closely to the source of exposure,
- Prolonged exposure to the toxic chemicals used or generated during production,
- Absence or inadequacy of exposure controls at the source, e.g. local exhaust system,
- Absence or inadequacy of personal protective equipment,
- Inadequate provision of make-up air and consequent negative air pressure in the complex,
- Application of large volumes of solvents, resins, PAHs, and paints due to large size of products,

- Long duration of exposure because of size and production schedule pressure,
- Inadequate knowledge about the health hazards and exposure controls for worker protection,
- Poor enforcement of safe-work procedures,
- Poor housekeeping practices,
- Eating and drinking and smoking at workstations,
- Inadequate hygiene facilities, and generally poor housekeeping.

Common Chemical Exposures:

Solvents: No matter what department one worked in, there was enormous use of solvents for cleaning and degreasing materials. Degreasers were used in large volumes and often applied by bare hands on large surface areas. Almost every department provided degreasers in the form of trichloroethylene (TCE) in very large tanks that measured upwards of 24 sq. ft. in surface area. Some were vapor degreasers that at times did not function properly. Residues of degreasers were drained on the floor producing large amounts of solvent vapor. Routinely, solvent vapors would migrate to areas where arc welding was performed thus producing HCL gas. Workers routinely washed down large metal surfaces with rags saturated with (TCE) or toluene in preparation for fabrication leading to inhalation and absorption of solvents. Workers frequently registered complaints about vapors and/or adverse effects such as eye, nose and throat irritation as well as narcotic effects. Other commonly used solvents included: toluene, perchloroethylene, MEK, acetone, trichloroethane, xylene, and naphtha gas. Many solvents, when heated, produced thermal decomposition by-products that were equally toxic. Some, including toluene, were highly contaminated with benzene, a group 1 carcinogen.

It is interesting to note that in one instance, an MOL inspector issued orders to protect workers from exposure to toluene despite concentrations below the TLV and protests from management, because the worker's adverse health symptoms were an indicator that the worker was over exposed to the solvent (regardless of the TLV reading). Solvents were used in every department under review (Advisory Committee Meeting notes).

Welding Fumes: Every department had some form of welding and/or soldering operation going on. These were usually large-scale operations involving from 1 to 8 welders working at fabricating electrical housings and parts for motors and generators. Mobile welding operations were also carried out in almost every area of the plant. Welding "booths," contained only by (frayed and friable) asbestos curtains, had little in the way of effective local exhaust ventilation. Welding work areas were commonly described as "thick with welding smoke-plumes," with many complaints related to irritating gases such as phosgene and ozone. MOL reports list many complaints about TCE vapors migrating from degreasing operations to aluminum welding areas (due to negative air pressure) producing phosgene gas. These were reported in focus groups then confirmed in MOL reports and JHSC minutes, as well as internal memorandum from GE Peterborough management. Management also indicated that workers suffered symptoms of COPD as a result of welding exposures. Workers themselves described being "surrounded by clouds of blue smoke so thick you couldn't see the person working next to you" (Advisory Committee meeting notes).

Welding operations included all forms of welding including oxy-acetylene torch cutting and welding, electric arc welding such as MIG, TIG, CO2, and plasma welding. Depending on the type of welding and materials used, both welders and by-standers were exposed to: 1) Welding fumes containing aluminum, beryllium, cadmium oxides, chromium, copper, fluorides, iron oxide, lead, manganese, molybdenum, nickel, vanadium, or zinc oxides; 2) Welding gases including carbon monoxide, hydrogen fluoride, nitrogen oxide, oxygen deficiency, and ozone; 3) Organic vapors such as aldehydes (e.g. formaldehyde), isocyanate, phosgene, phosphine and from metals coated with isocyanate paints, epoxy resins, polyester resins, solvents, or rust inhibitors.

As a result of the large volume of welding going on in every area of the plant and poor exposure controls and housekeeping, exposure to welding fumes was significant throughout the plant for both welders and by-standers. Significant exposure to ozone as well as phosgene gas was reported in some areas of the plant. Focus groups identified eating at workstations, poor housekeeping, and little effective exhaust ventilation. Smoke eaters were reported to “not be very effective,” thus with limited utility for controlling exposures. Welding, in some form, was performed in every department under review.

Epoxy, Polyester and Asphalt Resins: Epoxy and polyester resins were used in more than 70% of plant operations. The resin dipping and curing operations involved dipping, often very large, motor components (including huge coils, armatures and stators) in open vats of resin or in Vacuum Pressure Impregnation (VPI) tanks. In the case of VPI tanks, significant exposure to epoxy and polyester resin vapors occurred when: tanks were open for dipping, lift cables were attached by hitchers, and crane operators sitting above the tanks manipulated large items to and from curing ovens. Workers who squeegeed excess resin were also exposed. Finally, excess cured/hardened resins were ground off motor parts and the oven surfaces during grinding and cleaning operations. Retirees described “thick blue smoke” in the atmosphere during such operations, and “plumes of smoke” surrounding the crane operator’s cage. Workers described the grinding operations as particularly “dirty” operations where workers were covered in dust -- and thick layers of grinding dust covered all surfaces. Under heat, epoxies and resins break down into constituents such as bisphenol-A (BP-A/ endocrine disrupter) and epichlorohydrin (IARC 2A –probably carcinogenic to humans) and various aldehydes. Focus group discussions identified: workers using compressed air to blow off dust; eating and drinking at workstations; and poor housekeeping. Also identified was the absence of effective local exhaust ventilation and lack of respiratory protection for exposures to epoxy/resins, which was corroborated by inspectors’ reports and JHSC minutes. Retirees described an “overheated VPI tank exploding and catching fire after city firefighters sprayed water on it resulting in highly toxic, fumes -- the result of thermal decomposition -- quickly spreading through the plant and overcoming workers (Advisory Committee meetings notes).

Asbestos Exposures: For years, asbestos was the primary material used to (electrically) insulate nearly every component in the multitude of electrical products produced at GE. Along with PVC, lead, and rubber coverings, asbestos -- in various forms -- was made into electrical insulation in stators, armatures, rotors, and various wires and coils. Asbestos was carded, braided, cut, sawed, shaved, and embedded in plastic resin and rubber wire coatings. The Wire and Cable department was a major user of asbestos fibre. Its presence was apparent as airborne dust (“snow storms” as workers described them), on floors and machines, and in storage bins. Some departments shaved and or sanded asbestos-impregnated insulation from wires in preparation for brazing and soldering. Asbestos was used as protective curtains around welding operations and ovens, and as heat insulation blankets to protect welders and/or parts during welding. Workers used asbestos gloves for moving hot materials and parts. All of these were reported to be in tattered, friable condition and a significant source of additional exposure to asbestos. The Armature Department and Carpenter Shop performed major cutting of asbestos boards with band saws. These were pre-drilled and shaped with grinders and sanders, producing large amounts of asbestos dust. Asbestos was ubiquitous and frequently blown (off surfaces and clothing) with compressed air. Workers classified as labourers were assigned to clean out asbestos waste bins on the roof of the Wire and Cable department without respiratory or other protection. The company was cavalier about this hazard since it advertised the sale of waste asbestos for 13 cents a pound as “home insulation” (Advisory Committee Meeting notes and Local newspaper clipping). Exposures were significant for those directly handling asbestos as well as by-standers. As mentioned previously, negative pressure in the plant contributed to the migration of asbestos to other parts of the plant. Given the large volume used in production and the manner in which it was used, workers would be significantly exposed through inhalation.

Polychlorinated Biphenols (PCBs): The use of PCBs at the GE plant has left a long lasting legacy as witnessed by widespread contamination throughout the plant and the surrounding community of Peterborough well after its discontinued use in 1977. This highly toxic, carcinogenic chemical was used as a dielectric fluid in the production of capacitors in building #4 and in transformers and circuit breakers in building #16 and #10. In the process of filling and draining PCB oil from these very large tanks, there was a great deal of spillage and splashes on floors and on workers. This toxic fluid was used in very large volumes not only in the production of new electrical devices but also in the process of dismantling old, or damaged, tanks and in draining them and wiping down the tanks by hand with solvents such as toluene or TCE. PCB was used under the trade names of Pyranol, Askarel, and Inerteen. Workers from several areas (Bldgs #4, #16 and #10) reported heavy exposures to PCBs during the production of transformers, breakers and capacitors. The Ontario Department of Health reported levels ranging from 70 mg/10m^3 to 130 mg/10m^3 (Johnston July 20, 1945). These exposures included others working in the vicinity. Workers in these shops indicated exposure to decomposition by-products, including substances known to be even more toxic than PCB itself. These have been identified as chlorinated dibenzodioxins (CDD) and chlorinated dibenzofurans (CDF). Research indicates that PCB is not only carcinogenic but also acts as a tumor promoter, in combination with other carcinogens (IDSP, December 1987).

Documentation of contamination levels and exposures was the subject of ongoing discussion at JHSC meetings over the high levels found, at or above the TLV, at the time (JHSC Minutes October,1981). Also documented was an incident of contractors “failing to follow prescribed safety procedures” while handling PCB waste oils (JHSC minutes September 26, 1985). An internal company memorandum identified several areas as “highly contaminated.” Levels as high as 90,600 ug/100cm^2 were reported in lab test reports (Baker January, 18, 1989; Baker December 1, 1986).

At present, the widespread contamination of PCB waste oils is under the surveillance of the Ontario Ministry of the Environment, since PCB residues persist and have been identified in many areas of the plant -- as well as adjoining land where PCB waste oils were spread over parking lots and road ways as a “dust suppressant.” The Ministry of Environment (MOE) has recently identified that plant roof debris is contaminated, and since roof drains run through the interior of the building, chronically leaking into work areas, workers continue to be exposed to waste PCBs (Stephenson MOE memo, April 21, 2016).

Metal Working Fluid (MWF) and Machining: Another major part of the GE Peterborough operation was large scale machining that went on in Traction Motors (Bldg. 22), Induction Motors (Bldg. 18), Switch Gear (Bldg. 16), Transportation Equipment (Bldg. 16A), Tank Shop (Bldg. 14A), Structural Steel (Bldg. 14), Generator Assembly (Bldg. 10), Babbitt Shop (Bldg. 10B), Punch Press (Bldg. 12), Machine Shop (Bldg. 8), Fractional Motors (Bldg. 9), Bus Duct (Bldg. 30) and Steel Cutting (Bldg. 34). All of these machining operations used very large boring, milling, drilling, and lathing machines. Some were as large as 40 feet in diameter. These machining operations used large quantities of MWFs consisting of cooling fluids and lubricating oils sprayed on the machine’s cutters. There are several types of MWFs including straight oils, semi synthetic oils, and water-soluble fluids. Many water-soluble fluids are treated with biocides that contain arsenic. MWFs are heated by friction generated in cutting, thus producing mists and vapors containing thermal decomposition by-products as well as unused components of the fluids. Advisory Committee members describe machining operations as “overwhelmed with bluish smoke and mists, in addition to foul smelling vapors.” Operator clothing would be saturated with fluids. In addition to MWFs’ chemical components and thermal by-products, they would contain components of various metals being machined. Compressed air was used to clean surface areas -- further spreading MWF residue. Workers ate at workstations, thus were exposed to MWFs through inhalation, ingestion, and absorption.

Beryllium and Uranium Exposures: The nuclear department located in Building 21 was the source of exposure to beryllium and uranium oxide. The major source of beryllium exposure was the beryllium room where beryllium powder would be vacuum vapor-fused to zirconium sheets then cut into spacers and pads for the bundle tubes. In the early days of its use, levels as high as 41ug/m^3, are documented when workers "hand sawed" beryllium blocks into powder for processing (even though a letter from the Department of Health warned CGE to purchase its beryllium in powdered form). Despite efforts to keep levels as low as reasonably achievable, beryllium disease is on the rise, even as standard-setting bodies, such as the ACGIH, propose lower TLVs (e.g., 0.05 ug/m^3). Recent evidence indicates that this new standard is "unachievable," forcing producers to seek a safer alternative (Harmsen et al. 2010).

The identification of uranium risks has focused on measuring worker exposures (with personal dosimeters) to alpha particle emissions, yet indirect evidence in the form of suppressed monocyte production is reported to be an indication of worker exposure. A scientific study that included GE Peterborough workers identified that fuel bundle workers receive significant exposures to alpha radiation from uranium oxide (Chase 1992). The same study found that 44% of GE nuclear workers had reduced monocyte counts that were "abnormally" low -- 15-20 times lower than expected in a sample of healthy men and women. According to Dr. Chase "… therefore, there are valid and persuasive reasons to suspect that workers are being affected by their exposure to uranium."

What this description of "common exposures" indicates is that GE Peterborough workers were routinely exposed to a complex mix of toxic chemicals occurring throughout the plant with "business as usual."

HOW THE MAIN BODY OF THIS REPORT IS ORGANIZED, AND HOW TO USE IT

The body of this report contains twenty-two individual building/department profiles identifying in detail the work processes carried out and chemicals associated with these different processes. The information is presented in column form with "Production Process" listed on the left column and "Chemical Risk Exposure" listed on the right.

From the "Production Process" descriptions we formulate an 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 volume was used, what was the production rate, how much time was spent on the tasks, were exposure controls available and adequate, and what is the toxicity rating of the material? From Advisory Committee notes, backed by MOL and JHSC reports, we were able to 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. These are accompanied by an explanation for the assessment in terms of the nature of the production process. Where reliable hard data is available this is presented, but always in conjunction with the experiences arising from the production process itself.

To inform the reader, each building profile is preceded by a "face sheet" identifying (in outline form) the different processes that went on in each building, and listing of (identifiable) chemicals associated with the various work processes. Readers will note the repetition of many individual chemicals/chemical groups as one reads through these profiles.

DISCUSSION

GE Peterborough employees were exposed to a multiplicity of carcinogens and other toxic chemicals. The chemicals used at the plant have well-known adverse health effects and are associated with occupational illnesses. Moreover, workers were exposed to multiple carcinogens simultaneously which further increases the risk of developing cancer.

However, from what is identified, with respect to significant worker exposures to toxic chemicals including a large number of carcinogens, it is hard not to conclude that such exposures have harmed the health of GE employees working at various processes throughout the plant. What has been demonstrated in these exposure profiles is that not only were carcinogenic chemicals present, but they were used in large quantities, in close proximity to the workers, and frequently and for long durations—conditions dictated by the large size and intricacies of the products and parts being fabricated.

What Sonia Lal, of OHCOW, found in her retrospective exposure profiles of the Armature Department and the Wire and Cable Department applies equally to all other departments and buildings throughout the GE facility. Her observations are worth repeating with respect to current findings in this retrospective profile that included an additional 21 buildings.

Ms. Lal (in executive summary, OHCOW file # G884) observed, "The constant dipping, baking, curing of these products and the exposure forms, i.e. solids, liquids, gases and their decomposition products have been demonstrated here to be of paramount importance when trying to assess and establish exposures. One process cannot be looked at as stand alone, as the processes all occurred in a building, namely Building 7-5-8-10, for armature employees. Most buildings at GE were similar in that they all relied on natural ventilation. Hence the above statement applies to all buildings, as all the processes within the buildings were close to one another, contaminants were heavy and accumulated, (as there was no forced make-up air) and thus bystander exposure to different contaminants from several processes were incurred by employees" (Lal 2005/6 p. i-a).

The current findings of this much extended exposure profile corroborate what Sonia Lal found in her comprehensive, detailed retrospective profile of the Armature and Wire & Cable departments and are detailed in the body of this report.

While this project does not assign precise quantitative measures to the extent of exposures it is possible to infer the extent of exposures from the nature of the production process, the size and intricacy of the production process, the tasks performed by the workers, the quantities and types of chemicals used or produced, the proximity to the materials, the extent of exposure controls, the characteristics of the ventilations systems, safe work practices and work organization characteristics. Here are a few examples: extensive welding and grinding operations fabricating huge breaker tanks in confined spaces generating large clouds of welding fumes consisting of a complex mixture of gases and heavy metal fumes in the Tank Shop; lapping (sanding) large lead Babbitt bearings bare handed immersed in toluene up to the forearms in Bldg. 8 and Babbitt Shop; crane operators hovering over plumes of vapors from degreaser tanks and epoxy resin VPI tanks in several departments; draining and pouring PCBs in the building of capacitors as well as welding caps on in the Capacitor department; women doing hand work continuously exposed to solvents, lead and cadmium during soldering operations; workers inhaling and being soaked with MWFs during machining of large metal plates, 25' to 40' in diameter; hand wiping of large coils and metal surfaces with rags soaked in toluene; stripping of asbestos coated wires; hand squeegeeing epoxy resin from coils after resin impregnation; band sawing asbestos boards generating large amounts of asbestos laden dust, to mention but a few. What is described here was carried out without effective local exhaust ventilation or adequate protective equipment under intense production schedules.

These findings are corroborated through review of Ministry of Labour reports, JHSC minutes, employer-records available, and industrial hygiene studies on similar production processes. The research team has no hesitation in concluding that most GE workers were significantly exposed to carcinogenic and other toxic chemicals, and that it is highly likely that these exposures have harmed, and continue to harm, their health. GE employees laboured under very poor working conditions marked by inadequate to non-existent exposure controls and lax enforcement. Additionally, these workers were chronically exposed to substances that are potent carcinogens, or strongly suspected carcinogens -- as well as being capable of disrupting the endocrine system. This condition is aggravated by the fact that workers were exposed to complex mixtures of hazardous chemicals that have additive and/or synergistic effects. What we don't know, and is not well documented in the scientific literature, is the synergistic effects of such a multiplicity of exposures.

In conclusion, it must be reiterated that manufacturing in the 20th century was characterized by an historic intersection of the industrial and chemical "revolutions." The GE plant in Peterborough is a classic example, in design and function, of that dynamic social experiment. As such, workers at GE were both participants in, and witnesses to, the horrific working conditions associated with this historical pairing – and its significant toll on workers and their families.

LIST OF GE WORKER/FAMILY PARTICIPANTS

Retiree Advisory Group: John Ball, Lynda Brown, Jim Dufresne, Roger Fowler, Marilyn Harding, Sue James, Carl Jensen, Don McConnell, Gord Terry, Bill Woodbeck, Jim Gill

Invited Retiree Contributors: Sharon Armstrong, Bill Drain, Steve Casey, Mel Crowe, Gary Dalton, Steve Deal, Paul Evans, Bob Gaspari, Paul Graham (Ptbo. Firefighter) Jim Heron, Joe Keating, Ron Lang, Gord Watson

Telephone/In Person Retiree Contributors: Cheryl Armitage, Frank Blakely, Earlene Byrne, Barry Bunn, Frank Chambo, Debbie Chute, Paul Corp, Dave Dettman, John Flannagan,Theresa Flaherty, Teena Flood, Peter Flood, Joe Fraser, Jan Goodbody, Jim Gooley, Peter Gooley, Rob Hayes, Neal James, Joe Keating, Doug Kirkcaldy, Roger Lathangue, Jack Lewington, Wally Moore, Roger Morton, Peter Newmaster, Rick Page, Wayne Parker, Keith Reil, Deb Reyner, Steve Shiels, Jim Stabler, Percy Traynor, Doug Wellman, Roger Wild, Tom Worr, Lee Vitarelli, "anonymous x 2"

Widow/family member contributors: Diane Carl, Sandra Condon, Steve and Cindy Crossley, Debbie Chute, Higgins Family, Aileen Hughes, Pat Huzinga, Sandy Lebeau, Joan McKinlay, Marcelle O'Connell, Arlene Petrany, Sara Sharpe, Lenore Shiels

ACKNOWLEDGMENTS

While it is hard to single out any one individual when so much depends on the collective action of workers, one cannot overlook the debt of gratitude to a very tough, dedicated, Worker Health & Safety Representative at GE Peterborough who passionately fought for more than 40 years to better working conditions at the plant. He meticulously saved every piece of communication that passed through his hands during his years at GE. He was courageous to a fault and both loved and hated. If there is a hero, among so many who participated in this project, it is John Ball. We acknowledge also the important work of Sue James, as coordinator of the project who kept us on track, and whose insights, broad knowledge of the plant, and constant "digging" for information was critical. Essential and invaluable was both the individual and group contributions of the Advisory Committee "mainstays" including: John Ball, Linda Brown, Jim Dufresne, Roger Fowler, Sue James, Marilyn Harding, Carl Jensen, Don McConnell, Gordon Terry, Bill Woodbeck, and Jim Gill. As retirees, our advisory committee members were both willing and able to commit to the very significant time and hard work required to complete this project.

UNIFOR, as the union representing workers at GE Peterborough (specifically Joel Carr, Nancy Clark, and National Health and Safety Director, Sari Sairanen, and staff at the national office) provided meeting space and support as well as undertaking the creation of a data base for the storage and retrieval of government inspection reports, minutes of JHSC, internal company communications and MSDS. UNIFOR has worked to coordinate occupational disease claims with the Office of the Worker Advisor and is assembling supportive documentation, generated by this retrospective study, to go before the WSIB. Special thanks to Local 599-O and its executives for providing meeting space for the committee's work. We thank Laura Hargrove for her work in the final preparation of the report.

The detailed chemical hazard mapping of the GE plant done by both Gary Lane and OHCOW was critical to this project providing a reference point, and supportive documentation for focus group discussions. The work of Sonia Lal and OHCOW identifying risk exposures at GE provided a starting point for this project, serving as a guide and inspiration. Her excellent retrospective profiles on Armature and Wire and Cable departments were substantially relied upon, and incorporated into this report.

We thank Dr. Noel Kerin of OHCOW for his commitment to GE families, especially his support for many claimants through the clinics of 2004.

And finally, we acknowledge the long fight for justice led by the Occupational and Environmental Health Coalition of Peterborough (OEHCP) for promoting their vision of “A healthy viable community in Peterborough and for generations to come,” through their ongoing commitment to, and practical support for, GE families coping with occupationally related illness and death.

This broad community effort “to set the record straight” reflects a concerted collective effort on the part of many citizens and activists to get to the bottom of this occupational disease catastrophe.

BUILDING: #4 **DEPARTMENT: CAPACITOR**

General Description

Building Capacitors

Building Cans for Capacitors

Capacitor Reclaim Area

Laboratory 2nd Floor

Welding Operation

Known Chemicals used or produced:

Metals: Cadmium, Silver, Stainless Steel

Glyptol

Hexavant Chromium

Mercury

Polychloronated Biphenols (PCBs, Pyranol)

TCE, (Roylene)

Toluene

Tricholorobenzene

Dioctylpthalate

Building: #4 **Department: Capacitor**

Production Process **Chemical Exposure Risk**

General Description: This department had two large tanks containing Polychloronated Biphenols (PCBs), and a large degreasing tank filled with TCE. It employed 40 people working 2 shifts. The department was generally devoted to the building and filling of capacitors of various sizes with PCB dielectric fluids. These ranged in sizes from a few inches to 2-3 feet across. This work involved construction of canisters, formation of the coils and filling and sealing the canister with lead solder. The processes also entailed deconstruction of faulty or old capacitors and dumping old fluid. Note that PCB use was discontinued in 1977. It was replaced with a mixture of trichlorobenzene and dioctylphthalate.

Building Capacitors

1. The process begins with the construction of the components. This involves winding aluminum foil and "treated" paper together to form the body of the capacitor. The aluminum foil formed an anode and cathode with electrolyte paper layered between the two;
2. This wound body then placed in a tray on a conveyor;
3. Next, the windings are placed in a "canister;"
4. Leads for the anode and cathode foils are attached with spot welding, and/or crimped;
5. The canisters are then taken to a "treatment" area where they are dipped in tanks containing Polychloronated Biphenols (PCB up until 1977) and are filled by vacuum impregnation; (small capacitors are hand dipped);
6. Prior to dipping, the PCB fluid is poured into tanks of about 50 gallons with semi lid openings and exhaust ventilation. This fluid is circulated for about 5 hours then pumped into a storage tank, then used to fill impregnation tanks where capacitors are filled under vacuum pressure for 5 hours;
7. Capacitor caps are soldered closed after air pockets have been filled with PCBs. This welding occurred while capacitor was still

General Exposures: Workers in this department were highly exposed to degreaser TCE, PCBs, toluene, and various welding fumes that likely contained hexavalent chromium and cadmium from extensive stainless steel welding and silver brazing. These exposures took the form of dusts, fumes and vapours as well as liquid form. (After 1977, PCB was replaced by a mix of trichlorobenzene/dioctyl-phthalate [TCB] as the dielectric fluid in capacitor production. Hence exposure to TCB commenced around 1977). This was high production work involving direct contact with contaminants and very intensive job tasks. There was little or no effective local exhaust ventilation. Housekeeping was poor and no respiratory or skin protection was provided.

Inhalation and skin absorption were highly likely given these risk factors. And given that workers ate and smoked at their workstations, and there were no washing facilities, ingestion of these toxins was highly likely.

PCB Exposures: Workers were in direct contact with PCBs and worked in close proximity to this material. Workers were not provided with appropriate skin protection. Documentation of relatively high exposures to PCB is provided through a series of MOL reports of significant contamination in the capacitor department in bldg. #4. MOL reports available beginning in 1945 and up until 1984 document levels of PCB air contamination well above the current TLV of 0.05 mg/m³. The readings were as follows:

1. 7/20/45:130 mg/10m³ (open); 70mg/10m3(closed)"Well above the allowable concentration" of 10mg/10m³;
2. 2/20/48:140-360 mg/10m³;
3. 5/14/8: 7-220mg/10m³ (5 samples);
4. 6/03/54: New more volatile form of PCB introduced-"Recent changes in pyranol…has resulted in increased vapours …over those

Production Process

under the PCB liquid. During the process a great deal of combustion by-products from heating the metal were generated, as well as the PCBs;

8. Capacitors are then taken to a test area;
9. PCB tanks were located in Bldg. #4 North. There was signed prohibiting entry and entry limited to specialized personnel in recognition of high hazard;
10. After the sealing operation, capacitors were removed to the trichloroethylene degreasing tanks;
11. Then painted with Glyptol epoxy based paint.

Welding and Soldering: Welding was carried out by one person for these operations. Apertures on capacitors were soldered closed with lead and/or silver solder. This process was fairly intensive.

Large capacitors were rolled into an oven and a vacuum manifold was connected to a Schrader valve and left for hours. After removal from the oven cool oil was placed in and the valve closed with lead solder.

Building of "cans" for capacitors

1. 6x12 sheets of low grade stainless were used to form "cans;"
2. These were dipped in trichloroethylene degreaser in an open 6x6x10' tank;
3. Capacitor cans were then hung to drain before being welded;
4. Cans fusion-welded with stick welding (There was no local exhaust ventilation and atmosphere was thick with fumes).

Capacitor Reclaim Area

1. Damaged units, or those not meeting specifications returned to this area and the fluid is emptied into a tank 6'x2'x8' high at floor level. (During the operation splashes of fluid are scattered and vapours are dispersed. Local exhaust ventilation ineffective as per MOL inspector's use of smoke detector tube);
2. A pneumatic press is used to break the capacitor canisters apart. (Local exhaust was

Chemical Exposure Risk

previously used."

5. 6/24/56: Discussion of increased volume of PCB used and the need for better ventilation and personal hygiene;
6. 4/06/59: inspector recommends improving ventilation because vacuum tanks are rich in pyranol;
7. 5/08/59: "These results are higher than those obtained in 1948. We feel these figures are representative…and that a vapour problem exists";
8. 8/22/60: "Installed ventilation…Improvement shown but concentrations still above the MAC." Hygiene facilities unsatisfactory.
9. 01/11/61: Follow up air concentrations measured show PCB levels 5 to 11 times the TLV. Inspector recommends medical monitoring to see if further improvements should be made;
10. 08/27/79: Operators sampling TCB fluid for dielectric properties without PPE-no gloves, organic vapour respirator. Containers filled with TCB left uncovered and may contribute to TCB vapours. Splashes and spills in the TCB reclaim area dispersing into air. Local exhaust ventilation not effective to capture vapour and particulate. Local exhaust for pneumatic break up press "completely ineffective and should be modified." TCE concentration levels at the degreaser were 100ppm to 150ppm. TCB spillage seen and paper towels soaked with solvent left in an open barrel. "This could contribute to organic vapours being discharged constantly into the work room." Orders issue for ventilation, isolation and PPE.
11. 4/11/84: Test for seepage of PCB through concrete floors in bldg.#4N. No air concentrations above the old TLV. But recommend encapsulating the floors;
12. 8/24/84: Swipe samples show very high surface contaminations, stored transformers must be removed and workers advised of hazards and hygiene practices.

Production Process

ineffective as per MOL inspector);

3. Chemicals exposed to in reclaim process included: Trichloroethylene, Polychloronated Biphenols (Pyronal), Toluene, and trichlorobenzene/ dioctylphthalate.

Laboratory 2nd floor:

Mercury (from instrument spills and/or breakage) routinely swept up by staff without protection or ventilation. Staff would collect spilled mercury and dip into trichloroethylene tanks to clean for reuse. This was all done manually.

Chemical Exposure Risk

TCE/Cadmium Exposures (MOL reports):

1. 8/14/79: high levels of TCE vapour in filling and reclaim area. Ventilation found ineffective. Housekeeping and hygiene practices poor, e.g. open buckets of TCE, spills cleaned up by hand with paper towels and left on floor. Inspector recommended PPE, adequate ventilation, and improved housekeeping and hygiene;
2. 01/27/1982: Cadmium in urine levels high and exposure to cadmium confirmed by the MOL. Recommends no food or drink should be consumed in the silver soldering area.

Mercury Exposure: Inhalation and skin absorption of mercury in liquid and vapour state without protective equipment as well as inhalation and absorption of TEC during the mercury cleaning process. Ingestion also another likely route of entry given eating and smoking at the workstation.

JHSC report: 10/11/79
Re: unexpected test finding: “Ministry of Health conducted tests in area using personal dosimeters. Chemicals checked were trichlorethylene, trichlorethylane, and trichlorolenzene. Strangely enough, D1(2-ethyhexyl) phthalate is major component of this mixture and this was not mentioned during checks.”

February 5, 2017

BUILDING: #5 **DEPARTMENT: COIL IMPREGNATION**

General Description
Asphalt Impregnation Process
MICA Coil Processing
MICA/asphalt Tape Production
Maintenance and Cleaning of Impregnation Area
Compounding Tank Removal (1977)

Known chemicals used or produced:

Asphalt
Asbestos
Benzene
Coal tar
Coal tar pitch
Mica dust
Toluene

Building: #5 **Department: Coil Impregnation**

Production Process **Chemical Exposure Risk**

General description: the coil-impregnating department was attached to Building 7, in the Armature department, and was part of that production system, employing 10-20 people. This department housed 2 compounding "tanks" that were partially above and below the floor. Coils were vacuum pressure impregnated with asphalt and then baked to harden in an oven. Building 5 also carried on a Mica coil processing operation and a mica/ asphalt tape production operation during the 1960s.

Asphalt impregnation process:

Both compound tanks were pressure-impregnating tanks. When the doors were opened heavy asphalt fumes would flow out. A tray of coils would be place in the tanks and it would pressurize from 4 to 24 hours. With two tanks, one would always be running while the other was being unloaded or loaded. Workers did not wear respirator protection and there was no local exhaust ventilation to protect from fumes. No gloves were worn. The current TLV for asphalt fumes is 0.5mg/m^3 as benzene-soluble aerosol. Informants noted that fumes from asphalt were very heavy when the doors were opened. In the asphalt impregnation process there was constant cleaning of parts and hands with 1500 toluene.

MICA Coil Processing:

Coils coming out of the compounding tank process were taped and baked. Subsequently, 2 operators would strip off sacrificial tape and tar with knives and then go back to the coil taping process. Informants described the tasks as dusty and dirty since the tape was brittle. Some workers wore gloves and face shields.

Employees frequently complained that it was very hard to breath because of the heavy air borne dust.

Mica/Asphalt Tape Production Process:

Mica/Asphalt Tape consisted of a layer of Mica flakes sandwiched between two strips of tape coated with black sticky varnish (asphalt).

General Exposure risks: high risk of significant exposures of asphalt, toluene, benzene, mica dust through inhalation given the volume of usage and absence of exposure controls.

Risks of inhalation, absorption, and ingestion were present. Given workers' adverse health symptoms and detection of strong odours from the chemicals and heating of them, it is highly likely that reports of exposure are confirmed and that exposure controls were inadequate to protect workers.

Workers in this operation were heavily exposed to asphalt fumes and thermal decomposition by-products. Coal tar pitch fumes from the open pressure tanks and oven-baking processes were highly likely inhaled. Also workers handled these impregnated coils bare handed which put them at risk of absorbing these chemicals through the skin. This was even more likely given that workers used toluene to wash the tar off their bodies. Toluene would defat the protective oils from the skin thus aiding absorption.

Workers were also likely absorbing a certain amount of benzene, a known contaminant in toluene.

The mica/asphalt coil processing also exposed workers to asphalt fumes, mica dust and solvent vapours.

These were very likely inhaled/absorbed in significant amounts given the high level of production as well as the likelihood of absorption through defatted skin. The other factor contributing to the entry of this chemical into the body was that workers were eating and drinking at their workstations.

The mica tape production process and tasks also put workers at risk of exposure to inhaling both asphalt fumes and mica dusts in addition to inhaling and absorbing the solvent toluene used to clean equipment and exposed body parts, especially hands.

Production Process	Chemical Exposure Risk
1. Workers would feed Mica into a hopper 2' square that travelled on a conveyor into a shaker that "shook" the mica onto the sticky tape; 2. As the machine ran, mica black varnish was applied onto the tape; 3. At the end of the conveyor, a heating element caused the flakes to stick to the tape and formed a spool of tape; 4. This was then cut in various sizes by a slitter. This was a sticky and dusty operation and there was mica all over the work area. Compressed air was used to clean mica dust off equipment and clothing. A large 8'x4' steel tank in the area, which contained 1500 toluene, was used to clean equipment on the slitting machine. This tank was open most times. Employees routinely used the toluene to also clean their hands. Workers were very concerned about their health because they found it difficult to breathe and suffered from frequent coughing. There was a danger of fire should the conveyor stop and the paper begin to burn because of the heating element operating at between 300 and 400°C.	
Maintenance and Cleaning of impregnation: Maintenance workers were periodically sent in to clean up hardened resins and asphalt caked onto to rail tracks, ovens, and other equipment and surfaces. This usually involved the use of grinders and jackhammers to remove the hardened asphalt and resins. This was a very dusty operations and workers complained about the residue dust and fumes. Workers did not wear respiratory protection and there was no local exhaust. This was a long-term procedure to clean the area of hardened residue.	This operation put workers at high risk of exposure to dusts and fumes from asphalt and resins without any protective equipment or other exposure controls.
Compounding Tank Removal 1977: **Compounding Tank 1977 incident:** The compounding tank was used for asphalt coating of parts/coils by immersing parts in asphalt mixture. This tank stood 20' high and was encased in loose asbestos 2' thick in a friable state. Asbestos insulation was held in place	This event exposed these workers to enormous concentrations of asbestos and led to development of asbestos related pulmonary disease. In this case one of the workers was diagnosed with pleura fibrosis and the board subsequently accepted his WSIB claim. Workers would have been exposed to asbestos levels that were likely 1000 times higher than the current TLV of 0.1f/cc.

Production Process	Chemical Exposure Risk
by a 2x4 frame that surrounded the tank and was covered with a canvas tarp to hold the loose asbestos in place. When the tank was no longer needed an order for its removal was made leading to a major asbestos exposure. **Removal Process:** Workers were directed to remove and dismantle the tank. Workers cut the canvas open to get at the asbestos and began to remove the asbestos manually with shovels and buckets. The asbestos was taken to a local dump. Some was given to employees to insulate their homes. When an upper manager discovered this dangerous removal of asbestos the work was shut down and the MOL was called in to investigate. The work was halted and did not resume until protect procedures were put in place but by then a major exposure event had occurred.	

February 5, 2017

BUILDING: #7 **DEPARTMENT: ARMATURE**

Processes Armature Upstairs:

Sheer Station

Winding Lathes

Coil Forming Operation

Punch Press

752 Forming Machine

Above Ground Dip Tank

Cut Off Machine and Stripper

Flux pots

Sunken Dip Tank

Baking Oven

Taping Machines

Stator Coil Set Up and Wrapper

Bake Oven

Pole Face Bar Press

Processes Armature Downstairs: (1960s)

Substation

Copper Storage

Copper Lathe

Coil Winding Lathe

Tin Pot Operations

Spreader

Coil Taping Area

Asphalt VPI Tanks

Test Area

Assembly Winders

Overhead Crane Operation

Assembly Winders

Bending Process

Welding Area

Assembly Winders MD-CD

Assembly Winders (turbine rotors)

Assembly winders (induction bar rotors)

Ovens

Portable Ovens

Armature Dip Tank

Storage Tanks

Mica Tape Production

Hydro Poles Operation

Processes lower level 1960-1980:

Copper Storage Area

Assembly Winders

Banding Lathe

VPI Tanks

VPI Epoxy resin 6860 Dipping

Small VPI Tanks

Isonol 51 Tank

Xylene Tank

Sin-Bin

Cold Forming

Coil Manufacturing

Fridge Epoxy Storage Facility

Processes Armature lower level 1980-2005:

Coil Fabrication

Bake Ovens

Crane Cycle

Excitor Process

Isonel Tank

Winding Lathe

Shear Station

Known Chemicals used or produced:

Asbestos, fiberglass, epon glass, resi-glass cord, “castor” brand asbestos gloves

Asphalt 1592, asphalt varnish, “black varnish”

BCME, CPA

Benzene

Bisphenol-A

Chromatap,

Chromic acid

Copper, copper dust, brazed copper, gy wire

Dicumyl peroxide

Epichlorohydrin

Methyl Ethyl Keytone (MEK), MEK peroxide,

Fillers

Formaldehyde

Glyptol paint, 5105 paint, 5142 epoxy, epoxy 74023

Hydrogen cyanide

Isonel 51, 9700 Isonel

Lead, tin, beeswax

Liquid asphalt bonding agents specifications 1027 and 1028

MEK

Methanol

Mineral spirits

Muriatic acid

MWFs

Nomex

Ozone

Phenols

Rosin

Royalene, TCE

Shellac, varnish

Silica, silica dust, liquid silica

Silver solder, sylphs solder

Styrene/styrene oxides, tributyl styrene thinner

Tapes: FG/epoxy, FG/mica, Terylene, Kapton, mylar, hydro, permfil, shrink, fiberglass

TCE, TCE-1300glue, TCE 1500 thinner

Toluene, xylene

Toluene, xylene, methyl, Vinyl toluene

Trichloroethylene

Vinyl toluene

VPI Resin mixes: A311, M6860, 485 (50-50 thinner-resin), 9522, 9637, 5918, Isonel 51

Welding fumes

Mica, mica mat

Building: #7 **Department: Armature**

Sources: Sonya Lal, 2006 (OHCOW retrospective) and Advisory Committee

Production Process

Background: This was a large department employing 200 workers over 3 shifts. This department produced coils for motors and generators, stators, DC motors, and large size armatures for motors. Production process took place in building #7 measuring 350’x100’x70’ ht. There was a mezzanine covering half the building that ran N/S, open to the lower floor. Large-scale armatures were transported via dedicated railway to buildings #8 and #10 where same processes and chemicals were used. Hence exposures in buildings #8 and #10 were similar to those in building #7. In addition, VPI processes of coating electrical coils with polyester resins and epoxy were carried out in buildings #8 and #10. Winding assembly was also done in these buildings. Parts were transported from department to department via dedicated transfer cars on rail tracks. Depending on volume of parts, two or more cars were used. Building #10 built large water-wheel generators and building #8 processed 30-40 tonnes of equipment. Processes took place both in Armature Upstairs (mezzanine) and Downstairs:

Armature (Upstairs)

(Production carried out mainly by women making 5 coils per shift)

1. Shear Station: (replaced by winding lathes in 1980s). This was a large machine to cut insulation for coils. An operator cut fibreglass and asbestos sheets to size generating large amounts of dust resulting in free floating asbestos and fibreglass fibres suspended in the workplace atmosphere. Suspended fibres were dispersed further due to large-standing fans used to cool the area. Also used to cut asbestos wedges and fillers in winding process;
2. Winding Lathes (replaced shear station). This operation consisted of 20’ lathes where copper wire was run through the machine and ‘taped’ with cloth insulation after the wire was first ‘lubricated’ with silica powder

Chemical Exposure Risk

Summary of toxic chemical exposures: A large variety of chemicals were used in the armature department as well as in buildings #8 and #10. These were used in large quantities with little or no local exhaust ventilation, PPE, inconsistent housekeeping, and lack of appropriate hygiene facilities (no showers, no near-by potable water or wash facilities). Chemical contaminants affected all employees whether directly handling these or from by-stander exposures. Because they were mists, vapours, fumes or liquids, main routes of entry were inhalation and skin absorption. However, because worker ate lunch and smoked at their workstations, chemical were likely ingested as well.

Chemicals workers exposed to included: copper, Isonel 51 (solvent borne polyester resin), formaldehyde, BCME, mineral spirits, shellac, methanol, trichloroethylene, hydrogen cyanide, chromic acid, styrene/styrene oxides, dicumyl peroxide, asbestos, mica, vinyl toluene, rosin core solder, royalene, solvent mixtures, liquid asphalt bonding agents specifications 1027 and 1028, benzene, toluene, xylene, methyl ethyl keytone (MEK), MEK peroxide, chromatap, Bisphenol-A, epoxy resins*, fillers, phenols, epichlorohydrin, welding fumes, ozone, fibreglass.

VPI Resin mixtures workers were exposed to included: A311, M6860, 485 (50-50 thinner-resin), 9522, 9637, 5918, and Isonel 51 baked at 160c.

Inhalation of asbestos fibre and fibreglass. Levels prior to the enactment of the occupational health and safety act in 1979 were measured for asbestos at 10 fibres /cc. Prior to the Act, little was done to abate asbestos exposure or provide personal protective equipment. But even as asbestos levels declined in the plant after 1979, they still would be at levels far exceeding current exposure limits of 0.1f/cc.

Cloth insulation was likely asbestos and there is a possibility of silica exposure as well.

Production Process	Chemical Exposure Risk
in large tubs. Silica was released into the workplace if these tubs were damaged or cracked;	
3. Coil forming operation: This involved the shaping of diesel coil by a large hydraulic press using long strips of copper. Fibreglass insulated wire strips were formed using various size wooden forms or molds. The insulation used was 'Nomex', a fibreglass, or Mica Mat. The coil product was then dipped in methanol to secure a firm moist wrap. Isopropyl alcohol was sometimes used depending on specifications. The coil was next dipped in a green bonding solution and sent to 'dry press' to be compressed and baked in an oven. During the baking cycle the coil was wrapped in a 'Nomex' wrap. 1300 Glue (yellow glue) was brushed onto coil slots and coil was insulated again;	Risk of inhalation to fibreglass and Mica dust from frayed insulation sheets and during the forming operation. Also inhalation and absorption of alcohol vapours, bonding solution as well as thermal decomposition by-products during the baking and curing process. Additional inhalation of dust as 1300 glue fumes.
4. Punch Press: One employee assigned to the punch press used to flatten copper leads and pieces were punched out. Operation did not require heating of metal, but were treated with cutting oils. Press was very loud and no ear protection provided;	Punch press operation produced both copper dust (possibly coated with metal treatments such as degreasers) and insulation dusts (fibreglass, mica, asbestos). Risk of inhalation of copper and insulation dust likely.
5. 752 Forming machine: Flat copper wire was shaped into a loop and punch- pressed into a form. Insulation was added to wire consisting of either silica, mica, fibreglass, scotch tape, or 2-gauze fibreglass tape with mica sandwiched between layers. Wire was then dipped in isopropyl alcohol and fed into a taping machine where fibreglass wrap was applied with glyptol glue. Liquid silica was used as a bonding material. Minimal dust produced. Other issues: No local exhaust ventilation to capture fibres released during taping. Machines were used continuously on 8-hour shifts. Tape was cut in rolls with rough edges and loose fibres, which were not contained due to lack of exposure controls;	Risk of inhalation and absorption of alcohol and ingredients in glyptol glue. Inhalation of insulation fibres from edges of tape that would break off. Fibres were not contained without local exhaust ventilation.
6. Above ground Dip Tank for glass measured 3'x4'. Tank was filled with Isonel 51, (an orange dye) with toluene added. No local	

Production Process	Chemical Exposure Risk
ventilation. The tank was used to dye the tape in GE colours plus added texture. There was a strong odour of alcohol. The lid for the tank was rarely used to contain vapours. A wire basket lowered parts into the tank, and then employees removed the dipped wet tape with bare hands. No gloves were worn. Workers hands and arms were frequently in the dip tank. Some workers reported discoloration of hair and fingernails;	Inhalation of fumes and vapours from dip tanks containing Isonel 51. Exposure to formaldehyde and the formation of BCME, BPA. Also exposure to Yellow dye and both inhalation and skin absorption of dye and alcohol due to extensive direct skin contact with these chemicals.
7. Cut off machine and stripper: This 10" machine was used to straighten, strip, and cut fibreglass-covered wire. Copper dust was generated during the cutting process. The ends of wire were sent through brushes that stripped off fibreglass insulation and the wire then cut to length. Much of the wire was insulated with asbestos, also released in the process. There was no local exhaust ventilation. Machine used by one employee for 8-hour shift. The brushes stripped off a great deal of insulation, generating a large amount of asbestos/fibreglass fibre including Kapton Glass;	Risk of inhalation to copper dusts generated during cutting process as well as risk of inhalation of insulation dusts containing fibreglass during stripping process. Risk of inhalation of insulation dust very high, given the stripping process and lack of local ventilation.
8. Lead, flux, and tin pots: Lead pot (size of a crock pot) was heated to melt bars of lead at 621F. The leads of copper wire, as well as Gy wire, were dipped in the lead pot. The wire was placed on a rack to cool. While there was some ventilation above the pot, there was splashing, bubbling and vapours present in the air. No protective equipment was provided. Flux Pot containing a brown, sticky substance in gallon pails used to clean copper leads for soldering. The flux contained muriatic acid. When fluxed wire hit the molten lead, the lead would splash up producing fumes with a strong odour. A standing fan was used to disperse fumes, but was not always available since it was shared with others;	Risk of Inhalation of lead molten lead fumes highly likely. Supported by what we know about the industrial process as well as MOL and medical monitoring reports exceeding acceptable lead/urine/ blood levels. As well, ventilation was inadequate and process produced splashes and bubbling, increasing the potential for exposure. Also risk of inhalation and skin absorption of acid-based flux. **MOL:03/26/68:** re: lead/tin pots poor housekeeping, pots not cleaned, not provided with clear composition of tinning process. Local "exhaust inadequate and require complete overhaul." **MOL:03/26/68:** following previous report on lead pots. Ventilation inadequate in armature. Orders issued: medical surveillance, lead signage, no eating, drinking smoking, housekeeping, hygiene practices, PPE
9. Dip tank (4'x4') sunken in floor containing epoxy varnish thinned with toluene and xylene. MEK peroxide was added as an	**MOL:08/04/71:** Follow up of resin explosion to prevent further contamination; Clean up of phenolic

	Production Process	Chemical Exposure Risk
	accelerator. Parts were dipped and drip-dried over the tank, then baked in an oven. This area was full of heavy fumes from the tank and dripping parts as well as oven baking and drying parts. Tank was used to apply varnish to armatures or rotor-type coils in many sizes up to 7 to 8 feet. Due to dripping, varnish accumulated on floors. There was a heavy chemical odour from tank and drying coils. Employees in adjacent areas also exposed to strong fumes. Fans used, dispersing the fumes to other areas of the department as well as other departments. Employee workstations were near the dipping tanks. There was no local exhaust ventilation for the dipping operation;	resin vapourized and condense on structures. Institute adequate measures to avoid skin and inhalation. **MOL:06/7/73:** dermatitis as a result of epoxy impregnated tapes that are soaked in toluene and used in the winding operation. Gloves difficult to perform tasks with. Improved hygiene and latex gloves provided. **MOL:06/26/73:** Test results not reported but epoxy tape is soaked in toluene. Three types of tapes used: FG/epoxy, FG/mica/epoxy, terylene. Company failed to take proper protective measure because it was told by the manufacturer that epoxy was "mild". **MOL:06/19/74:** High exposure to resin while coating stator with resin using a hose. Worker was soaked in epoxy resin. High solvent and epoxy exposure. '"…company has recognized the hazard involved in this method… and taken steps to discontinue the operation. No orders issued. **MOL: 11/24/76:** Investigate asbestos exposures in armature dept.—workers using band saws to cut asbestos without local exhaust; ventilation should not allow fibres to re-enter work area. Air sampling suggested. Order issued for adequate ventilation. Risk of inhalation and skin absorption of epoxy resin, MEK peroxide was very likely given the amounts and surface areas of covered material and temperatures of oven. Thermal decomposition by-products. Reports of heavy fumes and odours from the dip tank and oven baking operation. There was no local exhaust ventilation.
10.	Baking Oven used for dipping was not properly ventilated. It was 8'-10' in size. Employees could see and smell smoke. Oven heated by electric heaters that forced air down the coils. Fumes were very heavy, consisting of: varnishes, lead, flux, and thermal decomposition by-products from the baking process. Employees experienced heavy solvent odours often reporting symptoms of eyes, nose, and throat irritations;	Risk of inhalation and absorption of resin fumes, lead, fluxes and thermal decomposition by-products is highly likely given the risk factors and observations of heavy fumes documented in this area.
11.	Taping Machines (see MOL report) 5 machines used with 5 or 6 employees assigned. Reports describe heavy fibres in air like a "snow storm." Process involved the use of Mica-Mat, Fibreglass, and Kapton tape. All production items were taped here. Process generated heavy fibres. Employees could not wear gloves due to fine nature of the work, hence had direct skin contact with treated tapes. Alcohol in 5-gallon pails used to moisten tapes. The alcohols consisted of isopropyl, MEK, Xylene, toluene, causing skin to go white, as well as cause burns and skin rashes. Machines were cleaned with solvents once per week with alcohol. Employees would get covered in glue and use MEK to clean it off with vigorous scrubbing. When	Risk of inhalation of insulation fibres highly likely during this operation given observation about visible fibre dust containing mica, fibreglass, and Kapton tape dusts. This is confirmed by MOL reports.

Production Process	Chemical Exposure Risk
working on diesel components, workers dipped their hands in alcohol continuously to position insulation, which led to many cases of dermatitis. Workers reported skin peeling off in sheets when showering at home due to solvent exposure;	Inhalation and absorption of treatments for tapes as well as several solvents handled bare handed. These included Isopropyl alcohol, MEK, xylene, toluene. Use of MEK to clean glue off hands. Exposures confirmed by the incidence of dermatitis and other symptoms.
12. Stator coil set up and wrapper: TCE-1300 glue used in this process had a very heavy odour. It was applied by brush and MEK was used to remove and clean up;	Risk of inhalation and skin absorption of ingredients in both TCE 1300 glue and MEK.
13. Oven (5'x6') used to heat coils prior to moving to die press. The 761, Gys and 581 epoxies were baked in oven to make slots solid. Workers often heat their food in the ovens and ate at workstations because of distance to cafeteria and limited seating;	Risk of exposure to epoxies through inhalation and absorption highly likely. Ingestion also possible given eating at workstations.
14. Pole face bar press. Solid piece of copper insulated with layers of tape, e.g. hydro tape, shrink Mylar, terrylene, tedlar tape, permfil tape, all done by hand. Varnish also used for adhesive (an epoxy resin) brushed on as a very sticky paste. A heated press heated both the copper wire and epoxy resins to cure tape on to the wire. There was no local exhaust. MEK was used to clean presses and remove epoxy brown varnishes. Rags dipped in MEK used to wipe down presses while still hot, thus emitting heavy fumes. "Free Coat" spray was applied to the press to act as a non-stick, which contained MEK. Employees ate and smoked at their workstations. Fibres were significant at the mezzanine level. The air borne fibres and fumes were dispersed to other areas of the building as well.	Risk of inhalation of tape fibres as well as their chemical treatments. Also reports of heavy dust accumulation at mezzanine level would support this assessment. Also risk of inhalation of epoxy resins and thermal decomposition products. Inhalation and skin absorption of MEK highly likely given use for cleaning hands and arms. **JHSC: 1/15/80** re: smoke Grievance filed on matter of enclosure of upper gallery and method of payment when fumes force workers to evacuate area. Although several corrections made, problem still there. Situation under investigation for long time (first brought to attention 10/79).
Armature Downstairs (1960s)	
1. A substation consisting of 2-3 transformers were located in this area, used by maintenance and fenced off from the rest of armature department. It included a degreasing tank measuring 16'x4'x6' deep. The tank was half in, and half above, ground. It contained #10000 Royalene (TCE). This was a vapour degreaser operation heated to 200F.	Risk of inhalation and skin absorption of trichloroethylene exposures was high given: proximity to the chemical, its form in high vapour state from being heated, direct handling, lack of local exhaust ventilation, and worker observation and experience of health symptoms of exposure.

Production Process	Chemical Exposure Risk
Parts were lowered in a basket containing copper and steel components by an overhead hoist. The degreasing process was monitored for 10-15 minutes. Vapour was very strong with workers stating that it "cleared their sinuses". There was no effective local exhaust ventilation. A water tank of the same size was heated with an exhaust over the top. Brazed copper parts from other operations were dipped into this tank for rinsing;	
2. There was a copper storage area where workers wearing cotton gloves picked up copper wire on reels to be made into coils. Some wire was insulated with asbestos from the carding operations;	Potential exposure to asbestos dependent on condition of asbestos laden insulation and whether this was stripped.
3. Copper lathe machine formed copper wire into a flat plate 2"x1/2" thick;	
4. Coil winding lathes operated on a 2-3-shift basis. This was a dry operation. Copper wire was fed into a lathe, which tensioned the wire and created coils. Mica or fibreglass and asbestos tape were applied automatically creating air borne fibre visible in the atmosphere. If the wire came from wire and cable, it was likely asbestos. There was no local exhaust or PPE provided. Motorized sweepers cleaned the main aisle. Workers swept other areas. Dust accumulation on all surfaces and airborne fibres were visible in sunlight. No change rooms were provided and work clothes were brought home. Workers complained about itching and dermatitis. Employer provided SBS 30 and PLY-gel to relieve itching as well as time for these to be applied;	Risk of inhalation of copper dust as well as dusts consisting of mica, asbestos and fibreglass. In the latter case, the winding machine applying the insulation tapes did generate fibres by abrading the insulation as it was being applied. Workers reports of high fibre in the workplace atmosphere that was clearly visible. Risk of asbestos more likely if wire came from wire and cable department. Note that there was no local exhaust ventilation, nor PPE. Dust accumulation, clear sign that the atmosphere was laden with fibres -- as well as workers' symptoms of dermatitis and itching. Latter is confirmed by the employer's attempt to address the adverse health effect.
5. Tin Pot operations/stripper flux. Tin/lead mixture (bees wax added as release agent) heated to 449F. Wire was mechanically stripped of insulation. Flux made of rosin and alcohol applied to clean copper in preparation of tinning. Significant amounts of vapour and fumes detected by those working on	High risk of inhalation and skin absorption of tin and lead fumes from heated molten pots as well as the alcohol based resin, given that the pots were open and workers handled materials directly without effective local exhaust ventilation and respiratory protection. "Sap-like" odours are also a sign that workers were exposed to these fumes.

Production Process	Chemical Exposure Risk
lathes adjacent to the pot operation (which produced sap-like fumes). Odours were heavy from tin/flux. Ventilation system inadequate, despite roof exhaust system. Molten tin was made of 60/40 solder lead/tin. Workers manually fed pots with bars of lead and tin. Asbestos gloves were worn (brand name “Castor”);	
6. Spreader: (used with high voltage coils) Machine spread the coils into the shape required for insertion in stator/rotor. The spreading operation generated and dispersed asbestos fibres;	Risk of inhalation of asbestos fibre highly likely given the generation of asbestos dust during the spreader operation.
7. Coil taping area: (30 workers per shift on 3 shifts) Coils were placed in clamps and lead taped with mica tape, then voltage applied to determine amount of tape required. Each round of taping required the application of black varnish (45 gallon drums). Required the application of 9 layers of tape and varnish. Fibreglass cord use to tighten coils back into position. Coils were then air-dried. Gloves not worn because detailed movements required. Consequently workers dipped their hands in 1500 (TCE) thinner to facilitate tightening of cord. Hands often broke out in blisters and dry skin. The work area was characterized by the accumulation of black varnish, mica dust, and talc and considered to be ‘one of the dirtiest jobs’ in the plant. Workers ate lunch at workstations with windows opened or fans provided in summer. Area filled with heavy fumes and vapours due to large number of workers and large production runs;	Inhalation of mica dust and inhalation and absorption of fumes from ‘black varnish’ as well as direct handling of this material. Also inhalation and absorption of TCE while direct handling and clean skin with this chemical. This is confirmed by adverse health effects on skin. The reported accumulation of black varnish, mica dust and talc indicates that workers highly exposed given reports of heavy fumes, volume of production and number of workers employed in the operation.
8. Two asphalt VPI compound tanks measuring 25’deep x 10’ diameter and 12’ deep x 8’ diameter. This was a vacuum pressure impregnation process to coat coils, et al. One operator/shift and two to fill and empty. Tank first filled with asphalt, then coils to be coated placed on trays and heated in tank for three 24-hour periods to allow asphalt to harden the mica and fit to size. One tank running	Risk of inhalation of asphalt fumes (likely containing TCE) was highly likely. Skin absorption risk, given direct handling of the coated parts. Also risks of inhalation of both glyptol paint fumes and dust from insulation tapes containing graphite and asbestos (which was in a friable state). Confirmation of exposure from workers’ adverse health symptoms. ***NOTE: See also Building #5 report regarding compounding “tanks”.**

Production Process	Chemical Exposure Risk
continuously. Baked coils and cardboard separators removed by hand. Paper dust masks were worn. Asbestos tape use to tape the leads came in a 1” wide reel with loose fibres secured with graphite tape. The remaining wire was painted with red glyptol paint. Exposure to resins became worse over time with workers experiencing burning sore throats. Fumes heaviest when lids were opened;	
9. Test area: Process involved high potential testing of 30 to 40 thousand volts. For large coils, test took 60 tests. Ozone was emitted in process, burning workers’ noses and sinuses. Ozone odours were detected at the upper level as well;	Risk of inhalation of ozone gas generated by application of high voltages was very likely given workers’ experience of odours (even in the upper level) and adverse health symptoms. Ozone is considered a lung carcinogen.
10. Assembly winders: (also conducted in buildings 8 and 10) Process involved 20 to 30 workers handling asphalt coated wire to be set up in the stators. Coils first placed into slots in stator then held in place with asbestos wedges. Varnish placed in each slot (1592 asphalt varnish), which held the asbestos intact. Additional wedges of leathered cardboard and wood used to secure coils in place. Varnished fibreglass cord further secured everything in place. Coils were connected individually, and then soldered in place with rosin core solder by acetylene/ oxygen torch. There was no local exhaust ventilation. Coil leads were insulated with a fibreglass tape also coated with 1592 asphalt varnish. This process was repeated 10-15 times per pair of coil leads. Workers were covered in black asphalt varnish; some wore safety glasses;	High risk of inhalation of asphalt fumes as well as TCE used to thin asphalt. High risk of skin absorption of asphalt given the amount of direct handling of coated materials. High risk of inhalation of asbestos and fibreglass dust. High risk of inhalation of solder fumes and thermal decomposition by-products. These exposures would be intense given the volume of production and the repetitiveness of the process and the fact that there was no local exhaust ventilation and little ppe.
Note: General environment can be characterized as similar to a road tarring operation with a heavy smell of tar and blue haze. There was no local exhaust ventilation and little, if any, PPE. Work practices included using compressed air to clean dust off surfaces and solvents to clean their bodies. Smoking and eating at workstations were permitted throughout the department. The other important	Environmental conditions are supportive indications that high exposures were very likely with weak exposure controls to protect workers from these toxic chemicals. These conditions were aggravated by the piecework system that was in place until 1988.

Production Process	**Chemical Exposure Risk**
aspect of work at GE was the institution of the piece rate system, which tended to exacerbate toxic exposure;	
11. Overhead crane operation: Armatures and other parts, were transported from one end of the building to another by mobile and overhead cranes driven by operators in wire mesh cabs measuring 5'x5'. Hitchers worked with crane operators, guiding them from the ground and attaching and detaching parts to be moved, dipped, etc. Overhead cranes were not enclosed and the operator was subject to large amounts of fumes and vapours from the degreasing tanks containing heated TCE as well as the resins fumes from the VPI tanks and baking ovens. This included asphalt, epoxy resins and degreasers. Observers indicate that the crane cab was engulfed in clouds of smoke and fumes. The operator would take parts in and out of the dipping and baking cycle 3 to 4 times or more daily, ranging in duration from 5 minutes to hours depending on the process. The operator hitchers were also at significant exposure risk in directing the crane operator and leaning over tanks and ovens to hook and unhook parts and monitor the process. Both operators had no protective equipment and there was no local exhaust ventilation. According to observations of other employees, the crane cab and operator would be engulfed in blue smoke. Also observed were large amount of resin dust on crane cab surfaces;	Crane operators were subject to rather high risks of inhaling resin fumes, degreasers and various dusts containing asbestos, fibreglass, and mica. Fumes would also include thermal decomposition by-products resulting from heating and baking resins and curing agents. Hitchers too were subject to high risks of inhaling fumes, often bending over tanks to hook and unhook products being transported.
12. Assembly Winders (Multi Circuit Field Armatures MCF) tasks included securing copper wire to the armature 1' to 5' in length. This involved inserting 3" to 4" sheets of varnished asbestos (wedges) in the slots of the stator as well as sheets of Mica and varnish. Epon glass wedges were also used;	Risk of inhalation of mica and asbestos dust from abraided wedges being inserted into slots. This would also include absorption of resins from directly handling these coated products.
13. Banding Process required the use of a banding machine located near the magnetic frame department. Here the machine would apply	Risk of exposure to fibreglass breakoff and tape resins. Inhalation of fibres and resin fumes and/or by products.

Production Process	Chemical Exposure Risk
a varnished fibreglass tape called Resi-Glass cord;	Risk of inhalation of welding fumes including thermal decomposition by-products from welding resins.
14. Welding area: TIG welding and brazing was mainly used to attach leads to the insulated bars of the commutators riser. This usually involved copper-to-copper welding with no filler. It also involved welding resins on the wires. This operation generated copper and thermal decomposition by-products from burning resins. These operations took 3-4 days with 2-4 welders. There was no local exhaust ventilation and no proper respiratory equipment. Silphos was also used to solder leads. Fumes were dense and rose to the mezzanine level. This was a lengthy process and produced a heavy accumulation of fumes and dusts throughout the building;	Risk of inhalation of fumes from soldering silphos, a silver-based solder. These fumes were heavy and permeated other parts of the building such as the upper level.
15. Assembly winders MD-CD: Same as MCF. Leads cut by lathe, dipped in tin pot heated at 500-600c. Hoisted by crane to the tin pot for 10 to 15 minutes. Wiped down with TCE coated rags manually and then taken for cutting, smoothing and sanding. Part was then placed in a walk-in oven, dipped in 9700 Isonel, dipped, baked and cooled 2 to 3 times. Fumes were heavy and would irritate eyes, nose and throat. Uncured resin would react in the 2nd dip and produce a chemical reaction that was stronger. The trapped uncured resins would be released when cooled and or grinded;	High risk of inhalation and absorption of tin and lead fumes. Fumes were quite dense and workers directly handled the coated part with bare hands. Also, inhalation of metal and resin dusts from sanding and grinding excess resins in addition to inhalation of uncured resins trapped in materials released when cooled.
16. Assembly Winders (turbine rotors): Insulation-blocks of mica and fibreglass and/or asbestos inserted into the slots and repeated several time between high potential testing. The large steel ring was heated to shrink into the rotor with wooden blocks continually sanded to create a proper fit. Finally a piece of insulation was added with a steel wedge;	Risk of inhalation of mica, fibreglass and asbestos when inserting these blocks into slots.
17. Assembly winders (Induction Bar Rotors): This process involved bare copper wire and mica-mat tape lined with Mylar or Nomex. Liner is then dipped in Isonel varnish. Additional	Risk of inhalation of dusts and resin fumes from Mylar, Nomex and isonel varnish high. Risk of inhalation of asbestos dust from paper. Risk of inhalation of TIG welding and Sylphs solder. Inhalation of resin fumes and thermal decomposition by-products from baking resins several times per cycle.

Production Process	Chemical Exposure Risk
insulation provided by asbestos paper varnished (with #1592) between bars 36' wide. Connections TIG welded with Sylphs. All coils tied with resi-glass cord. Product tested, banded, and cure-baked. The process of dipping, baking etc. repeated 2-3 times.	**JHSC: 2/12/80 Re: #3 oven ventilation system:** Padlock to ensure vent remains open not properly installed. Switch can be knocked off with padlock in place. Become obvious that careful monitoring of requested repairs necessary to ensure proper compliance.
Note: the above process involved close and intricate work with direct contact with materials and chemical processes including asbestos and chemical reactions associated with resin coating, curing, and welding etc.; 18. Ovens: typical oven was 15' deep 10' high and 10' door, heated to 160c. Workers walked in and out with parts and would be exposed to high temperatures and intense fumes. Doors would be opened quite often because of the piece rate operation. Odours were like burnt diesel fumes or varnish. Ventilation was inadequate;	Risk of inhalation of resin fumes and thermal decomposition by-products in and outside of the ovens. These would be quite intense in the ovens where workers were in the oven itself. Ventilation was not adequate to control exposures. **MOL: 10/04/82:** Investigation of heavy fumes and orders from curing oven. Report suggests odors may be due to cresol formaldehyde, hexaldehyde, acetaldehyde, propeanaldehyde, and phenol. **MOL: 10/25/82:** follow up on curing oven. Workers complaining of irritation, odors, and nausea. Leak detected. Employer concludes no hazard after testing. However, inspector notes—fumes contain a large variety of thermal decomposition products that at low concentrations can be irritants; exhaust system is likely compromised by roof exhaust and overloading of oven. No orders issued, just advice: don't overload oven and enclose upper end.
19. Portable ovens; (in buildings 8 and 10 also) Ovens were 20'x20'x15' equipped with Calrod heaters. Products were covered in an asbestos cloth that was greasy to the touch. Workers handled this cloth intensely, manipulating it repeatedly, e.g., by removing it and dropping it from heights. Workers came out covered in fibres, which were visible in the air;	High risk of inhalation of resin fumes as well as asbestos dust from handling the oven blanket, which was fraying and handled continuously.
20. Armature dip in Isonel 9700: Armatures dipped in tank 7'x7' containing 9700 Signal and toluene thinner. The Armature was manually hosed with varnish. Armature rotated as it was covered by varnish a section at a time. Worker repeatedly added toluene thinner to the Isonel 5 gallon pail. There was approximately 150-180 gallon of Isonel and about 20 gallons of toluene in the mix. This process produced heavy fumes that smelled like diesel. Workers experienced burning eyes and upper respiratory irritation. Varnish applied manually, then brush used to remove excess. This took 8 hours to complete. Armature moved to baking oven where it drip-dried while rotating as it baked to cure.	High risk of inhalation of Isonel fumes and toluene, handled directly and in close proximity to the dipping operation. Large volume of chemicals contributed to a heavy exposure over a long period of time. Resin and toluene were used in large quantities and handled manually. Risk of inhalation of asbestos fibre from cutting asbestos blankets to size and manipulating over coated and heated parts. Process took a great deal of time and was repeated several times per cycle resulting in a long duration of exposure. No local exhaust and high fume concentration confirmed by 1982 MOL investigation.

Production Process	Chemical Exposure Risk
After this, an asbestos blanket covered the armature. This was cut to size and put in place by an overhead crane and manipulated by the crane operator and worker. This was a high fibre operation and the worker directly handled and manipulated the asbestos blanket. Process also monitored by operator who was required to go into the oven to read/ record temperatures. Exposures to high heat (160c) as well as asbestos fibres. Process repeated 2-3 times. See 1982 MOL report regarding trapped fumes. No local exhaust ventilation;	Risk exposures during filling and cleaning. Exposure to both resin and solvents when tank door opened. After tank is drained for cleaning often had to grind out dried spots of varnish thus exposed to grinding dust as well as any fumes created by friction heat)
21. Storage Tanks: Tin, varnish, Isonel. Three-storey storage tank for asphalt;	Risk of inhalation of mica dust and fumes from black varnish and toluene was high given the open processing of flakes and varnish coated tapes.
22. Mica tape production took place in a room 30'x60'x30' where flaked mica particles were applied to a tape coated in warmed varnish. Mica was thrown into a hopper and traveled up and over into a shaker that deposited mica particles onto the varnished sticky tape that captured the flakes. As machine ran, mica black varnish was applied onto the tape (asphalt tar varnish). This was heated to keep it soft and sticky. Large amounts of varnish on floor and dust from mica. Tape rolls cut with a slitter machine. An 8x4' toluene tank used to clean the slitter blades and worker's hands. Compressed air used to blow dust from machines and clothes;	Risk of skin absorption of varnish as well as toluene high given extent that varnish got on workers' skin and use of toluene to clean it off. The volume of waste varnish accumulation would confirm the high risk of exposure from several routes of entry. Risk of inhalation and absorption of varnish fumes and toluene as a result of direct handling; worker reports of heavy concentration of fumes.
23. Hydro Poles operation: To secure copper wire to poles, insulated wires were attached to steel frames then varnished and baked. Workers cleaned poles with rags dipped in toluene and no gloves for about 30 minutes for a small item. Toluene vapour was overwhelming. Pole then painted with black varnish/ shellac alcohol based. Mica was applied, heated and painted with shellac and baked 3 times for 8 hours. Workers ground off excess cured resin generating lots of dust. No local exhaust ventilation during this because ovens shut off;	Risk of inhalation of mica dusts as well as cured resin dust from grinding excess resin from coated parts. Lack of local exhaust ventilation elevated risk of significant exposures. High risk of inhalation of TCE fumes, copper dust, and solder residues given the volume of materials, direct handling, and lack of exposure controls for long periods of time. Exposures confirmed by reported acute adverse health effects by workers. **JHSC: 5/20/80 re: armature stacks** Recently installed exhaust stacks creating heavy smoke and acrid fumes in whole east of plant area

Production Process	Chemical Exposure Risk
Armature Department: 1960-1980s:	including inside bldgs. now that warm weather is here.
24. Copper Storage Area: Tasks carried out included a TCE degreasing area and grinding excessive copper. No local exhaust ventilation. Generated a great deal of copper dust and residues of solder for 3-8 hours/shift. The TCE operation involved bathing parts in TCE for an hour, and then bathing in water. This produced a violent chemical reaction of smoke, producing rashes and irritations of eyes, nose and throat;	**JHSC: 3/23/82 re: fumes -** Polyurethane tent used to cover area where toluene thinners used to clean coils. Work refusal because of fumes. Tent to be used temporarily but the special job is done and tent still in use. Tent is not vented, also a fire hazard with toluene fumes.
25. Assembly winders: Workers in this area prepared and attached large copper leads for large DC and AC stators. The brazing produced thick blue smoke, affecting crane operator as well. Workers reported burning resins of the leads. In late 1980s smoke hogs were installed, but not viewed as effective;	High risk of inhalation of brazing fumes as well as resin fumes, intense enough to affect the crane operator. These were large leads and brazing and resulting fumes were substantial.
26. Banding Lathe: Resi-glass applied to armatures producing fumes from heating insulated parts, resins and other thinners. Armatures then dipped in Isonel for 10-15 minutes and lifted and drained over tank for ½ hour, producing heavy fumes and vapours;	High risk of inhalation of resin fumes and Isonel fumes from the banding and dipping process.
27. VPI Tanks: Two tanks installed in 1967-68 plus others added latter. Large VPI added in 1990 (10' partly underground). Small tanks 100''x116"x 152" deep. Materials heated include: catalyzed epoxy 74023, Tributyl styrene thinner, and resin M6860. Reports of rashes from thinners and resins. Tanks removed in 1994-95;	High risk of both inhalation and dermal exposures associated with VPI tanks. Workers throughout the plant complained of fumes from these tanks.
28. VPI Epoxy resin 6860 8-hr. dipping cycles went on 24/7. When lid raised heavy fumes emitted with adverse effects felt within 10-15 minute of lifting or placing armature in or out of tank. Tank operators used squeegees to remove excess resin when in oven and dripping over tank. Other activities included grinding excess cured epoxy resin. Leads were also ground and brazed. These activities generated heavy fumes from resins, and copper and resin dusts;	VPI dipping and curing operation involved extensive inhalation of resin fumes and thermal decomposition by-products from dipping and oven curing which would go on extensively in repeated cycles. Inhalation of resin and copper dusts from grinding excess resins after baking. Risk of both inhalation and dermal exposure to resin fumes and decomposition by-products. **MOL:06/24/83:** Lab test by MOL re: Workers concern about hazards from thermal decomposition by products from burning urea formaldehyde foams. Test indicated the following by-products: p-dioxane,

Production Process	Chemical Exposure Risk
29. Small VPI tanks involved dipping small parts in VPI tank resin for 1½ hours, generating resin fumes which would be drawn back into the room when doors opened. Oven baked at 160°C for 8 hours;	vinyl chloride, 2-chlorethanol, cyclopentanone, and isocyanates found. **MOL:06/02/87:** Investigation of excessive emissions from curing oven. GE epoxy resin GE74023 covered baffle. Excessive amount of epoxy on baffle suspected as source of fumes affecting workers and residents. MSDS no established TLV, but indicates that toxic gases may be generated. Stop work order issued until adequate precautions developed and instituted.
30. Isonel 51 tank used to coat coil with insulating varnish. Parts were dipped into tank until bubbles stopped. Varnish thinned with xylene and toluene. Then lifted and left to drain for ½ hour which would release vapours. Parts then placed in an oven at 160°C for 4-8 hours. After cooling, the dipping process was repeated. Since the parts were still warm from the first dip, the second dip would produce more vapour and heat. Leads were ground to remove excess resin creating lots of dust in addition to fumes. See JHSC Minutes re: an inspection in this regard;	High risk of inhalation of resin fumes and thermal decomposition by-products during the dipping and baking operation in the Isonel coating process. Inhalation of resin and copper dusts from grinding operations on leads.
31. Xylene tank: During the 70s tank (32'x12'x8') used to clean resin off bare hands. Sometimes soaked hands for 5-10 minutes. Produced heavy vapours. No exhaust ventilation;	Direct dermal exposure to Xylene in "washing" of hands as well as inhalation of xylene vapours without local exhaust ventilation.
32. Sin-Bin: A sanding area that produced and accumulated great deal of dust. No exhaust ventilation;	Risk of inhalation of various sanding dusts highly likely.
33. Coil forming: Coil cut, made hollow and then epoxied, painted and heated. Production of vapours from epoxy and paint;	Risk of inhalation of epoxy fumes from coatings and paint.
34. Coil manufacturing (Bruce Generating) Hydro coil bar forming. Coil was formed, then epoxied and heated. Very sticky;	Risk of inhalation of epoxy fumes.
35. Fridge: (Epoxy storage facility) 30x40x20'. Epoxy odour detected, staff could stay in there for a long period;	
Armature 1980s to 2005:	
1. Coil fabrication: Produced coil for armature. Involved winding enamel wire, tying (armature) legs with string. Then stripped and tinned upstairs. Nomex placed in slots, leads soldered, then brazed with rosin cored solder. Emitted fumes during the soldering operation.	Risk of inhalation of Nomex insulation, solder fumes.

Production Process	Chemical Exposure Risk
Product tied with resi-glass, banded, and shipped to oven;	
2. Ovens were at 160°C measuring 6'x8'. Parts carted in and out, pot tested and then process repeated 2-3 times;	
3. Crane cycle involved 3 cycles at 6 hours per cycle;	
Brazing Operations: Extensive brazing was carried out in this department. Armature downstairs torch brazed copper segments with silver solder then power sanded. White paste flux fumes from solder and flux. Silphos brazing rods used containing cadmium Oxyacetylene and natural gas. VPI, degreaser TCE, and curing oven.	
4. Excitor Process for inserting coils in stators: 1. Banding lathe (see #26 above); 2. Punch press to flatten copper, blank out corners, press flat, and push together, then braze corners, clean with water; this could take two weeks with copper dust all over; copper strips used silphos solder, air grinding generating copper and silphos dust. Washed with MEK, acetone wiped by hand with rags (workers report being overcome by solvent fumes); insulation could involve asbestos, quinogo, quintax, Nomex; cut to size with shears, slitter, use rectifier to bond everything at 135°C in press, cool to 40°C and clean coil. Insulation of pole with Mica M5680 epoxy on winding lathe. Rotor Pole 5105 red epoxy to pole with insulation using Mica epon glass, paint with 5105 paint then red epoxy between each layer; bake at 160°C for 8 hours; (warming up 5105 paint produces fumes); apply 5142 epoxy twice. Clean up with Toluene 1500. Workers ate at workstation;	Risk of inhalation and absorption of copper dusts, silphos solder, MEK, acetone and toluene. Risk of inhalation of asbestos and other insulating materials including mica. **JHSC: 5/20/80 Re: toluene incident** Employee working for 2 hrs. on armature bars using 1500 thinners in large amounts resulted in loss of consciousness and taken to Peterborough Health Centre (toluene recently substituted for acetone and workers had not been educated on use of chemical and heath risks). Risk of inhalation of epoxy fumes, toluene, Isonel, thermal decomposition by-products.
5. Isonel Tank: Parts were dipped for 10 minutes in Isonel then excess brushed manually. Low voltage coils prepped and dipped into VPI tank twice. Resin and flux then soldered and taped with fibreglass tape. Parts dipped again and placed in oven. After baking and cooling, excess cured resin air-chiselled off, leads burned by brazing, generating fumes and dust;	Risk of inhalation of epoxy fumes and thermal decomposition by-products generated by heating and curing. **JHSC: 10/27/81: Pole winding** A number of new employees have since moved from this work area because of epoxy rash. In 1/12/82 report it states "rashes increasing."

Production Process	Chemical Exposure Risk
6. Winding lathe: Rotor Pole #5105 red epoxy pieced poles insulated with coil; wet winding process; reel wire up and insulate with Mica. Epon glass paint with 5105 to bond first layer, paint all other layers with red epoxy, then bake in oven at 160°C for 8 hours; 5105 warmed to 60°C then back to varnish. Heavy fumes generated by Isonel at 160°C;	**JHSC: 12/8/81: rotor pole area** “Area very smoky and dusty. Request check for ventilation.”
7. Shear station: no exhaust ventilation. Materials sheared to size to fill slots. There were two machines running producing lots of airborne fibres. There was no local exhaust ventilation. Air from open window would disperse fibres further.	See above
Note: The hydro poles referred to in this text is a part of the armature and not to be confused with wooden hydro poles found on the roadside.	Risk of inhalation of airborne fibres generated from cutting operation.

BUILDING: #8 **DEPARTMENT: MACHINE SHOP**

General Description

South West Area

South East Area

North West Area

North East Area

Gallery North and South

Work Processes/Machines

Balancing Machine/Welding and Brazing

Phosgene Gas

Tread Cutting in 8A

Degreasers

MWF (Metal Working Fluids)

Babbitt Fitting (Midway in South End of Building)

Machining Process (Concentrated in South End of the Building)

Green Layout Paint

Grinding and De-burring Operations

Curing and Annealing Ovens

Known chemicals used or produced:

Epoxy Resins

Formation of new chemicals through decomposition or mixing (phosgene, BPA, formaldehyde)

Metal Dusts (Brass, Bronze, Stainless Steel, Steel, Nickel, Chromium, Cadmium, Zinc)

MWFs (Steel Kut, TrimSol, Cimcool, Dasco Tap, Benzene including additives: Arsenic

Chlorine, Sulphur, Mineral Oils)

Solvents (Toluene, Xylene, Acetone, MEK)

Welding Flux (Tin, Lead)

Brazing

Building: #8 **Department: Machine Shop Production**

Process

General Description: This department was primarily engaged in the production of parts for very large motors. This was a high volume department. There were approximately 250 employees in the machine shop. Workers carried out major machining processes including cutting, boring, milling, grinding, polishing and sanding. These various processes produced substantial amounts of fumes, dusts, vapours, mists and gases.

Parts production involved the use of a large number of metal machines (approximately 35 in the south end and approximately 20 in the north end). With this large number of machining operations going on there were extremely large amounts of MWFs which included: 'Steel Kut', 'Trimsol', 'Cimcool', Dasco Tap, and several other water soluble fluids containing arsenic as a biocide. Most operations also applied solvent degreasers to clean and prepare metals for machining, welding and finishing. There were 3 degreasing tanks containing various degreasing agents including Royalene (TCE), Toluene, xylene, acetone, and MEK. Tanks were refilled and cleaned manually during slack periods. Large surface areas were hand wiped by employees with rags heavily soaked in toluene, TCE or MEK.

South West Area of the Building:

There were 6 large vertical boring machines, 4 milling machines, several radial drills. This area also included: 2 slot L&S, planer, degreaser power wash, balance machine and welding booth.

South East Area of the Building:

There were 2 horizontal boring machines, one of which was a 25' machine in addition to the large "Red Gilbert," the Kozma machine, four grinding operations and small and large lathes beside the foreman's office. This area also included: a paint booth, clean and grind operation, NC vertical boring mill, radial drill, and three horizontal boring mills.

Chemical Exposure Risk

Workers were exposed to a variety of toxic chemical that could be inhaled, absorbed through skin, and/or ingested. These included various degreasers such as TCE, MWF such as 'Steel Kut', dusts such as asbestos, mica and metals such as copper, tin, cadmium, and chromate.

JHSC: 8/23/83: re: thinners: "Large gluing operation, operators using thinners to get glue off their hands. Recommend using green gloves to prevent contact with glue."

The lack of adequate local exhaust ventilation and PPE certainly aggravated exposure risks.

Inhalation and absorption of MWF as well as heavily used degreasers were in the high-risk category because of shear volume.

Workers are exposed to through inhalation various vapours from degreasing fluids such as TCE, MEK, acetone, xylene as well as phosgene gas when these solvents come in contact with welding operations.

Workers in most machining operations inhale and absorb through the skin, large amounts of MWF. One such cutting oil called 'Steel Kut' is particularly used in large quantities and is responsible for various adverse respiratory and dermal reactions indicating that workers are exposed significantly.

Exposures through inhalation and skin absorption were evidenced by observations from the MOL indicating that workers were soaked with this oil and that respirators would clog during machining. This product contains mineral oil, sulphur and chlorine. The latter two decompose into sulphur dioxide and phosgene. (MOL: Sept 10, 1982 – four operators identified with dermatitis in past 5 years).

MOL: June 25,1990 – report of soldering near furnace hood. Solvents in large covered beakers beside lapping machine.

Production Process	Chemical Exposure Risk
Gallery South/West: Spindle drills, 2 layout tables, drill, 2 milling machines, 2 Monarch NC machines and horizontal boring mill. **Gallery South/East:** 3 engine lathes, NC lathe and shaft grinder.	Workers are exposed to through inhalation various vapours from degreasing fluids such as TCE, MEK, acetone, xylene as well as phosgene gas when these solvents come in contact with welding operations.
North West Area of the Building: Just below the Main Aisle there was a small machining area, 3 horizontal boring mills, a spider and shaft assembly area and a very large open degreasing tank next to the welding operation across the main Aisle. A large degreasing tank was located in the NW corner. This area also included shaft shrinking operation with dry ice, horizontal lathe, large NC lathe, Large Wotan Lathe. **North East:** Large lathe. **Gallery North:** Assembly and shipping. **North East Area of the Building:** There were 5 lathes and 4 NC boring mills, de-burring booth and a paint booth. North of the main aisle, a shaft-balancing machine was located as well as a welding area, a small assembly area, a machining area, a tin-plating area, a paint shop, and a shipping area. The area also contained a large oven used to cure epoxied parts and armatures from the Armature Dept. across the outside driveway. **Balancing Machine/Welding and Brazing:** This process involved balancing of spinning motor parts such as shafts. This required a great deal of brazing by the welders who attached counter weights to the shaft to reduce wobble and friction. The brazing operation produce large amounts of welding fume as well as residues of degreasers and other metal pre-treatments.	**MOL: Dec 6,1982 -** Mica dust build-up on floor of lathe machine noted in Internal Responsibility System Cyclical Review. **MOL: Dec 6, 1982 –** exhaust ventilation at paint spray booth inadequate air velocity (signs of overspray noted on surrounding area). Significant risk of inhalation of welding fumes containing residual degreasers and heavy metals.

Production Process	Chemical Exposure Risk
Phosgene Gas: Since the brazing/welding operation was very close to the large open degreasing tank containing TCE, fumes from the tank would come in contact with the welding operation producing a highly toxic gas -- phosgene. This gas is referred to as poison gas.	**JHSC: 11/4/80 re: TCE exposure:** "(Company doctor) feels (worker's) medical problems probably related to close proximity of his work station to Bldg.#8 degreaser (as area) still considered a 'trouble spot' and number of other people have complained of discomfort as well." (Worker currently on layoff).
Tread Cutting in 8A: A major bolt threading operation was conducted in Bldg. #8A referred to as the 'hole in the wall'. During this process 'Steel-Kut' cutting oil consisting of mineral oils mixed with sulphur and chlorine, was sprayed liberally during the thread cutting operation on the lathe. 'Dasco Tap' was used during this thread cutting operation. The bolts to be cut were as large as 3-4" diameter and 12" long.	
Degreasers: This department manufactured various components of motor and generator production. During the process of machining, cutting, milling, grinding, buffing and welding there was a substantial use of degreasers, e.g. 2 tanks of Royalene (TCE) and other degreasers such as acetone, MEK, toluene, and xylene.	See inhalation and absorption of MWF and thermal decomposition by-products. The risk of inhalation of fine dust containing various metal alloys including bronze, brass, stainless steel, mild steel, combined with cutting oil fumes/vapours.
MWF (Metal Working Fluids): The various machining operation employed the constant and heavy use of MWF. The department used "Steel Kut" MWF, which was the subject of a health impact study during the 1990s because of reported health complaints and adverse effects experienced by the operators and other personnel. Other machining operations would apply large amounts of MWF that would be sprayed on continuously during the machining. Air in the building would be filled with MWF mist and bluish smoke from heating of fluids during machining. Workers' clothing would be saturated with fluid. Dermatitis, skin burns and irritation, irritated eyes, nose and throat were common complaints. After machining, operators used compressed air to clear cuttings and coolant and oils. This was followed	**MOL inspector observations, Sept. 29, 1982:** The chlorine and sulphur is bonded to the aliphatic chain in the oil and will decompose at high temperature and produce sulphur dioxide and phosgene gas. **JHSC: 8/24/82 re: cutting oils:** Four workers experiencing skin problems, some more severe than others.

Production Process	Chemical Exposure Risk
by a manual washdown with rags soaked in toluene, and/or TCE. MWFs: In building 8I, Bay 15 measuring about 30x60x60 feet two Herbert Turret lathes were operated. These were mostly used for cutting thread on brass, bronze, stainless and mild steel. This operation used Steel Kut oil for over 20 years at the plant beginning in the 1960s. This oil is a mineral oil containing sulphur and chlorine. The machines used 4 g per week and are dripped from a pipe on to the work piece. Most of the oil is dissipated by being thrown out by centrifugal force in the form of droplets or mists as well as thermal decomposition on the hot metal chips. Occasionally operators use respirator but when it is soaked with oil it is impossible to breathe through. At times the hot chips will cause the oil to flare up and produce irritating smoke. Operator's shirts and trousers are routinely soaked with oil as well as on operators' faces.	
Babbitt Fitting (Midway in South End of Building): Babbitt fitting was carried out in both buildings #8 and #10. This operation involved fitters sanding and smoothing imperfections in the babbitt bearings with bare hands in a trough of toluene. This process would take several hours depending on the size of the bearing (See building #10 profile).	Babbitt fitters experienced major exposures both through skin absorption and inhalation. Ingestion was also a factor because workers ate and smoked at their workstations. Working with bare hands in a slurry containing lead alloy and toluene would involved major absorption of both lead alloy and toluene, particularly since the toluene would defat the skin and make absorption more likely. As well, since the toluene volatilizes, vapour consisting of benzene-contaminated toluene would be inhaled readily. (MOL: May 23,1986 – air testing identified significant lead exposure which company attributed to use of compressed air. Practice terminated. Urine levels below alert level).
Tin Plating (South of Paint Booth in North East Section of Building): This department carried out tin-plating in the NE section of the building. The plating process involved cyanide acid and tin/lead salts. This process produced significant amounts of vapours as a result of the electroplating process. These vapour contained cyanide salts and tin/lead constituents.	The tinning operation would generate heavy metal and cyanide acid vapours would be inhaled and absorbed through skin contact during mixing and dipping and retrieving tinned parts.
Machining of Commutators (Concentrated in South End of the Building): Some of the machining involved the application of MWF while others would be conducted 'dry.' There was no local exhaust ventilation. Machining of Commutators involved the generation of copper, asbestos and mica dusts. Retirees described the area	Significant risk of copper dust inhalation dust as well as absorption through the skin. Since workers ate

Production Process	Chemical Exposure Risk
as covered with waste particles/dust six inches deep. Workers' clothing and skin would be encased in metal dusts. This dust consisted of fine copper and silica particulate.	at their workstations it is highly likely that workers ingested these dusts. Workers' skin and hair were reported to turn green from the oxidation process.
Green Layout Paint: Green Layout Paint containing lead and solvents was used to outline cuts and borings to be made on steel plates. This paint was applied with naphtha gas, which is highly volatile.	Vapours from applying layout paint are readily inhaled and would be highly concentrated on large surface areas. Since this process was by hand, absorption through the skin would also occur. **JHSC: 8/30/83: re: paint fumes:** Test-men in high potential testing threaten work stoppage if painters continue to paint large jobs outside booth. "(Union rep) disregarded notes circulating pump for water exhaust is not working properly." **JHSC: 12/17/84: re: paint fumes:** "jobs still being painted outside the booth. This problem existed before the new modern booth installed. However, all that has been accomplished is more material is in the booth and when full, work is painted outside…lots of excuses…but very little is ever resolved."
Grinding and De-burring Operations: All machined and welded parts needed to be de-burred of sharp edges and roughness. These grinding, de-burring, and buffing operations generated large amounts of metal dust that contained residues of MWF, degreasers and other contaminants. The use of Chromac, a cutting and grinding oil was noted.	The risk of inhalation of fine dust containing grit/resin, metal dust contains various metal alloys such as nickel, chromium, cadmium, zinc.
Curing and Annealing Ovens: Machining operations required metals to be annealed (heated) prior to machining. As well, large epoxy coated motor parts such as armatures were transported from the armature department to be baked and cured. This generated a great deal of resin decomposition by-products including BPA, formaldehyde, and other additives in the resin mixes.	Thermal decomposition by-products would be readily available to be inhaled in this baking and annealing process. This would include vapourized oils during annealing as well as decomposed curing resins in the form of fumes and vapours. **JHSC: 2/21/83: re: V-100 epoxy grout:** "Large quantities used for base of a machine. Product has highly toxic fumes. Workers complaining about fumes. Action offered: To notify workers in area next time product is used." **JHSC: 12/16/77 re: diesel exhaust fume incident:** While crane operator loading a transport truck, the driver started the diesel engine and "revved" it. Heavy smoke and fumes blanketed crane operator. Shortly afterward he complained of headaches and severe nausea. Next day felt poorly but reported for work and in evening suffered a heart attack and rushed to hospital (doctor couldn't confirm the

Production Process	Chemical Exposure Risk
	cause because he didn't know about his exposure to exhaust and required blood tests weren't done").
	JHSC: 4/27/82 re: pigeon droppings:
	Workers in #8 having problem with pigeon droppings in water fountain and on their lunch tables."
	JHSC: 12/13/82: re: drinking fountains: water tests show pipes leading to drinking fountains in #8 and #10 "rusting away."
	JHSC: 12/13/82: re: Imron Paint: (This is a special for a customer). Warning label is very strict on ventilation and air supply respirators (union rep worried about Isocyanates in paint). Question is how paint got onto the floor without safety unit knowing of hazard?
	JHSC: 5/27/83: re: solder fumes: "Solder fumes from capacitors travel along wall to female bench worker in balcony causing her to feel ill."
	JHSC: 1/22/85: re: hygiene station in rotor area: "Worker has developed a rash and needs the hygiene station. The area hygiene station is not maintained."
	JHSC: 1/22/85 re: eye wash station: "(In paint booth) an eye wash station is needed in this work station."
	JHSC: 12/10/85 re: lead assessment for rotor and bearing booth areas: "Assessment (legal document) recommendations included that workers be provided with proper showering facility. (This was) rejected by company."

BUILDING: #9 **DEPARTMENT: FRACTIONAL MOTORS**

General Description

General Working Conditions

Work Regime

Production Machinery/Processes:

1. **Punch Press Operation**
2. **Die Cast Operation**
3. **Grinding & Cleaning Operation**
4. **Machining Operation**
5. **Winding Operation**
6. **Degreasing**
7. **Asbestos Glove Repair**
8. **Brazing**

Known chemicals used or produced:

Aluminum Alloy
Asbestos fiber and dust
Copper and other metal dusts
Epoxy (Formex)
MEK
Release Agents
TCE (Royalene)
Thermal Decomposition (annealing and curing processes)
Silver solder (30% cadmium)
Silphos (cadmium)

Building: #9 **Department: Fractional Motors**

Production Process **Chemical Exposure Risk**

General Description: Fractional Motors produced electric motors that were fractions of a full horsepower motor. The production processes were housed in a low ceiling building attached to the Armature department in Building #7. In fact, workers had to walk through the Armature department to enter Fractional Motors. The ceiling was approximately 16' high and a floor space of about 500'x250'. This is the only department in the plant with a moving assembly line (i.e., small size of product parts).

Work Regime: This was a high production, labour intensive, operation employing approximately 80 to 100 staff on 2-3 shifts with a great deal of overtime on a 24/7 basis. Production was on the piece rate system involving building the various components of induction motors of different sizes. All motor parts were made from scratch— hand wound field coils; machined rotors, armatures, and stators; die casts; punch plating; grinding and cleaning; degreasing; resin coating; baking; welding, soldering and brazing. Two curing ovens (Cosmo and Kozma) were located in the low ceiling building.

Motor parts were assembled from start to finish by employees working on a moving assembly line. "The pace of work was punishing, but this is where you made good money" (Worker).

Production machinery/process included: Two punch presses, three die cast operations, open resin dipping tank, VPI tank, two ovens, open pot degreasing containing MEK and Royalene (TCE) tank, boring machines, keying machines, rotor lathe, and 2 parallel assembly lines.

General Working Conditions: Due to low ceilings and inadequate general and local exhaust ventilation, the building air quality was poor and contaminated with a mixture of very toxic chemicals fumes, vapours and mists generated from punching, machining, casting, resin dipping and baking operations, as well as grit, metal and resin dusts from clean and grind operations. Since production was intense -- in terms of pace of work and volume of materials used -- the

Low ceiling in Fractional Motors contributed to the concentration of mist, vapours, and fumes, gases and smoke in the general atmosphere of this operation. This toxic atmosphere was more available at the workers' breathing zone.

Additionally, workers were exposed to the great number of contaminants from the Armature operation. Not only did workers have to walk through Armature to get to their job, but they were also exposed to toxics that migrated from the Armature department.

The work regime in Fractional was intense with everything conditioned by the piece rate system. This meant that workers worked more intensely for long periods thus conditioning the amount of toxins that would be inhaled and metabolized by the body. This was most exhibited on the speed of the production assembly lines; punching operations, and die casts. It meant workers would short cut safe work procedures to maintain pay rates.

JHSC: 2/23/j83: re: Cosmo furnace: "Excess fumes reported in the Cosmo area. Area is poorly exhausted. When Feseco is sprayed on products the area is full of mist." MOL has written directive on problem.

JHSC: 8/23/83: re: Kozmo furnace: "Problem has risen again regarding poor ventilation around 2 furnaces in Fractional. Although management had indicated to Floor Safety members that both units would not be used, this in fact was not so. Both units were in operation the week of this meeting and fumes were very heavy."

A very complex mixture of chemicals was generated from all these operations combined. Most operations were not equipped with local exhaust ventilation and little in the way of protective equipment. This mixture would include exposure to a combination of solvents, resins, MWF, thermal decomposition products, various dusts from grinding operations. These were mostly inhaled but also absorbed by bare

Production Process

atmosphere was highly contaminated. In addition, these operations were labour intensive, e.g. workers handled all aspects of production directly by hand in close proximity with each other. Local exhaust ventilation and personal protective equipment was not provided. Workers ate and smoked at their workstations. Housekeeping was poor.

Specific Processes:

Punch Press Operation: Oil-lubricated and annealed steel sheets were punched at a rapid pace at about 100/minute. This operation produced large amounts of oil mists and vapour.

These punching were then stacked on spindles and pressed together on a 'capton' machine. These "pilings" were then ground and deburred and buffed with hand grinders and buffers, producing large amounts of dusts. A similar process was carried out for the rotors as well;

Die Cast Operation: This was a semi-automatic, aluminum, die-casting operation with molten aluminum alloy (2400°F) producing end shields and end caps. There were three die cast operations, simultaneously producing approximately 1000 per hour. Three die cast operators worked on piece-rate for 3 shifts. These operations created very heavy fumes and vapours from molten aluminum alloys and mold/die release agents. Operators and those working near by developed major sinus problems;

Grinding and Cleaning: Castings were then machined, ground and deburred before going into a soap wash and then into heated open degreasing tanks;

Machining Operations: In machining processes, large amounts of MWF were used during the boring, milling, drilling, and keying operations as well as in turning shafts on lathes. These various metal machining operations generated large amounts of metal dusts and mists and vapour from the heated MWF, which also contained biocides containing arsenic. Die casts were machined after coming out of molds. Machining with MWF generated large amounts of coolant and cutting oils would produce

Chemical Exposure Risk

hand handling and ingested because of smoking and eating at the workstation.

This metal punching operation generated large amounts of oil mists and vapours. Given the volume and speed of production this generated a high concentration of oil mists and vapour that would be inhaled and absorbed through the skin.

Since these were deburred by grinding and sanding this operation would produce large amounts of metal dusts that would be inhaled by those directly carrying out the process as well as by-standers given the proximity of other workers.

Molten aluminum vapours and fumes were readily inhaled at this operation. This was a very smoky environment. Reports of sinus problems would confirm the routine exposure to these fumes and vapours.

Inhalation of metal dusts containing residues of release agents. No local exhaust was provided and no respiratory protection worn.

Exposure to MWF: The machining operations produce large amounts of various MWFs that were inhaled and absorbed through the skin. These also contained biocides containing arsenic in addition to the chemical constituents of the oils and coolants and metals. MOL investigation of work refusal in 1976 indicated that a significant amount of overspray from oil mist from grinding machining was having adverse effects on workers using Chromac 2213. Inspector noted this should be corrected because of risk of dermatitis (OHB # 6L-111-7A-74; January 8, 1976). In 1983 an investigation into a worker illness from MWF exposure to Cimcool used in the same grinding process noted in the 1976 refusal investigation. Inspector noted 'tramp oil' in the MWF and small amounts of 'thiol'. Metal chips were blown off with compressed air, which would aerosolize the cutting oils and coolant called Cimcool 5 Star 40. Contaminants included small amounts of oil mist, ethanolamine, formaldehyde that were 0.69mg/m^3 (TLV=5mg/m^3), 0.07ppm (TLV=1ppm) and <2.0 ppm (TLV=3ppm) respectively. These are not insignificant

Production Process	Chemical Exposure Risk

significant amounts of overspray. Excello machines near the shaft grinding area had no local exhaust ventilation. Approximately 800 end plates were machined per day;

Winding Operation: Coils were hand-wound by a battery of two rows of women winding formex coated copper wire into coils that were then cut and shaped and pressed into stators/rotors. After cutting they were first dipped in degreaser MEK and then dipped into the resin tanks (about 100 coils per dip), taken out and allowed to drip dry. The coils were then placed into baking ovens for curing. Fraying asbestos curtains were hung at both ends of the belt-driven oven. After curing, the coils were cleaned, ground, and pressed into the stators/rotors along with insulation containing asbestos/fibreglass. The pressing and tapping of insulation released asbestos and fibreglass fibres into the atmosphere. This release was substantial give the volume of coils and insulation being pressed;

Degreasing: There were 2 large degreasing tanks containing TCE and MEK. Motor components were degreased in vapour degreasers. Degreaser fumes were very heavy and migrated to other areas of the operation.

These above operations produced large amounts of smoke, mists, vapours, and dusts from machining, grinding, degreasing, epoxy dipping and baking in curing ovens. Workers describe the work atmosphere as ‘a thick haze of bluish smoke 24/7’;

Brazing Operations: Extensive brazing was carried out in this department utilizing silver solder and silphos brazing rods as well as lead solder with white paste flux degreaser TCE, and curing oven;

Spot Welding: The motor shells were spot welded, producing a great amount of weld fumes. Note that this department was pushing out 1000 motors a day.

amounts for Formaldehyde and Ethanolamine since these levels represent 70% and 60% of their respective TLVs. No local exhaust provided. Coolant changed only 3 times a year. (See **MOL/OHB# 1183HMOW; 08/23/1983.**)

In addition to handling the Formex wire coils that contain resins that would be absorbed through the skin, the degreasing process and resin coating exposed workers through inhalation of heavy concentrations of degreaser solvents as well as resin vapours and thermal decomposition by-products from oven baking.

The large degreasing tanks contributed heavily to the inhalation of solvent vapours containing TCE and MEK.

Workers were also exposed to significant amounts of asbestos dust from oven curtains as well as asbestos insulation used in the motors. These were cut and pressed into motors and such action would release fibres into the atmosphere.

JHSC: 12/14/78: asbestos exposure: “On routine check (JB) found asbestos mitts being repaired in large quantities (hundreds per night). Obvious that the woman who repairs mitts is subject to much fibre when handling and cutting.”

JHSC: 1/25/79: asbestos exposures: “(Company doctor and Company H&S rep) are supposed to survey use of asbestos in plant. So far we still have a **good deal of it in use and control is, at best, very lax.”**

JHSC: 2/23/78: fibrosis diagnosis: “Worker (woman) diagnosed with fibrosis of both lungs. Her doctor says it could be caused by work environment.”

JHSC: 4/6/78: fibrosis diagnosis: (Company doctor) visit to investigate area where (woman diagnosed with fibrosis) worked. Safety Committee not informed even though we made the initial request for the consultation. He made a cursory inspection of end shield area then called in several (union) members for meeting. No rep from Safety Committee or shop

Production Process	Chemical Exposure Risk
	steward was present. To date no report on findings or opinion on matter. **JHSC: 5/4/78: fibrosis diagnosis:** "Test results on felt used in work under TLV in both samples, suggesting that felt is 'probably safe'. We feel further investigation is indicated." **JHSC: 2/17/81: failed clean up:** "Hydraulic oil clean-up originally dropped from minutes with understanding everything was to be repaired. Since problem still exists (from '79) checking why this was not completed? Our concern is that is may contain PCSs." **JHSC: 6/30/83: re: Cimcool:** "Work refusal due to cimcool."

BUILDING: #10 **DEPARTMENT: FOUNDRY**

General description

Babbitt production in the Babbitt Shop

Rotor Area

Lapping Process

Garlock Gaskets

Machining and Boring

MWF

Grinding and Deburring

Welding Operation

Painting

Layoff Process

Temporary Oven 1980s

Grinding and chiseling

Testing Process

MOCA in Mining Hoist

Known Chemicals used or produced:

Arsenic

Degreasers (Toluene, Benzene, MEK, TCE)

EMFs

Epoxy Resins (Glyptol, MOCA)

Flux

Lead Paint, Lead Alloy

Metals (Cadmium, Tin, Copper, Nickel, Chromium, Beryllium, Silver, Lead)

MWFs (Steel Kut, Cimcool, Dasko Tap)

Naptha Gas

Ozone

Polyurethane Foams and Adhesives

Release Agents

Building #10, 10A, 10B, 10C

Department: Generator Assembly/Babbitt

Production Process

General description: Building 10 was approximately 800' long and employed over 60 workers on each shift. It housed a major machining, boring, milling, turning, and welding operation as well as assembly and resin curing operations. The building is equipped with 25' and 40' large boring machines as well as smaller boring and milling machines. It also included large drills and lathes. The building had large baking ovens and resin dipping tanks used to resin-coat and cure-bake large armatures that were delivered from the armature department. This was a high production department involving the manufacture of very large motors (some as large as 400 metric tons when finally shipped out of the plant).

General Working Conditions: The work environment was heavily contaminated with a large variety of fumes, smoke, vapours and dusts. In most cases it was not only the operator who was exposed but there was a great deal of by-stander exposure. This was particularly true in welding, Babbitt molding, and resin curing operations. Ventilation was poor and local exhaust ventilation many times was not working, if it was provided.

Many tasks required bare-hand handling of toxics that enhanced risk of exposure. JHSC reports indicate that housekeeping was poor and work practices involved smoking and eating at workstations.

Babbitt production in the Babbitt Shop: Building 10B was used for the manufacture of 'Babbitt' bearings composed of a lead alloy called arsine—88% to 100% lead. Prior to pouring lead into the tinned bearing, one half of the steel bearing is heated in an oven to 220 c. The hot bearing is removed and lowered by crane into a molten metal bath (60% tin/40% lead) for 10 minutes. This is repeated 1 or two times. The melting pot was about 4'-5' in diameter and approximately 4' deep and raised up several feet off the ground. 2'x6" Lead alloy ingots were fed by hand into the molten lead pot. The molten alloy was gravity fed through a chute that directed the molten lead into large cast molds treated with a release agent -'CML' or 'CKL'. This process generated a great deal of smoke containing lead alloy fumes and

Chemical Exposure Risk

General Exposures: Inhalation and absorption (through the skin) of toluene and its constituents (e.g. benzene) was endemic to machining processes. Absorption was further enhanced by toluene's destruction of the skin's protective oil, thus increasing risk exposure. Both types of exposure involved long and close contact with these toxic chemicals, resulting in heavy exposure to these substances.

Inhalation and skin absorption of MWF mists and sprays are continuous throughout the machining process. Machining would involve exposures that could last for hours, daily. Also since the operator's clothing was saturated, the exposure would occur beyond the end of the process. MWF have been rated by several international agencies as carcinogenic.

Inhalation of various metal dust and particles is highly likely given the extent of machining, particularly when machining is conducted without fluids and wetting agents. Added to inhalation and absorption exposures was the risk of ingestion of toxic chemicals as a result of workers smoking and eating at their workstations.

Lead alloy fume exposure: The Babbitt foundry operation involved major inhalation of lead alloy and release agent thermal decomposition products. These were significant because of the large volume of lead alloy used in a molten form where lead fumes would be produced during the melting and pouring operation with operators directly involved. There was also significant standby exposure to workers in adjacent departments not isolated from the Babbitt forming operation.

Exposure to lead was confirmed by the fact that workers would exceed the regulated body burden for lead under the designated substances regulation of lead. E.g. See MOL report on Doug Twist. Company monitoring showed air concentration levels of lead at 0.02 TWAE during tinning and babbitting and urine samples ranging between 0.24 and 0.34 umol/l over a 2-year period. The OELs at the time was 0.15mg/m3 and 0.72umol/l. Are these readings reliable and valid? Were the conditions

Production Process

releasing agents. A huge plume of smoke would rise violently when the molten lead contacted the release agent which was so dense that smoke and fumes would migrate to building # 12, adversely affecting workers in the punch press operation. These Babbitt bearings could weigh up to 2 tons with a very large surface area.

After dipping, the surface of the poured metal is torched to prevent hardening. Then lead solder and paste were used to fill in remaining cavities. These coating and pouring operations took an estimated 3.5 to 6 hours.

The babbitts were then machined and dry sanded. The workers would sand scrape and file the bearing in preparation to be fitted onto a shaft and run to allow the bearing to wear in. Until 1986, dusts from sanding babbits were blown off surfaces and clothing with compressed air, dispersing lead dust into the general atmosphere. Joint committee minutes from the 1980s indicate that the ventilation system in the Babbitt shop was not working.

Rotor Area: This was a lead soldering operation that involved 4 workers in hand soldering 0.5" copper bar connectors on to rotors. The fitter heated the copper bars to 235°C causing the applied lead solder to melt and run onto connections. Workers spent about 10 hours a day doing this.

Lapping Process: (Babbitt Fitting Process Carried out in the 'bearing booth' in Building #8 and in #10): After the Babbitts were released from the mold they were machined to size and test run on a shaft followed by a lapping process. The lapping process took about ½ day. This was carried out by a 'fitter' who sanded the inside of the bearing with his bare hands immersed in toluene -- using 400 grit sand paper and 'scotch pad'. A slury of lead alloy and toluene would result.

Garlock Gaskets: Fitters also performed the task of cutting gaskets from 3'x4' sheets of Garlock gasket material. Garlock was an asbestos fibre impregnated rubber material. This was done either manually with a sharp or punched out on the punch press. This

Chemical Exposure Risk

sampled representative of normal conditions? Did an accredited lab analyze the results? While the air samples do not indicate the TLV standard was exceeded, the results of the urine samples do indicate lead uptake and potential for harm.

Rotor Area Exposures: The MOL originally issued an order to place the Rotor area soldering under the designated lead regulation requiring more stringent hygiene controls. This order was successfully appealed on the grounds that air concentration and urine concentrations were below the OELs. We have no way of determining the validity and reliability of the employer's air and biological monitoring. However, it was the professional opinion of the health and safety inspector that more stringent exposure controls were necessary since there was no local exhaust ventilation and it was noted that compressed air for cleaning was condoned by employer.

Babbitt Fitting exposures: The emersion of bare skin in the bearing trough de-fatted the skin increasing the risk of absorption for both lead and benzene containing toluene. Workers reported getting 'high' while performing this task. It wasn't until the late 1980s that the Ontario lead regulation was applied to this work task, requiring medical surveillance. This process was carried out in the north end of building #10. It was also carried out in a 'bearing booth' in building #8.

The company attributed the relatively high lead air concentrations of between 0.17 and 0.16 mg/m³ in the Babbitt shop to the practice of blowing off lead dust with compressed air. This practice was finally replaced by using a Shop Vac with a HEPA filter. During this period the Ministry of Labour issued orders to place these lead operations under the lead regulation that required more stringent protections. The employer successfully appealed this order. See OHB 86E049MOAR, March 18, 1986.

Garlock Gaskets: The cutting and shaping of gaskets from rolls of Garlock material exposed workers to asbestos fibres. Asbestos was released as the material

Production Process

could be an 8-hour/day operation depending on the demand from other departments. The process of cutting and/or stamping out gaskets from the Garlock produced asbestos dust together with other composition material.

Machining and Boring: These operations involved a great deal of MWF including cutting oils, fluids and coolants. The work included milling, machining, boring, metal cutting, metal turning on lathes for shafts, and shaping. These processes involved major use of MWFs, also referred to as cutting and cooling oils. Some are synthetic while others are natural products. Many have toxic additives to prevent spoilage, such as arsenic compounds.

MWF: Metal working fluids were sprayed on continuously during machining with cooling fluids sprayed from a large tank of recycled coolant and operators applying cutting oils manually. These would generate large amounts of mists, vapour and smoke produce by heat generate during cutting. The atmosphere would be wet with mist and vapour and workers would be soaked with these fluids. One of these MWF called “Steel-Kut” was particularly reactive and workers would often develop dermatitis as well as respiratory irritation and sensitization. Steel-Kut was the object of a major study in the 1990s in building #8 and #10. The MSDS for this cutting oil indicated that it contained mineral oil, sulfur and chlorine. See list of various MWF used in these processes. Cimcool and Dasco Tap were also used in machining operations.

The machining process would also produce large amounts of metal dusts. Some areas would accumulate several inches of dust/particles. Some machining would be conducted dry and this would increase the amount of air borne metal dust. Operators would clean off oils and particles with a compressed air gun, thus dispersing these contaminants further. With the negative air pressure these complex contaminants were spread to other areas, producing cross contamination.

Chemical Exposure Risk

was cut and manipulated. The close up work would also place workers at significant risk of inhaling these fibres. There might be further asbestos dispersion as workers cleaned their work area with compressed air.

MWF Exposures and Machining and Boring: Exposure to metal working fluids, both coolants and cutting oils was significant. These exposures involved large amounts of mists and fumes from MWFs broken down by high temperatures generated during high volume machining on large surface areas. Exposures were through inhalation and absorption through the skin. Dermal exposures were confirmed by reports of skin irritation and dermatitis as well as major investigation into these problems with MWFs.

JHSC: 9/21/78: re: drilling in 10C: Complaints of headache, nausea from operators. Sample taken of vapour produced identified Dasco Tap #2. Test tubes at face area of methyl chloroform registered excess of 650 ppm (whereas short term exposure level is 450 ppm for 15 minutes). Union rep called for operation to cease until corrections made. Face masks obtained to remove contaminant but union asked for ventilation to be installed since other persons in area are being affected as well.”

JHSC: 11/16/78: drilling update: “We have asked for a completion date from engineering (re: ventilation). To date we have had no luck on this. It may be necessary to take further action.”

Production Process	Chemical Exposure Risk
Grinding and Deburring: (After machining, milling, drilling, turning, cutting and welding) Materials were then ground and deburred with air driven wire brushes, and buffed. These tasks produce a large amount of grit/resin dust, and metal dust contaminated with residues of MWF and degreasers.	**Exposures During Grinding Operations:** The grinding and cleaning operations generated great quantities of inhalable metal and resin dusts. There was no effective local exhaust ventilation.
Welding Operations: This department contained a fairly large welding operation located south of the main aisle. This involved numerous types of welding and use of various types of fluxes and welding rods for mild steel, stainless steel, cast iron, and aluminum. Welders operated MIG, TIG, submerged welding, brazing, oxy/acetylene. This generated large amounts of welding fumes containing metals such as cadmium, nickel, chromium, beryllium, silver, copper, to mention a few of the routine by-products of welding in addition to residues of degreasers and MWF. Welding was also conducted with portable units carried to various locations. Since there was a great deal of oil on metal surfaces, welding operations would produce a great amount of smoke that was carried throughout the department. The arc air welding which involved a carbon rod coated with copper would be used to cut plates 3" thick and produce great amount of welding smoke. Also welders would perform welds on surfaces that were coated with epoxies and/or polyurethane foams and adhesives. The assembly and shipping areas would also involve a great deal of welding to fit motor parts, as well as securing these very large motors to flatbed rail cars. Securing a 400-ton motor was complex and involved a large amount of welding to the rail car, which could take over a week to complete.	**Exposure to Various Welding Fumes:** Welding was carried out extensively throughout the department creating a great deal of by-stander exposure. The main route of exposure was inhalation of welding fumes including gases such as ozone, residues from degreasers and various metal and flux fumes. A significant amount of welding involved oily surfaces, generating large amounts of smoke in the general atmosphere. Metals such as cadmium, chromium, silver, copper and beryllium were present in these fumes. Welders were also exposed to asbestos fibres from using asbestos blankets to protect parts and themselves during welding operation. Workers laid on these blankets that were in friable condition from heavy usage. **Solvent Exposures:** Welding operations involved risk of inhalation of various degreasers including TCE, toluene, xylene and MEK. Workers reported being overcome by toluene and exhibiting neurological symptoms. Investigation confirmed that workers were hand wiping the insulation off stator coils with rags soaked in toluene. The only ventilation was by "natural means" with no local exhaust ventilation. See MOL Report: OHB 05890GMOW; 08/12/1980 re: Bldg.#10 Bays 21to 29.
Degreasers: Motor parts were regularly dipped or hand wiped with degreasers as a pre-treatment prior to welding or painting and/or to clean off MWF from the machining processes. The degreaser of choice was usually TCE, or MEK, toluene, and acetone.	
Painting: Motors and parts were regularly painted with what was called Glyptol. There were frequent complaints about the vapours and odors from this	**Paint Exposures:** High risk of inhalation of glyptol paint ingredients including solvents and epoxy resins and pigments. This was particularly evident when paint was sprayed in open areas. See JHSC report

Production Process	Chemical Exposure Risk
application, particularly when it was sprayed on in the open. Glyptol was a GE product composed of a group of Alkyd polymers. Among its constituents were pigments containing magnesium silicate (asbestos), titanium dioxide, calcium carbonate as well as volatiles such as alkyd resins, butyl cellosolire, paropasal "P", and ammonia.	regarding a work refusal that occurred because of spray painting in Bay N-26.
Layoff Process: This process involved painting steel plates with lead paint mixed with naphtha gas. This was manually painted on the plates so that direct contact would be made with paint. This process was also carried out in building #34. This process produced naphthalene vapours as well as lead fumes.	**Exposure to lead and naphtha gas:** Risk of inhalation significant to very volatile naphtha gas and fumes from volatized lead.
Temporary Oven 1980s: In the 1980s a 'temporary tent' curing oven was constructed in Bay 24N of Bldg. #10 to accommodate coating very large armatures. It was constructed against the west wall of Bldg. #10. This oven was 25' high and 40'x40' square. It was lined with a very **thick asbestos curtain, which** surrounded all 4 sides of the oven to keep the heat in. A tin roof was also constructed to keep heat in which was equipped with a vertical exhaust duct. Activity in the oven involved rotating large armatures (ferris-wheel style) in a resin-filled epoxy (vinyl toluene) trough, 12'x15' in size. As the armatures were being coated with the resin the Kelro heaters would bake the coated armature to harden the epoxy resins. During this process workers would also squeegee the resin to ensure uniform coverage. Workers were noted in JHSC minutes to have made complaints about how they were required to handle the resins during this process, and demanded the hygienist come to view the work with respect to its health impact. Armatures were baked for approximately 72 hours. This resin dipping/baking process produced large amounts of thick bluish smoke throughout the department. The resins were used in great volumes given the size of the armatures being coated. Health and safety JHSC comment that ventilation in this oven did not work consistently.	**Exposure to Asbestos and Resin vapours:** Significant worker and bystander risk of inhalation of asbestos dust from curtains, which were in friable condition as a result of wear and tear from work activity. This combined with risk of inhalation of polyester epoxy resins and thermal decomposition by-products during oven baking made worse by lack of appropriate ventilation and dispersal of contaminants through air movement and work activities. Workers experienced frequent headaches and eye, nose and throat irritation from inhalation and absorption of the resin fumes and gases.

Production Process	Chemical Exposure Risk
Grinding and chiseling: After the epoxy hardened workers would grind and/or chisel off excess resin and hardened resin in the trough producing great amounts of grit and resin dusts since these (40-ton) armatures were very large. Per shift, 40 to 50 motors were dipped and baked in this manner. There was no local exhaust ventilation. Fumes were heavy and prevalent. There were frequent work stoppages throughout the 1980s as a result of workers concerns about these exposures.	**Exposure to Resin Dusts:** Inhalation of significant quantities of cured hardened resin dusts during grinding and cleaning operations to remove (baked on) excess resins as well as cleaning the oven trough. Generated dusts would also be deposited on and absorbed through the skin.
Testing Process: Large motors that would run at between 20,000 and 30,000 horsepower were regularly tested and run at extreme power. Gases generated during the process included ozone and nitrogen dioxide. This operation also produced strong magnetic fields in the ELF frequency range.	**Exposure to Electromagnetic fields** during electrical testing at very high voltages. Workers were chronically exposed to EMFs at very high amperages. EMFs are classified as a human carcinogen.
MOCA in Mining Hoist: Mining hoists were built in 10S. This involved fitting MOCA pucks in the slots of very large hoist drums. These were fitted in slots around the entire circumference of the hoist drum where the 2”-3” diameter cable would “ride” on them. The 6” MOCA pucks were hand machined, filed, sanded and then cut with a chain saw and hammered into the slots butt-joined. This involved hand-fitting large numbers pucks around the drum, producing significant MOCA dust that would cover the soles of workers’ shoes.	**MOCA Exposures:** This process generated large amounts of MOCA dust inhaled by workers handling the substance by grinding, cutting, filing and hammering to make it fit, as well as those in close proximity. MOCA, 4,4’-methylenebis (2chloroaniline is classified by IARC as a Group 1 carcinogen-carcinogenic to humans, IARC Monograph Vol. 100F, 2012). **JHSC: 11/3/77: re: Tar epoxy exposures:** “Crown Diamond tar epoxy is sprayed in unventilated area. This job questioned as far back as 2 years but no action taken to correct it.” **JHSC: 8/14/79: re: Asbestos dust:** “Large armature was being processed (epoxy bake) and large sheets of asbestos cloth and blankets of Kaowool draped over it. When cycle finished the asbestos and Kaowool was dragged off armature creating clouds of dust and fibre in large area of #10 bldg. Upon checking out situation it was badly contaminated so instructions given to use zero discharge vacuum cleaners to clean up particles.” **JHSC: 12/8/81 re: spray paint:** Painters painting 25 foot key bars outside paint booth. Also going inside stators to spray paint. Chemicals in paint are

Production Process	Chemical Exposure Risk
	ammonia magnesium silica (a form of asbestos). Management to get more information on paint. **JHSC: 8/24/82: re: hydrogen leak:** "Hydrogen leak led to evacuation of #8, #10, #10C, #12. Workers complained that evacuation route took them right past hydrogen tanker truck." **JHSC: 10/19/82: re: asbestos refusal:** "Workers in 10C were asked to heat an asbestos board. Laboratory worker had no work order for job and no authority to give men work without first contacting foreman." **JHSC: 12/13/82: re: drinking fountains:** "Water tests showed pipes to water fountain rusting away." **JHSC: 9/26/85: re: removing PCBs:** On Saturday, transformers were being drained of pyranol which contains PCBs. The prescribed procedures were not followed and as a result of the poor handling there was a work refusal by employees in the surrounding area." **JHSC: 12/86: re: showers for lead workers:** (As per recommendation in Lead Assessment done in #10) "…company is not prepared to supply showers for lead workers in Babbitt shop, Lead Rotor, and Bearing Fit areas." To be appealed to MOL by union.

BUILDING: #12 **DEPARTMENT: PUNCH PRESS**

Punch Press Operation

General Description

General Working Conditions

Punching/Machining

Welding

Grinding/Deburring

Annealing and Enameling Ovens

Enameling

Annealing

Copper Coil Annealing

Commutator Machining

Coil Stripping

Cutting with Carborundum Saw

Degreasing Tanks

Rebuilding Old Motors

Known Chemicals used or produced:

Asbestos

Caustic Soda: sodium nitrite/nitrate

Gasses: $C0_2$, helium, ozone, phosgene,

Decomposition by-products: formaldyhyde, benzene, PAHs

Degreasers: TCE, Toluene

Detergents

Fibers/Dust: Asbestos, Fibreglass, Insulation products, Mica

Metals: steel, copper, stainless steel

MWFs: Steel Kut, Dasco Tap

Resins/Resin fumes: Glyptol, others?

February 5, 2017

Building #12 **Department: Punch Press**

Production Process **Chemical Exposure Risk**

Punch Press Operation:

General Description: The Punch Press shop ran north south between buildings #14 and # 10. It employed 100-150 workers on 3 shifts. It was about 1000'x200'x60' high. It was a wide-open operation in the north section and partially enclosed in the south. It was a major punching and machining operation that provided punched out parts and punched sheets of steel as well as machined parts throughout the GE operation. It had very large punch press and a large shearing machine, small lathes, 2 large boring mills, a battery of small punch presses operated by women in the SE aisle and a laser operated press. Very large degreasers were located in the area. The 'Rim Plate' area contained a very large punch press that punched large plates for water generators. Finally, this department was heavily engaged in the 're-manufacturing' of diesel motors that were torn down, cleaned, rebuilt as necessary, and painted.

This was a high volume shop that in addition to what the punch press and machining operations generated, this department was subjected to contaminants from the welding and grinding operations in building 14A and lead and mold release fumes from the Babbitt shop.

These contaminants were highly likely to be inhaled. The complaints from workers concerning these fumes as well as symptoms attest to these over exposures.

JHSC: 2/23/78: re: degreasers: When degreaser scheduled for clean out, air-line put down to exhaust fumes and dry out residue. This process tends to 1. Blow strong vapours in a wide area creating real hazard to other personnel and 2. Creates a dangerous environment for worker doing the cleaning.

General Working Conditions: In addition to contaminants generated in bldg.12 operations, contaminants from the Tank Shop in bldg. 14 would migrate to building 12 punch press operators. This included large amounts of welding fumes, degreaser vapours, and grinding dusts. As well, fumes and gases would migrate from the Babbitt Shop in bldg. 10B consisting of lead alloy fumes and release agents. This infiltration was due to the negative pressure and lack of local exhaust ventilations in these two areas.

Ingestion also likely given that workers ate and drank at the workstation and did not have washing facilities.

Punching/machining operation and use of solvents and MWF: This was a major metal machining and punching operation, punching out large and small parts throughout, as well as shearing large heavy gauge sheets of steel with a large shearing machine. Metals brought in were coated with varsol prior to shearing and punching. The shearing and punching operation would generate large amounts of mist and vapour from the varsol coating being stamped and heated, from impact. The stamping process could produce 100s of parts per minute, so that the rapid punching process would produce large amounts of mist and vapour.

Inhalation, absorption and ingestions of several MWF, solvent and oil mists produced by punching and machining highly likely in large surface area and high volume production process.

Production Process	Chemical Exposure Risk
The Rim Plate operation would involve punching a steel plate that could be 8’x5’x1/4 thick. The plate was mopped with ‘Steel Kut’ machine oil in preparation for punching. During the impact a great deal of mist and vapour was produced.	
Welding: A substantial amount of welding was carried on fabricating parts which were then ground and deburred.	At times, welding activity would generate small fires and explosions as a result of TCE residue trapped in small cavities within the motor castings. Workers reported severe nosebleeds and sinus injury. Welders also used asbestos woven blankets during welding operations to protect certain parts from the welding splatter.
Grinding/Deburring: After punching and machining, parts had to be deburred by grinding, sanding and buffing. This was usually done with compressed air driven grinders and metal rotating brushes, as well as belt sanders using 400 grit sand paper. The deburring operation produced a great amount of air borne dust containing grit/resin, metal particulate with residues of MWF.	Grinding and deburring operations produced large amounts of dust containing solvents residues, heavy metals and epoxy resin dusts. Inhalation highly likely given the lack of adequate local exhaust ventilation and PPE.
	JHSC: 11/15/82: re: radiation: “Query radiation checks since x-ray room beside this work area has been increased. Workers upset this problem has persisted for over a year.”
Annealing and Enameling Ovens: There were two ovens located on the west wall north of the main aisle. These were enclosed except for an entry and exit ports with asbestos curtains.	Annealing and enameling ovens generated a mixture of thermal decomposition byproducts that were readily inhaled. These would include oil and solvent residues that were heated to high temperatures. This would also include epoxy resin fumes and break down byproducts from the curing process.
Enameling: After being deburred, punchings were placed on a conveyor belt that travelled through the oven. These were heated to burn off oils and then sprayed with brown epoxy and baked for about 15 minutes then taken off the line and stacked. This process generated a great amount of bluish smoke that permeated the atmosphere with a complex mixture of epoxy thermal decomposition by products such as BPA, formaldehyde, benzene, etc. While there were many types of epoxies used, this was most likely Isonal.	Inhalation and skin absorption of a variety of thermal decomposition by products from polyester and epoxy resins.
Annealing Process: During the annealing process punchings were baked at high temperatures to temper the steel parts. This also generated a great deal of smoke containing thermal decomposition by-products from the burning off of various oils, degreasers and MWF. This process would also generate asbestos fibres from the curtains being brushing against the punchings as they entered and exited. These curtains were replaced often as a result of the wear and tear.	Inhalation of asbestos fibres from fraying asbestos curtains, degreaser and MWF residues and decomposition by-products.

Production Process	Chemical Exposure Risk
Copper Coil Annealing Process: Flat copper coils are hoisted by an overhead crane and dipped into a vat of TCE, then dipped into a tank of molten sodium nitrite/sodium nitrate, and then soaked in a cold water rinse. Periodically, the caustic tank has to be replenished and the old material taken out and dispensed. **There is a possibility that this solution can react with an acid and produce nitrogen dioxide gas. This might be possible if there is insufficient time for the TCE to be completely dripped off before entering the caustic bath.** Because of the piece rate system operators were not allowing sufficient time to elapse between the two dips.	Exposure to TCE vapours, nitrite/nitrate salts, and possibly NO_2. While this was not measured the likelihood of NO_2 being formed and inhaled is entirely possible.
Commutator machining: Large commutators were machined on lathes in this area as well as in Building #8. This produced large amounts of mica, asbestos and copper dusts from the machining process.	Machining commutators generated copper, mica and asbestos dust which are highly likely inhaled and ingested
During this process, asbestos boards 2”x16”x1/4 were machined for commutators.	Inhalation of insulation dusts containing resins, asbestos, fibreglass fibres highly likely.
Coil Stripping: This involved stripping copper and insulation of coil rings, which were then ground, sanded and chiseled and then dipped in caustic soda. These were then sent to Bldg. 16A to be re-wound and re-insulated in and asphalt dip.	As above.
Cutting with carborundum saw: Constant cutting with a carborundum saw was a night and day operation that generated large amount of metal and grinder dusts. Workers describe area as ‘coated in dust’.	Inhalation of grit and resin dusts generated by saw.
Degreasing Tanks: This department had 3 degreasing tanks. TCE, caustic soda, possibly xylene. These were used extensively during the re-manufacturing process. Routinely, parts were dipped from TCE to caustic soda without allowing the residues to drip dry sufficiently. This would cause some severe reactions and noxious fumes that workers complained about. MOL reports noted this practice and ‘recommended’ that at least 15 minutes elapse between dips. Despite this recommendation the department continued the practice. (See MOL reports)	See **MOL report dated August 26, 1964** addressing employers concerns about the handling of waste sodium nitrite/nitrate. Fire broke out when materials spilled on wooden pallet. Asbestos paper subsequently used to prevent fire when stored on wooden pallets. The likelihood of inhalation of caustic soda salt vapour and asbestos as well as degreaser vapours. Inspector notes the possibility for caustic salts to be carried in the vapour and steam.

Production Process	Chemical Exposure Risk
Re-manufacturing used Motors:	
The re-manufacturing of used diesel motors was done in south end of bldg12 and 16A. These were reconditioned locomotive engines for CN. The operation continued 24/7 for many years. Area measures about 30x20x60 high.	
Manual Disassembly Process:	
1. Entire motors were steam cleaned with high-pressure nozzles;	Exposure to heavy mist of detergent, solvents, and unknown residues from motors.
2. Bolts manually removed from frames to release rotors, stators, casting parts;	
3. The disassembled parts were steam cleaned;	
4. Newly cleaned parts first dipped in a (10'x12') vat of heated TCE;	Steps 4 and 5 generated heavy fumes from the dipping in TCE and caustic soda.
5. Parts were then dipped in a (5'x6') vat of caustic soda;	
6. Parts then steam cleaned under high pressure;	Steam cleaning generated heavy mist of detergent and solvent residues.
7. These heavy parts were maneuvered by overhead cranes, which would at times hit asbestos insulated pipes thus dislodging large amounts of friable asbestos. These would fall on welding operations and cause flash-fires when ignited;	Frequent exposures to loose asbestos fiber falling on workers and floating in the air.
8. Crane operators worked in open cabs with no building exhaust system;	Crane operators exposed to mists and fumes from degreasing operations carried out below them. Described as “clouds of dust and fumes.”
9. Welding operations going on simultaneous with the manual disassembly operation adding welding fumes to the other chemical fumes and mists generated in the disassembly process. Approximately 3 welders in the area carrying out MIG and CO_2 welding in the area of a TCE degreasing tank and operation;	A “toxic soup” of chemicals and fumes generated in a process that went on for 12 hours per shift, around the clock for many years. (Producing 3-4 remanufactured units per day).
10. Located between the disassembly building (12) and remanufacturing building (16A) was a major welding operation. The gasses used were CO_2, helium, and fumes from molten metal, which would be carried into buildings 12 and 16A as all of these buildings were not physically isolated, rather divided by low partitions that did not prevent fumes from reaching other parts of the complex;	This “toxic soup” included: welding fumes and gasses, MWFs, degreaser fumes (TCE), heavy metals, toluene, insulation dusts/vapours, resin fumes, which workers would be exposed to for 12-hour shifts. **Welders' Health Issues:** Workers made frequent complaints of irritated nose, eyes and throat. Workers complained and filed workers' compensation claims for nose bleeds. These welding operations can generate significant quantities of ozone gas that is a known respiratory irritant as well as a probable human carcinogen. As well, in
11. Armatures of heavy copper coils were made	

Production Process

in the shop, then cleaned and annealed before using. Cleaning was done in a vapour degreaser of TCE tank 7x5x9' deep fitted with exhaust slots. Degreasing takes about 20 minutes with crane operator handling the basket. Then crane operator places the basket next to a salt bath of sodium nitrite/nitrate in a 8'x4' tank of molten salts (Draw Temp-275°F). Bath is maintained at 800°F. The parts soak for 6 hours in the salt bath then are soaked in a rinsing tank at 200°F. Considerable steam is generated during the rinse phase. The crane operator is above these tanks while vapour and steam is generated upward.

Chemical Exposure Risk

contact with TCE, phosgene gas can also be produced. This gas is highly toxic and a major respiratory irritant. Measurement via Draeger Tubes of TCE in the area where the nosebleed occurred was 25 ppm. **Report # IE-67; June 5, 1970. These tubes have an error rate +/- 25-35%.**

Welders made frequent complaints about ozone gas and welding fumes from arc MIG and stick welding. The report notes that one worker was well on his way to developing COPD and should find other work than welding -- particularly MIG and TIG welding which generate significant amounts of ozone gas which is a major irritant.

Crane operator health issues:

Department of Health report dated April 1, 1970 concerning a crane operator who filed a work related illness claim as a result of exposure to the annealing chemical while he was dipping the coils in these solutions. Nose bleeds, swelling of the ankles, rashes and a fever.

While the investigators concluded that this couldn't have been work-related, there is a possibility that nitrogen dioxide could have been formed as a result of acid being formed from the TCE degreasing operation being near the welding operations. It is possible that NO_2 was formed by reaction of the salt bath and the acid mists.

Department of Health report dated April 6, 1970 indicated that a field visit on March 23, 1970 found a number of problems with the operation:

Poor housekeeping; "visual inspection. …Indicated that the exhaust system was completely ineffective"; and there were no eye wash fountains near caustic soda tanks. Crane operator experienced adverse health effects while dipping coils in caustic soda as well as steam generated by quench tanks.

BUILDING: #14 **DEPARTMENT: POWDER PAINT/STRUCTURAL STEEL**

General Description Powder Paint

Steps in Powder Paint Process

General Description Structural Steel

Tank Shop

Specific Operations:

- Welding Air Blast Tanks
- Stainless Steel Tanks
- 102” and FGK Breakers
- Evidure Torch and Aluminum Welding
- Bertram Vertical Boring Mill
- Radial Drilling
- Horizontal Boring Mill
- Grind and Clean
- Grit Blasting
- Paint Booth
- Welding
- Welding Fumes and Dust
- Electro-Magnetic Fields
- Asbestos
- Solvent Vapour and Fumes
- Machining
- Metal Working
- Metal Grit and Dusts

Known Chemicals used or produced:

Anti Splatter Paint
Caustic Acid
Chromates, Cadmium
Epoxy Resin Paint and Dust
Grits
HCL
Metal Fumes (Cadmium, Zinc, Chromium, Nickel
Metal Particulates
Metal Working Fluids (coolants and oils)
Silica Dust
Stainless Steel

Building #14 **Department: Powder Paint (upper) Structural Steel (main floor)**

Production Process **Chemical Exposure Risk**

Background for Powder Paint Operation:

Powder paint operation involved the spraying of electrostatic ionized powdered epoxy paint on metal (steel and some aluminum) products that involved two floors in building 14. This process was used specifically to coat housings of electrical panels for switchgear between 1977-1985. The entire process was controlled via conveyor belt system. There were very low ceilings on second floor with temperatures often as high as that of the bake ovens used (105°F). Steps in the Process:

1. Parts prepped and hung on hooks attached to a conveyor belt on first floor taking products up to the 2nd floor;
2. Hanging parts travel through a 3-wash open tunnel: hot wash, hot caustic soda bath, hot rinse;
3. Parts travel to semi-enclosed automatic powder spray area for painting;
4. Edges and any areas missed in spray area painted manually by workers using hand-held wands;
5. Newly painted parts enter a 50’ bake oven for 2 ½ hours;
6. After baking, parts travel back down to 1st floor to be unloaded and shipped to various departments;
7. Hooks used to carry parts taken off conveyor and soaked in an (uncovered) “acid” bath to remove any sprayed powder paint. Tank was located at ground level and originally had no barriers to prevent falls (barriers added after worker fell in);
8. Responsibility for cleaning acid tank was left to the painters.

Observation: The process generated a great deal of floating paint dust that covered workers. Operators reported electric shocks from spray wands touching charged metal. Aluminum products were baked for 24 hours prior to painting, which meant coming to work at all hours to meet the production schedule. Run with three shifts of 5 workers per shift. The general

Workers exposed to epoxy resin paint dust in great quantities with nothing more than paper masks and paint overalls. They worked in an electrically charged environment and were exposed to extreme heat and electrical shocks. Chemicals used in the production process included: epoxy resin, caustic soda and acid.

Workers complained of excessive dust exposures; MOL tests identified dust levels close to TLV as ventilation inadequate. **MOL, 14A, March 17, 1981.**

JHSC: 9/27/79: re: heavy dust: “We have recurrence of this problem. (union rep) reports the collector bags have not been cleaned in almost two years. They probably need replacing. There is heavy dust accumulation in the area.”
JHSC: 10/11/79: re: collector bags: The bags have not been cleaned or replaced in a long time. Also we tried to get info on epoxy paint dust from engineering lab but new policy guide has short-circuited that source of information.”
JHSC: 12/20/79: re: epoxy paint dust: “Still waiting for research on possible hazards of epoxy paint dust.”
JHSC: 2/12/80: re: epoxy paint dust: “Problem here is severe and health of workers seems to be reflecting those problems more and more as time progresses.” Notes one worker on leave with severe rash, another experiencing bad cough and trace of blood in sputum, another worker removed from job with severe rash. Dust escaping is polluting not only the immediate work place but also structural steel and parts of GPC. The only process involving a chemical exposure on first floor was the use of caustic acid to clean the hooks following their use. Workers wore gloves and glasses but described the acid as “stinging” when splashed on them.

Any exposures during the 3-wash stage could occur when products moved out of the wash tunnel, which was self-contained.

Large amount of epoxy paint overspray due to electrostatic charge. Workers subject to electrical shocks due to electrostatic environment.

Production Process	Chemical Exposure Risk
area was near structural steel where a great deal of welding and machining took place.	Employees wore paper facemasks and white overalls – no respirators. Only exposure during baking process would occur as products moved outside the ovens. Workers exposed to fumes from newly painted parts and products. Workers exposed to acid residue and dirt particles when scraping and wiping tank. After a serious incident when a worker fell into tank with severe burns on his legs (and died two years later), a barrier was installed. Workers exposed to high level of paint dust, possibility of electrical shocks, high levels of heat (105°F), paint and cleaning fumes and additional chemicals and fumes related to welding taking place near-by. By-stander exposure to welding fumes was significant. Inspector noted significant escape of dust from paint enclosure and indicated that the paint operation was not sufficiently enclosed and ventilated. **(MOL Report # 41181CEAA; Building 14, April 14, 1981).** Inspector: “It appears because of inadequate enclosures and air velocity into the enclosure, significant amount of dust may escape from the booths.” Concern of union committee members when new filters installed dust escaped and settled on machines 100’ away. A work refusal initiated and then settled when told new filters would be installed on next shift. Inspector ordered that workers be provided with approved respirators.

Building 14/14A **Department: Structural Steel (66-85)**

Production Process **Chemical Exposure Risk**

Structural Steel Department:

General Description: In addition to the powder paint operation, building 14 contained the major operations of the Structural Steel department involving: large scale machining; cutting, rolling, welding, grinding, fabrication and de-burring; coating and painting of large steel (102"+dia.x 1"-2" thick) sheets. In addition to supplying metal sheets to other departments, this department fabricated large housings for the switchgear department in what was called the Tank Shop, north of the main aisle. A Shaft oven used to heat shafts in preparation for assembly was also located North of the main aisle. South of the main aisle major machining, welding, fabricating, clean and grind operations took place.

These operations generated large amounts of environmental contaminants including: welding fumes, metal and grit dusts, degreaser fumes and vapours, mists and fumes from metal working fluids, as well as large amounts of "white dust" containing fibreglass and resin (from machining, drilling, boring and grinding large epoxied fibreglass interrupter tubes).

Workers also used green layout paint that contained white lead, kerosene, trichloroethane, black oil and naphtha gas.

According to reports of GE retirees, respiratory protection and local exhaust ventilation was not provided.

Tank Shop (North End Bldg. 14)

Much of the production in the Tank Shop located in the north end of Building #14 was for the Switch Gear department (building #16). The shop was equipped with:

- Three large boring mills and a large radial drill;
- A paint booth;
- Three large welding tables;
- An aluminum welding operation;
- Three grit blasting operations.

This multi-process operation employed approximately 65 workers on three shifts. The operations consisted

Exposures in Structural Steel involved the following:

Machining involves the risk of inhalation and absorption of various MWFs including large amounts of coolants likely containing arsenic as a biocide as well as various cutting oils that could include sulfur, mineral oil and chlorine. These MWF would break down as a result of the heat produced during the machining process exposing workers to other toxic compounds. As well, metals would break down into various metal compounds that would further contaminate the fluids. Metals could include: chromium, nickel, zinc, mild steel, cadmium and copper. These inhalation and absorption exposures would affect other workers in the area.

Welding operations would expose workers through inhalation to various welding fumes and gases that would be produced through the welding process; e.g., heavy metals such as mild steel, chromium, nickel, cadmium, zinc, copper, aluminium -- as well as various gases produced during the welding process, e.g., ozone, phosgene from residuals of degreasers --or vapours from other areas containing substances such as trichloroethylene.

JHSC: 3/23/78: re: fumes and dust: Fumes and dust still a problem in this area. The dust is rising into Powder Paint, causing problems there. We have encountered problems getting test tubes for checking fumes and gasses but hope to find some shortly."

JHSC: 12/2/80: re: Oil coating fumes: "There are people with dermatitis on their forearms. Check for phosgene gas and carbon monoxide gas at Bldg. #14, spot welding where oil coating is heated."

MOL order regarding poor housekeeping and over exposures. The breakdown of some fluxes that were used in the welding process would likely be inhaled also. MOL order that all welding areas in bldg. 14 shall be cleaned up, indicating that housekeeping was very poor **(MOL, Building 14,Nov. 27, 1989).**

Production Process	Chemical Exposure Risk
primarily of fabricating very large circuit breakers ranging in size from 28” to 102” and the even larger FGK breakers. This operation involved cutting, rolling, welding, grinding, grit blasting, buffing and machining, boring, and finally painting large plates of steel and stainless steel. The operation used large amounts of metal working fluids (MWFs) laced with biocides containing arsenic compounds to kill bacteria and fungus that grows in the fluids. This generated large amounts of MWF mists and vapours. Workers describe a “bluish smoke” that permeated the atmosphere in the entire shop (“After 15 minutes on the job, the work area was filled with blue smoke that lasted the rest of the shift” – GE retiree). Welding operations in the area generated large amounts of welding fumes as well as thermal decomposition by-products from degreasers, applied by hand (with a cloth or brush) in preparation for the welding operation. These included: trichloroethylene, xylene and acetone. Welding operations involved several types of welding including: submerged arc welding employing black granulated flux; and stainless steel welding of large tanks which generated heavy metal fumes containing cadmium, hexavalent chromium, and nickel alloys. Much of the welding took place inside the large tanks being constructed, in confined space. Workers reported being overcome by the fumes from the degreasers and welding fumes. Workers (especially cleaners) also described becoming “high” from the fumes. Inside welders were not provided with air-supplied hoods when performing inside welds. And, the supply air was of questionable quality given that the air came from a compressor pumping air from the shop. The steel supply lines were equipped with oil sediment bowls to prevent lines from rusting. After welding, workers would perform “grind and clean” operations on the welds as well as further machining using the boring mills. This process	In addition, workers were at risk of exposure to various dusts produced during the grinding and cleaning operations. In this case workers were at risk of inhaling fine dust particulate containing resin grits, various metal dusts such as mild steel, aluminum, chromium, cadmium, nickel, epoxy resins, and paint coatings.

Production Process	Chemical Exposure Risk
generated a great deal of black dust that workers were required to remove and discard. Workers would dry sweep and shovel large amounts of dust and discard into a tote box. This process generated airborne dust throughout this area. Dust was blown off work surfaces (and clothes) using compressed air -- a practice that was wide spread, further contributing to the airborne contamination. Workers were not provided with adequate respiratory protection and there was no local exhaust ventilation. Clean and grind operators were supplied with air-supplied hoods inside the tank while cleaning welds. The grinding operation involved using an air powered wire rotating brush as well as a bay-flex stone grinding wheel for buffing and smoothing welds. This task also removed anti-splatter paint further contributing to the mix of dusts generated in the process. Grind and clean operations took 8 to 9 hours to complete on the large breakers. After grind and clean, breakers were again wiped down with degreasers in preparation for painting and the application of undercoating. These paints contained isocyanates and/or epoxy. Degreasers were either TCE or Toluene.	
Specific Operations:	
Welding air-blast tank: Mild steel welding of inside seams using stick electrodes by an inside welder while outside seams were arc welded with aired carbon rods by outside welder. End flanges were welded with submerged welding using black granulated flux.	Inhalation of welding fumes containing mild steel and fumes from black granulated flux use.
Stainless Steel Tanks: All flanges (solid stainless) and seams were welded with stainless steel stick electrodes and outside seams arc aired with carbon rod electrodes to prepare the seam for full penetration to the inside weld. Inside seams were stainless stick welded. But the shell was made of mild steel and stick welded accordingly.	Inhalation of stainless steel welding by-products such as cadmium and hexavalent chromium
102" and FGK Breakers: Outside seams were submerged arc welded using black granulated flux. Inside seams and parts were stick rod welded. All	Same as above with respect to inhalation of welding fumes and residues of degreasers.

Production Process	Chemical Exposure Risk
three sizes of breakers were prepped with degreasers and anti-splatter paint by hand. The FGKs were stick welded inside and outside.	
Evidure torch (TIG) and aluminum welding (MIG): Asbestos blankets were used to cover some jobs to prolong cooling and prevent damage to the materials during welding operations. Asbestos curtains were hung around the perimeter of these welding operations.	Same as above.
After welding, all tanks were grit blasted, x-rayed, cleaned and grinded, horizontally machined, subjected to hydrostatic testing, then painted/coated and shipped to Switch Gear for assembly.	Exposure to ionizing radiation (from x-rays) a known carcinogen. Same as above.
Machining process: Bertram Vertical Boring Mill used for machining weld preps and trepanning plates for breakers to accommodate gaskets. White coolant (MWF) applied with a squirt bottle or black oil as a cutting fluid were both used resulting in MWF mists and vapours during the machining process due to high heat which caused the fluids to vapourize and mist.	Inhalation and exposure to MWF containing coolants and cutting oils. Ingredients likely include biocides containing arsenic.
Machine's tables, slots and ways were cleaned with kerosene, naphtha, soaked rags by bare hand and compressed air was used to blow off dust.	
Radial Drilling Process—Angle iron 3/8 to 5/8 thick were drilled, tapped, and spot-faced. Plate steel 11/4 thick for breaker domes 28" to 54" were drilled. Green layout paint used with naphtha gas as degreaser; white lead paste mixed with black oil used for tapping and white MWF (laced with biocide wafers) used for drilling. This process generated vapour and mist from all three chemicals because of heat generated during drilling.	Inhalation of fine resin dusts (epoxy or polyester vinyl toluene as well as fibreglass dust. **JHSC: 4/5/79: re: smoke hazard spot welding:** "Complaints from operators indicate minor to severe discomfort. One man out of work with suspected laryngeal cancer has other operators concerned."
Horizontal Boring Mill: Machined fibreglass interrupter tubes were bored, tapped, drilled and spot-faced, generating large amounts of fibreglass and resin dusts. Workers were provided with paper pants and shirts, but not adequate respiratory protection. Air Blast tank parts were also machined using black machining oil from a squirt bottle which created great amounts of fumes -- especially when	**JHSC: 3/25/80: fume hazard spot welding:** "Strangely enough not able to get MSDS on oil used as preservative on steel. Law says we can demand MSDS. Since supplier claims they don't know oil used, we simply can't accept that, since we know companies have disposed of chemicals such as PCBs. We can't risk that this anti-rust preparation could contain very dangerous products."

Production Process	Chemical Exposure Risk
machining on the inside of the tank. Black oil mixed with kerosene was used to polish surfaces using different grades of emery paper. White coolant with biocide was also used.	Inhalation of fine metal dusts and resin grits from grinding wheels.
The clean up of the (horizontal boring mill) machine was done with kerosene and a compressed air gun causing dust and vapours to become airborne and migrate to other areas. Operators used oil squirt cans for velocity when machining various parts for all metal breakers. This generated large amounts of fibreglass dust containing various resins (cured and uncured).	**Anti rust residues: Inspector notes that in Bay 68** –spot welding area--welded parts have residues of rust preventatives and that its evapouration during welding is causing eye and upper respiratory irritation at levels below the TLV of $5mg/m^3$. "No mechanical exhaust. The firm stated it was not required. They have supplied a bench fan to blow the smoke away…Operator stated his throat is sore." (MOL: Building 14, March 17, 1981). It was noted that: "Order issued to wear respirator until the inspector's visit."
Grind and Clean Operation: Workers used bay-flex buffers, stone grinders, belt sanders and vibrators that were air-powered to remove and smooth weld "grapes", weld splatter, and anti-splatter paint. The 102" and FGK tanks were rotated while being ground and cleaned simultaneously by both inside and outside workers. These operations generated large amounts of metal dusts and welding by-products. 102" tanks were rotated on large rollers while FGKs were rotated by crane for clean and grind. Inside grinders were supplied with air supply hoods and were required to sweep dust and debris out of the manhole opening onto the shop floor.	**JHSC: 2/12/80: re: fume hazard:** "Steel supplier does not know what the temporary oil coating consists of so (JL) will try to get sample of oil for analysis. Good luck (JL).
Grit Blasting Operations: Grit blasting took place in enclosed booths that air propelled alloy pellets. While these were enclosed, the worker had to periodically clean the dust holding chambers. When the levers were opened large amounts of dusts would be released into the environment. Workers described this as a continuously dusty job with no respiratory protection or local exhaust ventilation. Some grit blast operations were done by workers using a hand-held blasting nozzle and wearing protective clothing including an air-supplied hood with questionable air quality. Grits would have to be retrieved for re-use which involved shoveling out the alloy pellets, generating large amounts of dust during recapture.	Same as above.

Production Process | **Chemical Exposure Risk**

This operation utilized a 'wheelabrator' on two shifts using small alloy pellets propelled by a steel impeller.

There was a build up of black dust that was released from the rapper with levers into a steel tote box. Workers described this operation as a dry, dusty and dirty job with lots of exposure to the dust.

Small grit blaster was used on 3 shifts using large pellets. These operators wore air supplied hoods.

Paint Booth Operation: Booth was equipped with a water capture system. All steel products were degreased with various thinners then primed with 'red primer'. These were applied by hand and brushed or sprayed.

Inhalation and absorption of paint particulates and vapours containing isocyanates, epoxy, and various solvents and thinners.

Structural Steel - Building #14 South

General Description: That portion of Bldg. 14 south of the main aisle contained very large boring and milling machines, lathes, metal cutting and welding operations. This was a very intensive operation involving large volumes of product.

Welding Operations:

The west side and south end of the building housed major welding operations. This was an area approximately 600 feet long from the aisle to the end of bldg. #14. During the 1980s this department also operated a very large 'burner' used to cut large plates of structural steel into various patterns. This burner also in Bldg. 34. Welding operations were intensive, running 3, sometimes 4, 12-hour shifts. Welding took place on 4'x4'x6" thick welding tables whose surface was grated so welding waste could fall through. These tables were supported by H frames about 18" off the floor.

Same as above with regard to inhalation of welding fumes. These were high volume operations that generated large amounts of fumes and gases without adequate exhaust ventilation or protective equipment. Therefore risk of inhalation very high.

Same as above as well as large amounts of welding dusts settled on floors and surfaces.

There was also a larger table available at the south end of building #14. It's important to note that welders regularly ground the surface of these tables to remove weld spatter and 'grapes' so that new materials laid true.

Retirees reported more than one hundred of these tables used by welders in this area, with from 30 to

Production Process	Chemical Exposure Risk
50+ welders welding at one time. Such heavy welding in the area produced very large amounts of welding fumes: “the welding fumes were so dense that sometimes you couldn’t see your workmate at the next table” Retiree.	
Welding fumes and dusts: Very large amounts of welding debris and dust would build up under each table. This dust would become airborne during cleaning and dry sweeping, as well as from traffic movement from vehicles and employees.	
Electro-magnetic fields (EMFs): A great deal of the welding was electric arc welding. The welding machines could operate at 600 amperes and produced very strong magnetic fields. Welders worked in close proximity to these welding units while others nearby worked in by-stander positions to these fields.	Electric welding involves very high amperages and produce very high EMF in the ELF frequency ranges. IARC has classified EMFs as a probable human carcinogen.
Asbestos: Asbestos curtains were hung around the entire welding area of about 550 feet. These asbestos curtains were in friable condition due to the amount of wear and tear and abrasion from product movement. Asbestos blankets were also used to cover product that was to be welded -- either to protect the product or keep it warm during the welding process. For example, large shafts were heated to between 300 and 500 degree F in an electric oven and then covered with a thick blanket of asbestos to keep the temperature consistent during welding. Welder would lay on top of an asbestos blanket that was in friable condition. When they were done, the front of their clothing would have a coating of asbestos fibres.	Inhalation of asbestos fibres very likely given the friable conditions of asbestos curtains and manner in which asbestos blankets were used by the workers.
Solvent vapour and fumes: In preparation for welding or machining these large steel plates were typically coated with residues of cutting oils/ degreasers/rust inhibitors.	Inhalation of solvent fumes was routine and chronic. These vapours and fumes from solvents were ubiquitous.
Machining Operations: Machining operations were located along the length of the eastern part of the building. It contained several large vertical and horizontal boring machines, milling machines, radial drills, grinders and lathes. This department also used	Same as above with respect to inhalation and absorption of MWF during machining operations.

Production Process	Chemical Exposure Risk
a 40’ boring machine. Machining operations involved large volumes and sizes of product.	
Metal Working Fluids (MWF): All machining operations involved the use of large quantities of MWF to protect the equipment. MWF were drawn from tanks and sprayed on metals surfaces and cutting blades. These operations generated large amounts of mists, vapours and fumes. Workers described “large clouds of blue smoke rising and hanging in the atmosphere.” The use of “Steel-Kut” machining oil was associated with many employee complaints of: dermatitis, breathing problems, skin rashes/burns. It was thought to contain mineral oil, sulphur, and chlorine. (Types of MWF: mineral oil, water soluble, semi-synthetic, synthetic, additives such as sulfur and biocides containing arsenic). WD-40 was applied with a squirt bottle to the high speed tool bits when turning on the 25’ vertical boring mill, **Solvents used to clean:** Tables were cleaned with various solvents, which included rags soaked in: MIK, 1500 thinner, toluene, roylene, naphtha, and alcohol. **Metal Grit Dusts:** Workers describe excessive dust buildup on floors and surfaces as a result of machining/ grinding. **Compressed Air:** participants noted that compressed air was used universally to clean dusts off surfaces and clothing. This practice continued to be used during the late 2000s. **Balconies on 2nd and 3rd floors:** Workers performing work on the balconies located above these operations on the ground floor were subjected to all the fumes, dusts, vapors generated on the ground floor. The operations on the balconies on the 2nd and 3rd floors were engaged in winding of small coils, assembly of switches and magnetic switches.	Same as above re: inhalation of MWF **JHSC: 6/1/78: re: scorched fumes:** “Safety Committee was called re: a very bad working condition, high ambient temperatures due to atmospheric conditions and larger than usual shaft in oven, which in fact was too large for the unit and as a result was causing a terrific heat loss into the work area. Also the asbestos cloth still being used to cover the oven during heating was emitting a scorching stench that ranged over half the building.” **JHSC: 2/26/80: re: air pollution problem:** Since fire, doors between #14 and #16 have been kept closed because of TCE problems; a new situation has arisen in #14 as smoke and fumes from welding now being trapped in North part of bldg. Ceiling vents will not solve problem. **JHSC: 11/28/83: re: pigeon droppings:** “Complaint received on pigeon droppings on inspection table, lunch table, and stored steel area.”

BUILDING: #16 **DEPARTMENT: SWITCH GEAR**

General Description

General Working Conditions

Production processes/Machines

Assembling Breakers

Disassembling/Refurbishing old or damaged Breakers

Metal Clad assembly

Sulphur Pot Area

Other components

Magna Blast Breakers

Machining Operation

Exposure controls

Known Chemicals used or produced:

Aluminum, iron, copper, brass, magnesium, stainless steel, particles and dust

Asbestos and Fiberglass dust and fibers

Brominated fire retardants

Epoxy resins and dust (Glyptol)

MWFs (Cimcool. TimSol, Steel Kut, Roco, Dasco Tap, Chroma Tap, Kerosene)

Ozone

PCBs

Solvents (TCE, Royalene, Acetone, MEK, Toluene, Naptha Gas

Sulphur, lead, tar,

Building: #16 **Department: Switch Gear**

Production Process **Chemical Exposure Risk**

General Description: Switch Gear Department was located in Building 16 north of the main aisle between Buildings 18 and14. There were no walls between these three building. It was entirely open. At its peak, employees numbered between 100 and 150 employees with 3 to 4 shifts. This was an intense production, high volume operation conditioned by the piece-rate system.

The production processes consisted of the assembly and fitting of very large circuit breakers, limit amps, metal clads, rectifiers, exciters, GPC relays as well as drive systems.

The assembly operation, carried out by assemblers and fitters, involved machining and milling internal electrical and mechanical parts both metal and fibre glass, as well as drilling. Assembly also involved various types of welding operations including aluminum and stainless steel, arc MIG and TIG welding. Grinding and cleaning of welds were also carried out involving grinding and buffing machines. These numerous machining operations required the use of various metal working fluids containing arsenic biocide agents.

Welding operation involved metal preparation with solvents, including trichloroethylene, acetone, naphtha gas, MEK, toluene, among others. The central area of the building was equipped with a tank of Royalene (TCE) degreaser that measured 8’x12’x6’ and was heated.

Breakers were first prepped with primers and glyptol paints, then filled with PCB dielectric oil, and tested, drained, adjusted, refilled, re-tested until the breaker was fully functional. The east side of the shop contained three tanks of PCB oils.

The high voltage potential test (used for quality control) involved the application of very high amperage between 0 and 3,000 amp.

General Working Conditions: This was a very smoky and dusty environment with very strong odours of solvent, metal working fluid mists and vapours, and heavy welding fumes from various welding

General Risk Exposures: There was a very high risk of inhaling and absorbing various solvents used in the degreasing and cleaning tasks. Not only were fumes intense from the degreasing tanks in this area and elsewhere but also workers were applying degreasers by bare hand with rags over large surface areas. Some of these contain contained the contaminant benzene.

MWF and coolant mist were generated during machining operations with operators clothing soaked with these fluids. All three routes of entry were involved: inhalation, absorption and ingestion since workers routinely ate and drank at their work stations.

Skin absorption and inhalation of solvents highly likely.

Because these migrating fumes came in contact with welding operations, there was a high risk of inhaling phosgene gas.

The use of glyptol paint also generated vapours from the volatiles contained in the paints. These were readily inhaled and workers frequently complained about the fumes particularly where the paint was being sprayed.

Since this operation also involved filling breakers and transformers with large amounts of the PCB oil there was a high risk of inhaling and absorbing this toxin during filling and emptying procedures. PCB spills would involve clean up as well as residues left behind.

Fitters are also exposed to inhalable dusts from grinding and deburring operations. Workers would inhale metal and grit and resin dusts during these operations. These were performed without respiratory protection or local exhaust ventilations.

Machining operations would involve the high risk of inhalation and absorption of coolants containing arsenic and cutting oils. Soaked clothing as well as symptoms of adverse skin reactions and foul odours evidenced this.

Production Process	Chemical Exposure Risk
operations. The large numbers of operations going on at the same time contributed greatly to very high concentrations of contaminant mixtures. These operations also produced great amounts of welding, grinding, and milling dusts. The machining and milling with MWF produced large amounts of visible blue smoke. Workers said that there was always a blue haze in the air. Housekeeping was poor and dust and spills accumulated in the work environment.	There was also a high risk of ingesting these contaminants because workers regularly ate and smoked at their workstations. The risk of these exposures was high given the volume of work and product use, the close contact with the contaminants, the direct handling and intricacies of the work tasks and finally the lack of adequate exposure controls.
There was no local exhaust ventilation only natural ventilation, and no adequate make-up air, so that atmosphere in the GE building was under negative pressure resulting in contaminants from other areas be drawn into building 16 (at the centre of the plant where ceiling height was the highest) which exacerbated the toxic atmosphere. (See H&S management memo regarding these negative air pressure conditions, as well as MOL inspection reports).	
Eating and smoking at the workstation was routine and permitted by the management. This was a result of a work regime defined by the piece-rate system with its individualistic culture and lack of sufficient eating facilities.	Risk of exposure to very high magnetic field was very high given the proximity and strength of these magnetic fields based on the very high amperage.
Detailed production processes: **Assembling Breakers:** Breaker assembly involved several "fitters" who would carry out a number of tasks to build a complete breaker. The breakers varied in size from 28", 36", 48", 54", 102" as well as the larger FGK breaker. Completing these would involve several days to a week. These tasks were carried out with the fitter inside the breaker shell. Fitters would: 1. Degrease the breaker shell by hand with rags soaked in TCE; 2. Fit and install various parts that had to be machined or ground to fit, including the bushings, welded studs, and other parts spot welded on the walls—some of which were made of asbestos and were machined to fit; 3. Prepare breakers for painting, which involved buffing and hand wiping with TCE;	Inhalation and absorption of cutting oils, inhalation of solvent vapours, inhalation and absorption of PCB oils was prevalent. Exposure to PCBs while draining old breaker tanks. Wash down of PCB residues with solvents—TCE, toluene, MEK. Evaporation of PCBs enhanced during hand wipe down. **JHSC: 11/16/78: re: Ozone from welding:** "Ventilation is in use but situation still very bad. There is a conglomerate of fumes present in the building and it is obvious that a broader control is only answer." **JHSC:1/25/79: re: Ozone build-up:** "No improvement in this area. In fact, problem seems to be more intense. Not only that men in area feeling chronic problems from it but it seems to be much more

Production Process

4. Painting the breakers with epoxy glyptol paint inside (gray) and outside (green);
5. Filling the completed breaker with PCB oil dispensed from the PCB storage tanks;
6. Testing the filled Breakers at the 'high potential" testing area where a very high voltage was applied -- at up to 3000 amperes. High magnetic fields are produced during testing at extreme voltages in the high bay area of the building. (Noted during discussions that there seemed to be a high death rate among testers);
7. Depending on test results, Breakers could be drained of oil, adjusted, refilled and retested several times over.

This assembly operation produced a number of atmospheric contaminants: welding fumes, cutting oil mists, solvent vapours, paint fumes, metal and grit dusts. By-stander employees would be affected as well as the fitters who directly handled these contaminants. As well, PCB spillage during dispensing and draining would also contribute to the mixture of contaminants. PCB leakage also occurred during the testing phase. Air blast breakers were filled with SF-6 gas as an insulator in this type of breaker.

Disassembling and refurbishing old or damaged Breakers: This involved draining used PCB oils from the tanks, which exposed workers to spillage as well as handling leaky tanks. Once drained, electrical and mechanical components were disassembled and surfaces were hand wiped with TCE soaked rags producing large amounts of solvent vapours. Tanks were ground and buffed, prepped with TCE, and painted with glyptol prior to refitting. Tanks would also have to be hydrostatically tested for leakage.

Metal Clad assembly: This involved fitters assembling what were actually metal sheds used to hold electrical equipment. These were prepared in building 14 and then equipped with hinges and other components that had to be assembled. Fitters would perform drilling, grinding and machining to fit parts together.

Chemical Exposure Risk

concentrated (as reported by people coming into the area). Asked Health Dept. to make checks once again."

JHSC:2/15/79: re: Noxious fumes: "A reading of 6-16 ppm of TCE in welding area. Although well below TLV, when present in welding it becomes a different problem. Tests then made for HCL and TVA of 5 ppm was exceeded to a large degree. Reading went off scale completely."

JHSC: 9/27/79: re: Noxious Fumes: "About three times a week this (HCL) pollutant becomes very apparent. On Sept 27, a reading of 4.5-5 ppm was recorded. This originated from TCE in a cold process tank. (DM) a welder in area is on sick benefits after a throat operation. He has complained of respiratory problems for some period. Others are suffering discomfort as well. Task operator will be told to keep lid closed to control fumes."

JHSC: 12/20/79: re: Asbestos dust: "Diesel poles using asbestos sheets are being ground and cut, ventilation is totally inadequate. New material being slated from armature is also asbestos under another name. Although safer in its original form, hazard doesn't improve when cut or ground."

Inhalation of metal, paint and residue dusts from grinding and cleaning operations during refurbishing. Also exposure to volatiles from paint fumes.

Production Process	Chemical Exposure Risk
Sulphur Pot Area: This area included the use of hot open pots of sulphur, lead and tar with no exhaust ventilation. A mixture of lead, sulphur and tar were applied to seal joints to prevent leakage. These mixtures were contained in a heated liquid state and applied to the metal clad joints. Molten lead was hand ladled onto the part, then sulphur, and then it was covered with tar. Workers indicate that very strong pungent odours emanated from the various pots during application. Local exhaust was introduced much later in the department's history.	Inhalation of sulphur, lead and tar fumes was high given the state of the chemicals, the confined area to work in and the direct handling of materials. **MOL Report May 28, 1982. Order 0123, Bay 327, Bldg. 16** re: pouring lead sulphur without exhaust; also **Order 0126** re: silver solder booth, inadequate ventilation.
Other components: Connecting metal clads to breakers also involved fibre glass tubing used as insulators that were secured over bus bars then taped with black urethane tape, bolted, sealed with duct seal putty, covered with fibreglass tape and painted with a fire retardant paint. These fiberglass insulators were first taped with brown insulation, then taped with black urethane and finally sealed with duct seal containing asbestos and has a putty- like consistency. This was again taped over and painted with a brown fire retardant paint that came in gallon tubes. MSDS likely a brominated fire retardant. The outside of the metal clad was insulated with fibreglass. Other products such as rectifiers, exciters were assembled utilizing aluminum arc welding producing high levels of ozone gas as well as other metal and chemical by-products associated with aluminum welding operations. Preparation for aluminum welding included the use of naphtha gas. **Magna Blast Breakers:** These mechanical breakers are spring-loaded, motor-driven breakers referred to as electrical impact drivers. The bearing are spring loaded and 8"x11"baffles made of machined asbestos, then glued and bolted on by fitters. This disturbed the asbestos fibres, which were dispersed in the general atmosphere. **Machining Operation:** The machining operation was quite extensive, employing approximately 40 to 50 workers and utilizing 35 large boring, milling, drilling, and lathing machines, in addition to many smaller pieces of machining equipment.	Inhalation of fibreglass and resin dusts as well as particulate from materials containing brominated fire retardants was very likely during this operation. Inhalation of asbestos fibres likely during this operation since workers had to fit and work asbestos baffles in place. Exposure to asbestos dust likely inhaled given direct contact. Inhalation and exposure to MWF very likely given the amount of fluids used during these machining operations. Workers report that there were dense clouds of bluish smoke over these operations as well as mists surrounding the general atmosphere. **JHSC: 2/12/80: re: Noxious fumes:** "It was noted by all present that heavy fumes reached the aluminum welding area about 3 minutes after VPI tank at south end was opened, even though tank was cold and had no load in it for some time. We are hoping that make-up air vents will reduce the negative pressure and perhaps better control of air movement in bldg." **JHSC: 3/25/80: re: Noxious fumes:** "Despite two make-up air systems in place to reduce negative pressure factor, problem fumes still occurring. (e.g., complaints of ozone at 3 ppm vs. TLV of 1 ppm in north end welding area)." **JHSC: 4/8/80: re: Noxious fumes:** "Checks as required not being done on regular basis. (Union rep) asks that more people on floor be trained to take

Production Process	Chemical Exposure Risk
Very large motors built in bldgs. 8 and 10 were machined with a Mazak milling machine in bldg. 16. Important to note is that the Mazak machine, located in Building 16, was operated by Building 8/10 employees.	(air) samples. (Name) logged readings of 3 ppm, but neglected to warn workers of dangerous levels."
Machining also included large amounts of tapping of large machined bolts as well as a major cleaning and grinding operation utilizing large grit blaster, grinding, deburring and polishing machines. This operation milled, bored, drilled and turned steel, cast iron, copper, aluminum, brass, magnesium, stainless steel, and fibreglass structures.	**JHSC: 11/28/83: re: Xylol complaint:** " Xylol fumes made (worker) dizzy and gave him a headache while washing his tools in a tank of xylol. Job is done for 15 to 20 minutes, 1-2 times per week." **JHSC: 10/21/86: re: Asbestos:** "Workers not been included on assessment for asbestos in this area. They should be instructed on proper procedures for handling asbestos and included in the control program."
In the latter case, workers would mill, bore and drill large fibreglass tubes 3'x4'x12"dia.1/4" thick. This operation generated large amounts of resin/fibre glass dust that workers complained about because it caused dermatitis and skin irritations.	**MOL:06/27/76:** Ozone TLV exceeded during aluminum welding.
When machining and refurbishing used 102" breakers, workers would encounter asbestos insulation originally used in the older breakers. The machining process would generate significant amounts of asbestos dust during the refurbishing operation. All machining operations, including tapping, used large amounts of MWF that were both automatically or manually applied by the operators. MWF included: TrimSol, Cimcool, Black Oil (containing sulphur compounds), Steel Kut, Roca, kerosene, and both Dasco and chroma Tap for tapping. This was a very high volume area that generated large amounts of solvent vapours, MWF mists and smoke as well as dust consisting of metal, fibreglass, and grit and resin dusts from all operations. MWF were recycled, and many times the fluids would become biologically contaminated.	**MOL:2/13/78:** Ozone exposure during welding operation in bldgs. 16 and 30. Worker complaints irritated upper respiratory tract and eyes. **MOL:03/1/79:** Hydrogen Chloride Gas higher than the TLV during MIG /argon gas welding in combination with TCE degreaser vapours from tank. Employer refused to replicate conditions for MOL tests. **MOL:03/17/79:** HCL concentration MOL test unrepresentative. **MOL:03/17/81:** Tool Room-tungsten carbide dust escaping during carballoy tool grinding. Dust accumulation high. **MOL:04/2/81:** carballoy grinding dust revisited. High welding fumes.
Aluminum Welding in Bay 319 used very high amperages exposing workers to very high EMFs. Also, phosgene gas from migration of TCE. **MOCA:** Exposed to MOCA produced and fitted. **Exposure controls:** Up until the 1980's there was little or no local exhaust ventilation and no adequate respiratory protection provided to these machine	**MOL:05/20/82;05/28/82;06/2/82:** Lead/sulphur/ chlorine pouring operation. Inspector indicated that worker shows all symptoms of over exposure. Issues stop work order. **MOL:05/8/86:** Order for lead assessment under designated substance regulation for lead.

Production Process	Chemical Exposure Risk
workers. It was common practice for workers to eat, smoke and drink at their work-stations.	**MOL:11/27/89:** MWF/coolant mist clouds heavily emitted during machining; ordered to clean up the paint shop, which showed poor housekeeping.

BUILDING #16A **TRANSPORTATION/DIESEL EQUIPMENT**

General Description

General Work Conditions

Production Areas

Diesel Production:

- **Diesel Control**
- **Circuit Boards**
- **Resisters**
- **Machining Area**
- **Welding Areas**
- **Winding Area**
- **Assembling Area**
- **Epoxy Dipping and Baking**
- **Painting Operation**
- **Diesel Offices**

Diesel Rebuilding:

- **Rebuilding Coils**
- **Re-machining**
- **Assembling Rotors and Stators**
- **Testing**
- **Painting**

Known Chemicals used or produced:

Aluminum, iron, copper, brass, magnesium, stainless steel, particles and dust

Asbestos and Fiberglass dust and fibers

Brominated fire retardants

Epoxy resins and dust (Glyptol)

MWFs (Cimcook. TimSol, Steel Kut, Roco, Dasco Tap, Chroma Tap, Kerosene)

Thermal decomposition

Ozone

PCBs
Solvents: TCE, Royalene, Acetone, MEK, Toluene, Naphtha Gas
Sulphur
Lead
tar

Building #16A **Department Transportation/Diesel Equipment**

Production Process **Chemical Exposure Risk**

General Description: This department built large motors and generators for transportation vehicles, mining equipment such as hoist elevators, crushing equipment etc. This included various control devices and circuitry to control the functioning of this machinery. The department was located between the induction motors and structural steel department and south of the switchgear areas (bldg16).

Open to adjacent departments: These building were not separated by walls and essentially shared the same air space. Work in 16A involved several operations that included: assembly of motors, building circuit boards and wiring configurations for controls, producing the various parts for motors. These processes included machining, drilling, grinding, cleaning, and various types of welding. This operation involved the use of boring and milling machines, lathes, radial drills, spindle drills, grit blasting units, burring booths and winding machines. These processes used various chemicals including: solvents and degreasers including TCE, toluene, MEK, acetone, and naphtha gas; a variety of MWF, epoxy resins and catalysts, asbestos, fibreglass, moca, and paints.

The large motors department employed approximately 200 to 250 workers on 3 shifts, mostly on day shift. This was a high volume production operation that ran 24/7. All chemicals were used routinely and directly, and in large quantities.

General Work Conditions:

Negative Air Pressure: There was no local exhaust ventilation and **little if any make up air**. As a result, the entire area was **under negative** pressure and major build-up of heat. According to a worker: "It was a terribly hot building." Consequently, cross contamination occurred regularly with **contaminants from other areas drawn into the area.** The use of large oscillating fans to deal with high temperatures, further disturbed and distributed contaminants. The atmosphere was very smoky, with a constant bluish haze over various work areas. This was particularly true in areas with welding fumes, MWF mists, and

Negative Air Pressure Impact on Exposures: Due to negative pressure in the building complex, contaminants from other areas and operations were drawn into this area. This was noted by the GE Safety Unit management in memos dated:

October 2, 1979 from A.K. Faggetter, Hygienist; and October 29, 1979 from P.J. Kyselka, Manager Plant Facilities Section.

This was particularly true for the migration of TCE vapour making contact with the aluminum welding operation in bldg. 16A.

Inhalation of phosgene gas as well as heavy ozone exposures. Worker reported symptoms of nose bleeds and irritated eyes, nose and throat indicating over exposure to both contaminants

Production Process	Chemical Exposure Risk
grinding operations. Housekeeping was very poor and dust build-up was very high. Personnel in the office located in the eastern area of the plant would need to clean their desks and other surfaces of settled soot and dusts each morning and after lunch. Workers also smoked and ate lunch at workstations and washing facilities were not easily accessible.	
Production Areas:	
Diesel Control: This area made control mechanisms and switchboards, circuit cards, rectifiers, reversers and resisters for diesel electric motors. This work involved an extensive use of **epoxy resins and catalyst identified as MOCA** in hand buckets that were mixed and applied by hand into molds, which were then placed in VPI tanks to ensure uniform coverage for approximately 2 hours. These MOCA molds were then baked in ovens.	Inhalation of MOCA vapours and dusts during mixing and molding operations was high since this was without any controls or respiratory protection. The MOCA was manually mixed and poured into molds. Vapour during the mixing and curing process would expose workers to the risk of inhalation. Further inhalation and skin absorption would occur during the process of filing, sanding and cutting the cured resin.
Circuit boards were also formed using a**sbestos fiber and concrete**, as well as epoxy resins. These were also placed in ovens for curing and hardening.	Workers were exposed daily to large amounts of asbestos fibers and dust with no personal protection.
MOCA, a synthetic chemical used to make urethane and a catalyst for epoxy resin, was also mixed in molds to form parts for high force/friction operations. Workers would saw, grind, file, and shape this product in its solid state thus causing large amounts of dust. **MOCA (methylenebis[2-chloroanaline]) is recognized as a group 1 carcinogen**.	**JHSC: 2/21/83: re: fumes in varnish area:** "Complaints of fume problem since air replacement bags (for ventilation system) out of commission." **JHSC: 8/28/85: re: varnish spray:** "Crane operators concerned about varnish spray while stators suspended from crane."
Resisters were made by assembling 8 tiers of asbestos board stacked in a layered grid, framed by heavy gauge steel dividers, contained in a 2'x2' frame. Copper coils were placed between the asbestos boards (boards served as insulators). Workers were in direct contact with asbestos and other bi-products when grinding and fitting these boards. The completed resisters were then soaked in linseed oil and baked.	
Machining Area: The machining area utilized 2 large horizontal boring machines, 1 large vertical boring machine, large radial drills, milling machines and lathes. Large 2" thick cast iron frames as well as plate steel were machined, milled, bored and drilled	Chemical names and/or MSDS needed of machine fluids, cutting oils, varnishes, degreasers, as well as composition of welding fumes.

Production Process	Chemical Exposure Risk
on large boring and milling machines, lathes and drills. The machining operation utilized large amount of MWF that was sprayed on both manually and automatically. Machining generated large amounts of MWF mists and bluish smoke as well as large amounts of metal particulate in the form of dusts. Machining also involved tapping, deburring, grinding, buffing of machined products producing more grit and metal dusts that were contaminated with epoxy resins and degreasing and MWF residues.	
Welding Area: The welding area was locate next to the machining area and was surrounded by asbestos curtains, which were in friable condition. Metals to be welded were degreased by over-head cranes dipping the metals in a 12’x12’ degreasing tank containing Royalene (TCE). The tank was not covered and the degreaser produced large amounts of TCE vapour. In addition to TCE vapours, the air was filled with various welding fumes and dusts. Negative pressure promotes long distance migration of vapours and other contaminants to other departments.	Welders exposed dermally to large amounts of machine fluids. While protected from welding fumes by personal exhaust ventilation, captured fumes were vented into the workspace, putting other workers at risk. Due to continual friction and fraying of asbestos curtains and blankets, workers were exposed to significant amounts of asbestos dust and fiber. In sunlight, the air appeared to be filled with snowflake-like particles.
Aluminum Welding Area 16A, Bay 319: The aluminum welding area employed 8 to 10 welders involved in electric arc MIG/TIG welding on various aluminum alloy sheets pretreated with xylene degreaser. This was a high production area producing large amounts of aluminum fumes as well as other metal alloys, ozone gas, and phosgene as a result of the ultraviolet light coming in contact with solvent vapours from nearby TCE tanks and/or similar degreaser residues on the metal being welded. Some aluminum alloys welded also contained beryllium. ***NOTE:*** See report by A.K. Faggetter, hygienist for GE dated Oct. 2, 1979 documenting a heavy concentration of TCE escaping from TCE tank and finding its way to 16A aluminum welding in Bay 319 and producing hydrogen-chloride gas when arc welding came in contact with TCE. Also minutes of meeting Oct. 29, 1979 indicating that negative air pressure in buildings 16A and 18 was drawing in TCE vapours from TCE tanks.	Ozone gas is classified as carcinogenic and also causes a narcotic effect and damage to the mucus membrane of eyes, ears and throat. Many complaints of eye and throat irritations. EMFs classified as carcinogenic and also an endocrine disrupter and can affect central nervous system. Negative pressure in 16A are drawing fumes in from long distances in other departments. In contact with welding operations TCE produces phosgene gas that workers are exposed to. See Mgt. memos date: October 29, 1979 from P.J. Kyselka regarding degreaser fumes and negative pressure; October 2, 1979 for A.K. Faggetter regarding heavy concentration of TCE escaping and the formation of HCL gas. **JHSC: 1/22/81: re: aluminum welding:** “air testing shows 2ppm and 3ppm of TCE at doorway of degreaser.”
	Workers were at high risk of inhaling epoxy fumes during dipping and baking operations. Workers

Production Process	Chemical Exposure Risk
Winding area: Involved the manual and mechanical process of winding of copper wire coated with epoxy and insulated with asbestos called 'deltabeston' copper wire. Approximately 50 wound coils were pressed into appropriate shapes and dipped in 2 VPI tanks containing epoxy. The dipped coils were hand squeegeed and baked in the oven. Following this, coils were ground and cleaned of any excess hardened epoxy resin. Coils were then assembled into motors by approximately 10 assemblers.	describe the intense fumes and odors during these operations. Exposures to resin dust also occurred during grinding and cleaning operations. Inhalation of paint and toluene vapours was highly likely. Exposure to significant amounts of toluene and epoxy resin due to the size of engine and motor parts.
Assembling area: Assemblers first inserted asbestos wedges into the coils and then into the motor frames. Asbestos wedges had to be fitted and pounded into the coils and frames. These large pieces were then moved by hoist or crane to the 10'x10' heated degreaser tank and dipped where vapours condensed on frames and drip dried almost immediately due to high temperatures.	Inhalation of asbestos dust from the cutting of asbestos sheets highly likely.
Epoxy dipping and baking operation: Assembled Motors were dipped by a hoist person (for less than 2 tons) or crane operation (if over 2 tons). In the same manner motors were dipped in VPI tanks for 2 hours, then brought to the baking ovens for curing. Subsequently, workers would hand grind excess hardened epoxy resin. The bake ovens were regularly maintained by grinding and sweeping hardened epoxy spills from oven surfaces.	**JHSC: 8/27/79 re: epoxy fumes:** "We still have no word re: this chemical. To date we have no idea what substance to test for…people working in area are becoming sick from the fumes." **JHSC: 9/27/79: re: epoxy fumes: "**(Management rep) was supposed to get information on the epoxy product being used but he got his buildings mixed up. No report as a result."
Painting Operation: This was an open 4'x4' area where one person, per shift spray-painted each motor with epoxy based black enamel paint over a grate containing flowing water. The painter pretreated the motors for painting by hand wiping them down with toluene.	Inhalation of vapour from solvents and paints likely.
Diesel offices: Staffed by (mainly female) employees who conducted clerical and other duties. The air in these offices was very dusty due to migration of dusts and fumes and gases from various operations machining, grinding, welding, degreasing and painting conducted in this department.	By-stander exposure to diesel fumes likely. Several workers in an adjacent office taken to hospital with dizziness were found to have high levels of carbon monoxide in their blood. Workers throughout area exposed to large amounts of diesel fumes from idling vehicles. **JHSC: 2/17/81: re: mica dust**: (need to address) long standing reports of mica dust. **JHSC: 3/28/83: Noise test:** "Request for noise test in Diesel Grinding area."

Production Process	Chemical Exposure Risk
Rebuilding Diesel Motors: **Background:** After disassembly of used diesel motors in building 12 the parts were moved to building 16A for rebuilding and/or reassembly. The work processes included: 1. Rebuilding the Coils: Solid asbestos sheets were cut by sheers into strips 3'x1/2' used to protect electric coils from excessive heat. The strips were driven between engine components manually generating substantial amounts of asbestos dust. 2. Re-machining of old castings by welding on addition steel to attain proper size. These parts were then re-bored using large boring machines, which produced large amounts of welding fumes. These machining processes involved the extensive use of machine fluids and cutting oils (Only identified was cimcool). Welding fumes were captured by personal exhaust ventilation worn by welders but fumes were then blown out into general work area. 3. Stators and frames assembled manually with final closures welded shut by welder lying on asbestos blankets. 4. Testing Processes: Testing went on throughout the re-manufacturing process to ensure product met performance standards for quality control. Motors were run with high voltages called heat runs. This produced high EMFs and Ozone gas. 5. Paint Area: Finished motor sent to paint shop where it was wiped down manually with toluene in preparation for painting. After this degreasing, engines were spray painted with glyptol, a waterproof paint manufactured by GE (Port Union plant). 6. After final performance test, engines were prepared for shipping, then loaded onto trucks or trains parked with motors running.	Heavy use of MWF would highly likely involve the inhalation and absorption of fluid mists and smoke. Inhalation of welding fumes and asbestos fibre likely. Exposure to magnetic fields likely given strength of fields and proximity to them. Also inhalation of ozone gas likely. **JHSC: 8/24/82: re: toxic fumes:** "Workers in test area of diesel report irritation from VPI tanks. (union safety rep reports fumes as 'extremely harsh'." **MOL Reports:** **04/06/59:** Grinding area not locally exhausted. High concentration of grit resins dusts and metal dusts. **06/4/70:** Worker suffering nose bleeds and upper respiratory irritation during welding aluminum—TCE, ozone, HCL gas exposures possible. **01/25/79:** Aluminum welding assembly involving 6 welders. Worker complaints eye irritation. Ozone and HCL gas generate from TCE vapour and arc welding and ozone gas producing HCL gas. Ozone levels at 0.1 ppm; company records on HCL 0 to 0.4 in 1978. **06/26/81:** Kozma furnace not adequately exhausted. Poor housekeeping noted. Ban saw cutting Mica generating lots of mica dust in Bays 405, 414. **05/8/86:** Order issued for lead, silica, mercury benzene, and isocyanate assessment under respective designated substance regulations. **JHSC: 4/18/83: re: insulation fire:** 200hp destruction test had gray foam insulation stuffed in ducts. When armature burnt out, insulation caught fire. Fumes from fire were high.

BUILDING: #17 (#21, #18N) DEPARTMENT: CARPENTRY

General Description

General Working Conditions

Production Process:

- **Building Structures and Fiberglass Molds**
- **Cutting and Drilling**
- **Fiberglass Operation**

Known Chemicals used or produced:

Acetone

Beeswax

Benzene

BPA

Cabasyl

Epoxies

Fibreglass

Formaldehyde

MEK

Peroxide

Styrene

TCE

Thinners (e.g., 1500 and Partal)

Toluene

Vinyl ester resins

Xylene

Building: 17 (21, 18 N) **Department: Carpentry Shop**

Production Process **Chemical Exposure Risk**

General Description of Carpenter Shop: The shop was originally located on the ground floor of Bldg. 21, and then moved to Bldg. 18. Then it was subsequently moved to a separate building located at the north end of the GE site and designated as Bldg.# 17. The building was clad with what was called 'ASBESTOS LUMBER' a nickname for asbestos sheets for external siding.

The shop was an open concept building approximately 200' X 300' with 20' ceiling height. The building contained approximately 40 – 50 non-metallic/woodworking machines, lathes, drill presses, band saws, table saws, planers, joiners, sanders, and grinders, etc.

Carpentry employed approximately 80 – 90 workers on 3 shifts. The majority of workers were on day shift, as was most of the plant.

The shop also had a 10'x10' oven with double door entry of 5' x 6' in height to accommodate products that needed to be heated or cured. The carpentry shop also had a specialized area for laying up fibreglass molds or housings. Some were huge, produced for the large motors area. The area also had a small degreaser tank.

General Working Conditions: The shop had poor ventilation, with little or no local exhaust ventilation and was also affected by poor replacement air, which created negative pressure. Workers were not provided with adequate ppe including rubber gloves for handling acetone or respirators for spraying various resins on fibreglass. It wasn't until the 1980s with the enforcement of the new OHSA that protective equipment began to be provided. Prior to 1980s protective equipment was not made available.

The atmosphere in the shop was generally very smoky and dusty and heavily contaminated with solvents (acetone, MEK, xylene and resin fumes such as styrene and formaldehyde). Housekeeping in the shop was poor with large amounts of dusts from sawing, sanding and grinding operations on equipment and floors.

From the descriptions of the various work tasks performed in the Carpentry Shop, workers were likely exposed to a number of toxic chemicals used in production through inhalation, absorption and ingestion.

1. There was a great deal of inhalable/respirable dusts generated without adequate local exhaust ventilation. These dusts contained various wood particles that would contain formaldehyde from glued wood laminates, epoxy and polyester resin dusts from sanding and grinding fibreglass molds. Also included, were mineral dusts from cutting asbestos and fibreglass sheets and cloth. Asbestos and composites like Textalite were frequently cut with saws and then drilled, planed and shaped generating lots of dusts;
2. There was a great deal of solvent and resin vapours generated from laying up epoxy and polyester resins, and curing these in ovens. The use of epoxy and isocyanate paints that were sprayed or rolled on added to the vapour mix. Large surface areas required great amount of paint/solvent, thus producing large amounts of vapour/mists;
3. The curing oven generated a great deal of fumes and vapour as a result of heating various coatings. This process produced a number of thermal decomposition by-products when epoxies and polyester resins were heated including BPA, Formaldehyde, and benzene;
4. Also contributing to these routes of exposure was a lack of local exhaust ventilation and PPE;
5. Housekeeping was poor and dusts and other volatiles were not looked after;
6. Workers used a great deal of solvents for cleaning up paints and resins which were mostly applied by hand with rags soaked with TCE, MEK, toluene, xylene, and acetone. Many of these are PAHs, containing benzene. Workers also handled mold-release agents.

Production Process	Chemical Exposure Risk

Types of raw materials worked on included: Asbestos Lumber and boards, fibreglass, various woods such as maple, cherry, oak, etc. and composites such as Textolite. Workers would also cut various metals such as steel and aluminum. This shop used large amounts of plywood sheets for construction of parts and structures. Plywood laminates used contain many types of glue treated with formaldehyde compounds.

Chemicals used: Acetone and MEK (for cleaning equipment) and Styrene, Thinners such as 1500 thinner, Partal, and beeswax, which were used as mold release agents. Cabasyl, a spray was also used. Various resins were used in large quantities in liquid or powder form. These were both epoxies and vinyl ester resins. Workers used a great deal of fibreglass cloth of different grades in molding process. These chemicals were handled in 5-gallon pails.

Production processes: Workers were engaged in building various wooden structures, building molds for fibreglass parts and molds, and laying up fibreglass and resins in the molds. Mixing of resins, fillers, and additives for layups was done; as was cutting of composite asbestos lumber, other composite materials and pressure treated materials. These materials were dry cut without dust suppression measures taken. The saws utilized stone cutting blades, which were changed to diamond saw blades after 1980. Asbestos board was grey in colour and would produce large amounts of white dust when cut. Asbestos dust and cuttings would fall under the large saw table, and sometimes into the sewage system through drain grates in the floor. After cutting Carpenters would move to drilling and beveling the edges, depending on where the product was going. All of these products were supplied to other areas of the plant for use in motors and generators. This held true for all raw materials brought into the carpenter shop. With cutting asbestos, wood and textolite -- and having a fibreglass molding operation -- the dust factor was huge, especially with the poor ventilation system. Workers spoke of smells, coughs, and eye irritations experienced. Asbestos and fibreglass dust were part of the overall debris. Parts were layed off (scribed onto the material) and cut by hand using

These would be inhaled and absorbed through the skin;

7. The chemical, styrene, was used extensively as a component of resins and gel-coats as a thinner. This was inhaled and absorbed through the skin;
8. Mixing resins by hand also produced a great deal of chemical vapour from off gassing resins and catalysts;
9. Workers ate and smoked at their work-stations, increasing the risk of ingesting chemicals they were using or were in their work area.

Dusts were generated in large amounts without respiratory protection and local exhaust ventilation, were inhaled routinely. Operators worked directly and closely, carrying out detailed tasks using substances in large quantities.

JHSC: 9/9/80: re: Dust sampling: "Non-metallic machine shop report identified 20% of dust sample checks indicated higher than TLV on dust and fibres."

MOL: 04/26/79: Investigation of asbestos exposure concludes confirmed risk of exposure for carpenters and very high risk of exposure for maintenance personnel. Recommendations re: controlling asbestos exposure: wet asbestos when removing, enclose area, use respirators, clean up area, launder clothes in plant. No orders issued.

MOL: 06/7/79: Asbestos concentrations tested. Found in excess of the TLV.

MOL: 11/16/82: Investigation of worker complaint of illness, e.g. tiredness, headache, feeling sick during silver soldering. Inspector indicated that exposure likely to cadmium oxide, but no air sampling were carried out. Suggestions made for local exhaust ventilation. No orders issued.

These chemicals were routinely and directly used and applied by hand. They were inhaled and absorbed through the skin routinely, and in large quantities.

Production Process	Chemical Exposure Risk
handsaws or sabre saws, and also drilled on small drill presses. Some products had rubber seals pop-riveted on. **Fibreglass operation:** Spray nozzles containing razor blades in the tip were used to cut fibreglass strand that would feed into the nozzle. As part of this process there would be two 45-gallon drums -- one containing a resin, the other a hardener. The resin and the hardener would be pumped together from the drums into the spray hose along with the fiber strand. When sprayed onto the mold the razors in the nozzle of the sprayer would cut the strand to create the fibreglass product. Could be sprayed with several coats to reach desired thickness. Two or three people would be waiting to roll the product down with rollers to make sure fibreglass adhered to all areas of the mold. This same process is used extensively in the boat building industry using similar chopped fibre/resin sprays. Atmosphere was heavily contaminated with styrene. Local exhaust ventilation and PPE inadequate for these operations.	In addition to various wood dusts inhaled, workers routinely inhale asbestos fibre from cutting and sawing asbestos board and sheets for non-metal fabrication. These were handled directly and routinely with detailed tasks by hand. Workers directly handled large amounts of fibreglass and polyester and epoxy resins and hardeners directly and routinely. They inhaled and absorbed various fumes from resins such as styrene, MEK peroxide, BPA, formaldehyde in large volumes given product size and the detailed work performed. They also inhaled fibreglass resin dusts during sanding and grinding tasks on cured fibreglass and resins.

BUILDING: #18 **DEPARTMENT: INDUCTION MOTORS**

General Description

Die Cast Rotor Production: 140, 180 210 motors

Spin Cast Production for 520 and 580 motors

Machining and metal cutting

Coil and winding process

Coating parts with epoxy shellac

Additional Factors associated with exposure risks

Assembly of medium size motors

Chemicals used or produced:

aluminium, lead and steel particles/dust

arsenic

asbestos

“black paste”

brominated fire retardants

dasco-tap

decomposition by products (BPA, PAHs, formaldehyde, benzene)

duct seal

dusts (mica, copper solder, metals, fibreglass, asbestos, epoxies)

Epoxies

Formaldehyde

glyptol/shellac

MEK

MWFs

TCE

toluene

varsol

Building: #18 **Department: Induction Motors**

Production Process **Chemical Exposure Risk**

General Description: Induction Motors (referred to as small motors) were built in building #18. The following is a description of the building of one component of induction motors—the production of 'die cast' and 'spin cast' rotors. This involved the production of punch sheets using a large punch press as well as the machining of space blocks. In the early days this was done in building 18, but later punching and space block machining was carried out in building #12 and plates delivered to this department in building 18. With die cast rotors for #140, 180 and 210 motors, steel sheets were punched to create predetermined holes and then annealed in an annealing oven. When partially assembled a casting was made by pouring molten aluminum into the form. This was further ground and machined and fitted with a shaft and installed in the stator. The rotors for the 580 motors were produced using spin cast process including the use of asbestos and Kozma furnace in the production.

Summary of Chemical Exposures: Oil mists and vapours from various types of chemicals including many different MWF; dusts and residues from treated papers and tapes that contained brominated fire retardants; fumes from heavy metals such as heated aluminum and lead; heavy concentration of heavy metal dusts from grinding, sanding and buffing metal castings; dust and fumes from epoxy coatings that were heated and baked; dusts from fibre glass and asbestos used as reinforcement and insulation; MWF and metal particulate from machining operations; various epoxy paints and coatings; degreasers and solvents such as TCE, MEK, and varsol.

Die-cast Rotor Production of 140, 180, 210 Motors:

Punch Press operation: 3' wide steel sheets coated with oil were sprayed with varsol and sent through a high powered punch press to cut out predetermined holes in the sheets. During the punching process the impact of the press would cause the residues on the plates to vaporize. Steel sheets were fed manually by the operator, at a rate of 10 sheets per second. This created dense mist oil residues that would coat the operator and his clothes.

Inhalation and skin absorption of oil mists and varsol. There was no local exhaust ventilation and no adequate respirator equipment and workers handled these directly. This would also involve ingestion because workers ate and smoked at their workstations.

Annealing the plates: The punched plates were manually placed on a conveyor, which carried the plates into an annealing oven run at a temperature of 300 to 400 degrees Fahrenheit. The oven opening at each end was approximately 3'x4'. Annealing would take 5 minutes. Annealed plates then taken off conveyor at exit end by operator wearing asbestos gloves to handle the hot plates. Participants indicate that fumes were strong at both ends of the oven and permeated the area. An asbestos blanket hung over each end but did not provide a seal. The asbestos blanket was worn and frayed from contact with plates and belt when passing through.

Inhalation of fumes from residues on metal surfaces during the annealing process involving heating between 300 and 400 degrees F. Thermal decomposition by-products such as PAHs. Workers would incur exposures because these were handled directly in great volumes, e.g. 10 sheets per second. Workers indicate heavy fumes /odours during annealing. No local exhaust ventilation.

Production Process	Chemical Exposure Risk
Die Cast operation: Punch sheets were placed on a stationary arbour where they were stacked and separated with spacers between each sheet. Once stacked the sheets were covered with fibreglass paper, which formed a barrier for the pouring of aluminum/lead alloy into the cast to form the structure of the rotor. Prior to the pouring operation, a "black paste" was applied to the bottom of the cast.	Inhalation and skin absorption of chemical treated (flame retardants—brominated retardants) paper applied by operator around the casting. Also exposure to fibreglass particles from fibreglass paper.
Aluminum/lead pouring operation: An open furnace containing a trough of molten Al/Pb supplied the operator with molten mix (60:40). The operators manually scooped the mix out with ladles and then poured its contents into the die formed by the stacked sheets and fibreglass paper wrap. Operators produced 40 to 50 die-casts per day for the 140, 180 and 210 motors. Operators reported heavy fumes during this process of pouring molten Al/Pb.	Inhalation of aluminum and lead fumes from heated vat and pouring operation handled directly by the workers at high volume with no local exhaust ventilation. Production volume was high and would influence the concentrations of alloy fumes workers would be exposed to.
Aluminum oven maintenance: Regular maintenance was manually undertaken 2-3 times per week to remove slag from the molten trough with rakes. Operators were provided with heat shields, but no respiratory protection. Operators report heavy fumes during maintenance. No local exhaust ventilation provided for ovens.	Further inhalation of aluminum and lead fumes during maintenance operation. This would involve higher concentration because the workers were dealing with removal of slag for an intense period.
Shaft placement into rotors: Shafts were pressed into the rotors with a pressing machine. Operators applied an asbestos based 'black paste' called Duct Seal on to the rotors. The rotors were then placed in a tote box to another station where it was turned and balanced in preparation for installation into the stator.	Inhalation of vapours from 'black paste' Duct Seal as well as skin absorption when in contact with skin.
Grinding, sanding and buffing of die cast for fitting: Operators would manually grind and sand to smooth casting surfaces which produced lots of fine dust.	Inhalation and absorption of large amounts of air-borne particulate containing heavy metals, epoxy paints, fibre glass, treated paper with fire retardants as a result of grinding, sanding and buffing.
Machining: Rotors would also be machined to proper size for installation of coils and placement in stator. Machine oils could be used in this operation.	
Spin Cast Production for 520 AND 580 Motors: 1. Plates were punched in same manner as 'die cast' process and placed on arbour; 2. Space blocks were inserted between plates	Exposures same as above for die cast.

Production Process	Chemical Exposure Risk
and an asbestos insulation called ‘fibre fax’ was pressed with bare hand into the spaces created by space blocks. This required that the workers tear off chunks from a large sheet of asbestos. The tearing and stuffing of asbestos chunks created a substantial amount of dust. Workers did not use respirators nor was there any local exhaust ventilation;	Inhalation of asbestos fibres from tearing and stuffing asbestos in rotor spaces.
3. Next, asbestos tape was used to wrap and seal the rotor cast, which was subsequently painted with ‘glyptol’ epoxy paint in preparation for oven curing;	Inhalation and skin absorption of epoxy paints and asbestos fibres from asbestos tapes.
4. The rotor cast was then placed in a casting oven where the rotor was baked overnight;	Inhalation and skin absorption of fumes and vapours of epoxy coatings and thermal decomposition by-products such as BPA, formaldehyde, benzene.
5. After baking, the molten Al/Pb mix was poured into the cast and spun in a Kozma aluminum-casting furnace. Here the mix was poured in mechanically and through centrifugal force penetrated all cavities in the casting thus producing a significant amount of Al/Pb fumes in the vicinity of workers;	Inhalation of fumes and vapours from aluminum and lead as well as residues of coatings.
6. The completed rotor was then cleaned with spinning wire brush powered by compressed air to clean off the glyptol paint and asbestos tape. An air chisel was used to remove excess aluminum casting. The process would take 1 to 1½ days. This cleaning process generated a great deal of dust containing epoxy, Al/Pb, and asbestos fibres. Local exhaust was not functioning at most times.	Inhalation of heavy metal dusts, epoxy paint dusts, fibreglass tapes from power grinding over an 8 to 10 hour day without local exhaust and/or adequate respiratory protection.
Machining and Metal Cutting:	
Shafts were machined and prepared on metal lathes, cutting machines, and keying machines. These machines used large quantities of MWF including trade name Dasco-tap, a cutting fluid containing methyl chloroform. There were instances where workers were overcome by the fumes from this substance. There was no local exhaust ventilation.	Inhalation and skin absorption to mists and aerosols of various metal working fluids such as Dasco-Tap and others treated with biocides and other ingredients.
Red cutting oils used created clouds of mist and aerosol that surrounded the operators and those standing by in the vicinity. Some of the MWFs contained toxic biocides (e.g., arsenic) to control	Descriptions by workers of “clouds of mist” and aerosols hanging in the atmosphere as well as reports

Production Process	Chemical Exposure Risk
bacterial and fungal growth, which would be included in the mist and aerosol generated by machining.	of irritated eyes, noses and throats, and dermatitis would support relatively high exposures.
Welding took place on a regular basis in the machining process producing large amounts of welding fumes. Degreasing was also a part of this process and utilized several types of degreasers including TCE, MEK, et al.	Inhalation of welding fumes as well as residues of degreasers and thermal decomposition by-products. This would involve: PAHs, heavy metals, et al. By-stander exposures to MWF and metal particulates. Handling coated wires in the winding process.
Coils and Winding Process Production:	
Winding process performed by women working near the machining area for the production of coils to be inserted in the stator slots. Several tapes were used in this process containing fibreglass and Mylar as separators and stiff fibre glass wedges were also inserted into the coils.	Inhalation and absorption of ingredients in treated tapes—e.g. fibreglass, flame-retardants, et al.
Coating Parts with Epoxy Shellac:	
Parts were slowly rotated above a 20 gallon trough 3’ deep with a controlled spray of shellac coating the parts for ten minutes. This process produces a great deal of fumes and over spray. Note: Ventilation was a serious problem in this and other buildings because of the building configuration, the use of compressed air for cleaning and removing dust from work surfaces, parts and workers’ clothing as well as cooling their bodies. The whole ventilation system was under negative pressure that created a tendency for toxic fumes and dust to be transported to other areas. Also, ceiling-high walls did not separate buildings -- at most, there were low partitions separating work area.	Inhalation and skin absorption of heated epoxy shellac. Likelihood of high exposure due to spraying operation and heating of shellac. **JHSC: 8/24/82: re: thinner fumes:** Large paint tank in north end of #18 has very high (level) of thinner fume by smell of it. Workers have complained they get “high from fumes when mixing the paint with the large paddles.”
Additional Factors Associated with Exposure Risks: Work Organization: work organization was characterized by the ‘piece rate system’. This resulted in intense work activity, circumvention of exposure control measures by management and workers to meet production quotas.	Inadequate ventilation both local exhaust and general in addition to the work organization based on the piece-rate system as well as poor housekeeping, hygiene practices such as eating and smoking at the work station and circumventing exposure control measures where available, supports the validity of the conclusion that the risk of exposure was high in these operations.
Practices and Hygiene: As in many other parts of the entire GE operation workers ate their lunches and sometimes smoked at their workstations. This was conditioned by the piece rate system and the	**JHSC: 8/20/84: drinking fountain:** “There has been a long delay in respect to correcting the distasteful

Production Process	Chemical Exposure Risk

unavailability of safe eating facilities. There was also a problem with the availability of potable drinking water.

The use of compressed air to clean work surfaces, parts, clothing, and to cool workers' bodies was prevalent in this building and throughout the entire GE facility.

Assembling Medium Size Motors: This process involved approximately 100 to 150 employees on two shifts.

The processes involved:

Parts received from Punch Press

Coil Winding

Coil insertion into stators:

Cutting asbestos (or fibre glass, mica) wedges and separators

Insertion of asbestos/fibre glass wedges with asbestos 'felt' backing:

Insertion of separators composed of treated paper, fibre glass, asbestos:

Assembling punch sheets and piling sheets:

Connecting leads by brazing with a torch applied to SilPhos solder:

Lacing with cotton or fibre glass cord to hold coils in place

Testing connections:

Dipping assembled motor in a dip tank (large and small tubs) filled with epoxy resin:

Then baked in oven:

Grinding excess cured resin:

Chemicals/Material by-products produced by processes:

Production of dusts (asbestos, fibreglass, mica, epoxy resins, (copper/solder dust) from cutting, inserting

water at fountain in Bay 523. This Committee has received numerous complaints."

Exposures risk during assembly:

This operation involved exposure to several toxic chemicals in the form of dusts, liquids and fumes vapours or mists.

The likelihood of inhalation and absorption of these chemicals was relatively high given their physical state, the proximity to the work, the intensity of the work, the lack of local exhaust ventilation or ppe.

These workers inhaled various fibres (asbestos/fibre glass) from cutting and shaping wedges and separators, pressing materials in slots and general handling. Also inhaled metal fumes from brazing leads, resin applications and baking, and application of solvents (TCE,MEK, Toluene).

MOL Reports:

MOL:09/17/75: Investigation regarding zinc chromate paints. Exposure identified as low because it dried quickly and hard. Orders issued for better housekeeping and no eating, drinking or smoking. Recommends: adequate exhaust ventilation and good hygiene practices.

MOL:06/30/81: Hozma and Kozma furnaces generating large amount of smoke and fumes escaping from under the canopy. Orders issued for local exhaust ventilation. GE management request 'minimum exhaust required'.

MOL:09/30/81: Aluminum fumes from Kozma furnace. Prior orders issued to address escaping fumes into plant. Suggestion to redesign the fume hood to proper size.

MOL:03/31/82: Paint and solvent vapour affecting worker who is stirring paint into a dip tank. Order

Production Process	Chemical Exposure Risk
wedges, separators, grinding resins, and brazing leads. Production of fumes and vapours from brazing copper and solder, and the application and baking of epoxy resins. There was no local exhaust ventilation nor was PPE provided.	issue to “reconnect the local exhaust instituted to greatly reduce exposures.”

BUILDING: #20 **DEPARTMENT: DRIVE SYSTEMS**

General Description

Printed Circuit Board Production

Work processes:

- **Etching:**
- **Rotating Track**
- **Flow-Solder**
- **Solder Benches**

Semi-Conductor Production

Work processes:

- **Degreasing and etching**
- **Metal fusion and cleaning**
- **Assembly**

Known Chemicals used or produced:

Acids: ferric chloride, HSC, sulfuric acid
Degreasers: Acetone, TCE, MEK
Heavy Metals: lead, cadmium, chromium, mercury, copper, gold, tungsten
Thermal by-products:

- Polymers: PVC, VCM
- Phthalates: DEAP, BBP, DBP, DIBP
- Brominated fire retardants

Building: 20 **Department: Drive Systems**

Production Process **Chemical Exposure Risk**

General Description: Drive Systems was located in building #20 and consisted of two electronics production departments: Electric Circuit Board production and Semi-conductor production. These related production facilities used significant amounts of degreasers, acids, and heavy metals including: lead mercury, cadmium, and chromium 6. Except for specialized areas in semi-conductors, these departments lacked adequate local exhaust ventilation. Workers were also exposed to chemicals that were contained in the parts they handled including: PVC, VCM, fire retardants such as PBBP, PBDP and phthalates (DEHP, BBP, DBP, DIBP) these latter were imbedded in the laminated insulated substrates of the boards.

Major exposures: Given the quantity of production and lack of PPE and other effective exposure controls operators were likely exposed significantly to a number of very toxic chemicals, chronically. These exposures included acid mists, solvents such as acetone, TCE, MEK, and heavy metals including: lead, cadmium, chromium, mercury, copper, and gold. Other exposures were polymers, such as PVC, VCM, phthalates, and brominate fire retardants.

Printed Circuit Board Production:

This production process employed approximately 25 to 30 workers who were mainly female.

Workers were provided with pre-printed circuit boards that were laminated fibreglass epoxy insulated substrate with a thin layer of copper foil laminated on one or two sides.

Etching: Laminated board was etched in an acid mix of ferric chloride bath creating tracks in accord with the pre-printed circuit. A male technician did the etching in an etching room, which was equipped with general ventilation and a fume hood over a sink.

Risk of exposure to acid mists generated by acids interacting with substrates and copper. Copper fumes from removal/breakdown of copper. The potential of inhalation significant.

Rotating Track: After etching, the etched boards were sent to the rotating track where 4-6 operators inserted the various electronic components (diodes, capacitors, resistors) in the circuit boards.

Workers handled components barehanded thus were exposed to residues of metals and polymer contaminants from the acid bath. Risk of slight inhalation and absorption through skin. Also likelihood of ingestion from workers eating and drinking at their workstations.

Flow-Solder: After the rotating track process, the boards were sent to the flow solder room where a male technician would operate the flow solder machine which was inadequately ventilated and subject of health complaints and MOL investigations and issuance of orders.

Solder Benches: A number of female operators (5 or 6) equipped with soldering irons engaged in touch up soldering of the soldered boards to

Workers are likely exposed to lead solder fumes containing lead, cadmium and flux. In addition these workers are exposed to the solvent vapours indicated above as well as resins. This likely through both skin absorption and inhalation. Over exposure indicated by complaints of physical symptoms as well as the volume of production carried out by 4 to 6 women soldering the printed circuit boards.

Production Process	Chemical Exposure Risk

ensure proper connections. This area was filled with heavy lead solder and other breakdown products from applying heat to the PVC boards. These could have lead, cadmium, chromium, VCM, brominated fire retardants and phthalates. The area had no ventilation and no PPE was provided. There were only portable fans to blow fumes away from operators. After touch up, soldering boards were degreased with isopropanol alcohol and toluene and then dipped in poly-butyl-methacrylate resin.

Note: Frequent complaints of respiratory irritation and difficulty breathing. MOL investigation

Semi-conductor Production:

This department employed approximately 15 to 25, mainly women, workers in the production of various semi-conductors such as diodes and Silicon Controlled Rectifiers (SCR). This production used tungsten, gold, a mixture of acids and solvents including: acetone, TCE, MEK and ceramic coverings. The operation involved 1) etching the surfaces of gold, tungsten and silicon discs in preparation for construction of the electronic components; 2) the fusion of gold leaf on the tungsten disc and 3) the layering of these and placement into a ceramic covering.

Degrease and Etch: Operator would first degrease and etch the gold flake and tungsten disc with acetone/TCE and then bathe these in acid usually ferric chloride, HCL, sulfuric acid or a mixture of this with other compatible acids. This was carried out over a sink equipped with a fume hood.

Fusing of Discs: After etching, the operator placed a tungsten disc on to a hot plate. This was followed by placing a gold leaf on the tungsten in order to fuse the two metals. Once fused these were removed quickly to a beaker in order to cool.

Disc cleaning: After fusion, the discs were transferred to a beaker with acetone and toluene for cleaning in an ultrasonic shaker machine which measured about 4’x3’. This was carried out in the open.

The Flow Solder operation as well as the bench soldering was a major source of heavy metal (silver, lead, cadmium), solvent fumes and vapours, with a high risk of exposure.

This was recognized in the **October 7, 1981 MOL inspection report.** Inspector noted that the local exhaust ventilation was ineffective and could be interfered with by random air currents. The inspector noted that the complaints of eye, nose and throat irritation were indicative of “over exposure” and ordered the employer to conduct a lead exposure assessment to determine level of skin absorption as well as exposure to isopropyl alcohol from solvent. Workers reported frequent headaches during the flow solder operation. Two workers were reported to have had epileptic seizures as well. Workers complained about strong solvent and resin odours as reported in **MOL: December 30, 1981** investigating worker complaints and detecting isopropanol and toluene in the work atmosphere through air monitoring.

JHSC:6/30/81: Workers in vicinity of deep-wave soldering machine complain of dizziness from fumes. Hood reading approx.. 50-75 F.A.M. (using Kester flux #1571 and Kester flux thinner #104.

Although there seemed to be effective engineering controls meant to provide an extra modicum of protection to “products” being made, there were conditions that would allow exposure of the operator to the acid mist, solvents, and possible heavy metal residues. Etching was carried out in the open but with a fume hood over the sink where the etching was performed.

Since workers could detect prominent acid odors, it is likely that workers were being exposed. This could occur where materials were handle without protection. In areas where materials were cleaned with acids or solvents in the open, the likelihood of exposure would occur during the shaking process with solvents.

There were a number of cancers in bldg. #20 including several women employed in each of the

Production Process	Chemical Exposure Risk
Alternative layering of discs: These discs were then transferred to an assembly area where the gold fused tungsten discs were alternatively layered with the silicon disc and then placed in a ceramic container.	two operations, which should be investigated. These included several cases of lung, breast, and brain cancers, as well as lymphoma.
Diode assembly: Some of the larger diodes were assembled on an aluminum heat sink.	Since this work was carried out in the open area without local exhaust ventilation, it is highly likely that workers were exposed to solvent vapours.
The only protective equipment provided was for those working with acids in the clean room including a pair of yellow rubber gloves, a polyester smock, and a fume hood over the sinks where acids were mixed. There were noticeable odours from the acid fumes as well as from solvents such as acetone. Workers reported acid burns and eyes, nose, and throat irritation from acid mists and solvent vapours.	Likely exposures via inhalation and absorption to solvent vapours and residues from manual assembly.

BUILDING: #21 **DEPARTMENT: NUCLEAR**

General Description

General Working Conditions

Exposure Controls

Nuclear Bundle

Work Processes:

- **Sand Blasting**
- **Beryllium Deposition**
- **Other Procedures**

Chemicals used or produced:

Beryllium

Degreasers

Detergents (caustic soda)

Graphite

Silica

Uranium Oxides

Zirconium (Nickel Zinc, Tin)

Building: #21 **Department: Nuclear**

Production Process **Chemical Exposure Risk**

General Description: This department is dedicated to the production of nuclear fuel bundle structures and loading of these bundle tubes with uranium pellets for CANDU nuclear reactors. The nuclear division is located in its own separate building #21 on Monaghan Road at the west entrance to the GE complex.

From the mid 1960s to the present, the department has employed 120 to 150 workers on 4 shifts, 24/7, producing 18 to 20 fuel bundles per shift or around 3 bundles per hour. The work is tedious and stressful because of the precision required and fear of radiation and beryllium.

General Working Conditions: This is viewed as the cleanest work environment in the GE complex. But at the same time the toxicity of the materials, namely uranium oxide and beryllium, present a high hazard. In addition to handling uranium oxides and the potential for exposure to beryllium, there are other potential exposures e.g., to silica, graphite, degreasers, and detergents of concern.

Exposure Controls: Local exhaust ventilation has been provided and air seems clean. Radiation and beryllium exposures were monitored and federal and provincial regulations were applied. Workers have been provided with lab coats and cotton gloves, but no respiratory equipment except during maintenance and cleaning operations. In the latter circumstance, air supplied respirators are provided. A shower is provided outside the beryllium room.

Nuclear Bundle: The nuclear bundle produced is comprised of between 26 and 36 nuclear fuel tubes made of an alloy of tin-zirconium. Fuel tubes are held in parallel to one another by a pair of end plate frames. In the assembly of the bundles, small zirconium spacers are brazed to the surface of the zirconium tubes. The spacers are applied to the tubes by a brazing process. These spacers and pads are coated with beryllium.

Beryllium Exposure: According to a paper delivered at the 11th International Conference on CANDU Fuel, current fuel bundle production using Beryllium would not be able to meet the new TLV of 0.05ug/m^3 proposed by the ACGIH. The paper also indicates that current health research on Be exposures shows that Chronic Be Disease (CBD) is on the rise despite exposures being below the current 2ug/m^3 TLV and provincial OEL for Be. This has a direct bearing on the GE nuclear facility in Peterborough. (see J.G. Harmsen*, et al, 'Beryllium Brazing Considerations in CANDU Fuel Bundle Manufacture' 11th International Conference on CANDU Fuel, Niagara Falls, Ontario, October 17-20, 2010). IARC classified Beryllium as a Group 1 carcinogen.

JHSC: 8/23/83 re: degreaser urine test results: "Urine tests on full and part time degreaser operators showed that all had traces of TCE in their urine. Dr (C) explained if TCE is showing up in urine then operator is being over exposed. (Foreman?) told group he was satisfied that operators were working safely and problem is not caused by method of operating."

JHSC: 8/18/84: re: graphite oven: "When ovens are being cleaned workers are being exposed to heavy concentration of fumes."

JHSC: 11/18/86: Be air sampling: "Sample results indicate higher than normal levels of Be for 1st and 2nd quarters of '86. The latest quarter shows levels now back to normal. Employees wore respirators for a time. Since early October, no longer needed. Employees would like this reported on their charts and also recorded with their family physicians."

Exposure Risk to Be: Throughout the Be coating process, there are many opportunities for Be dust to become air borne and inhaled by workers. Measuring out the Be powder, placing it in the crucibles, placing the crucibles in the Be furnace, opening the furnace doors to remove or adjust the strips should they come loose during the process, punching the separators and bearing pads, and

Production Process **Chemical Exposure Risk**

PROCESS

Sand Blasting: Zirconium metal sheets used to make spacers are degreased, then sand blasted in the sand blasting room and washed in detergent.

Beryllium (Be) Deposition: Next beryllium is applied to the sheets' surface by vacuum vapour plating deposition under negative pressure conditions in the beryllium furnace located in the 'beryllium room'. The beryllium is purchased in 2 lb tubs in powder form. The powder is hand weighed into a crucible in 5 to 10 g batches in a fume hood. The crucibles are used in a vacuum plating system to deposit a thin layer of Be on zirconium alloy strips. The operator wears a smock, shoe covers and a half face respirator with a high efficiency dust filter (NIOSHTC-21c-135). A maximum of 4 batches are processed per day. During maintenance a full-face air supplied respirator is worn. Coating operators can spend from 1 to 4 hours per day. Longer hours are required during equipment maintenance.

Be plated strips are then processed on two small automatic punch presses. The spacers are stamped on one machine and bearing pads are stamped on the other. Both processes are enclosed and locally exhausted. Punchings are collected in a plastic bag. There are up to 4 operators in this room at a time. Punchings are taken by cart to the coining room to be contoured to tube shape by two operators. These operations generate Be/Zr dusts.

Spacers and pads are tack and brazed to the tubes on 4 tack and braze units. This is done using small RF induction furnaces in enclosed and locally exhausted units.

Other Procedures:

Ultrasound testing to ensure the integrity of the tubes;

Sandblasting in preparation for coating;

Rough cutting the length of the bundles;

Applying liquid graphite to the inside of the tubes;

Baking the graphite coated bundles in oven;

tacking and brazing these to the tubes. All of these procedures can generate Be dusts. And the potential for these eventualities to be realized is reflected in the monitoring results undertaken by the MOL.

Throughout the years of the GE Beryllium coating operation there have been several instances where beryllium-monitoring levels exceeded the old 2.0ug/m³. Note also, that most of these reported levels exceed the new, currently proposed, TLV of 0.05ug/m³. See MOL inspection reports as well as work refusal investigations. Report by H.M. Nelson, Industrial Hygiene Branch indicates personal sample results of 41.5 ug/m³ of Be in the breathing zone during hand sawing of Be bar to obtain beryllium dust for coating. This hand sawing was contrary to what the regulatory agency recommended for the safe handling of Be. Accordingly, the inspector notes: "The sawing of bar stock is a very crude operation. It would be better to either purchase correct size bar stock or obtain powdered Beryllium". **(MOL reports: Building 21, March 23,1965)** Be sampling results obtained the next year were still not satisfactory. Test conducted by GE Safety Unit showed levels of 1.97 ug/m³ and 1.95 ug/m³ very close to the TLV of 2.0 ug/m³. In 1964, prior to GE opening the nuclear unit, the Department of Health recommended three precautions be taken to minimize exposure to "beryllium…considered to be about the most toxic material handled industrially" including: 1) purchase Be in a powdered form to reduce direct contact; 2) place Beryllium room under negative pressure to prevent Be contamination of other areas; 3) separated locker and cleaning areas. **(MOL: Building 21, April 11,1964)**. These recommendations were ignored resulting in excessive Be air contamination of 41.5 ug/m³ in 1965, demonstrating GE's callous disregard for the health of workers and its poor safety culture.

Note also that these reports indicate that in some instances these measurements were taken when the coating process was not in operation. Be vapours can escape when Be coating oven is opened or being cleaned. Small amounts of Be inhaled or absorbed through the skin can cause serious disease, including

Production Process	Chemical Exposure Risk
Cutting the bundle of tubes to length; Filling tubes with uranium pellets (while not enriched pellets still emit alpha particles); Execute final cut, then weld end caps to the bundled tubes.	cancer. Exposure usually peaked during maintenance operations in beryllium coating operations. Air borne Be flakes noted by workers during brazing operation led to a work refusal in 1983. Tests conducted by the Safety Unit indicated that level of Be was high but below TLV **(MOL: Building 21, February 15, 1983).** During punching of the spacer from the beryllium coated sheets, beryllium dust/vapour is generated, potentially exposing workers to a very potent carcinogen and sensitizing agent. While the main route of entry would likely be inhalation, skin absorption should not be ruled out given the wearing of cotton smocks and gloves. **Uranium Oxide Exposure:** **Monocyte Suppression:** Alpha radiation exposure from Uranium oxide is likely to occur through inhalation given the direct close handling of uranium pellets during the loading process. This is likely evidenced by the low monocyte counts for workers who worked in the nuclear department. This was indicated in the report prepared by Dr. R. Chase at the L.A.M.P Occupational Health Program for the United Electrical Workers, entitled The CGE Nuclear Project: Report on the Investigation into Possible Monocyte Suppression in Uranium-Exposed Workers. It is proposed that reduced monocyte production is a measureable effect of radiation exposures as heavy metal uranium settles in the bone and emits alpha particles. That study found that 44% of GE nuclear workers had reduced monocyte counts that were abnormally low—15-20 times lower than expected in a sample of healthy men and women. When compared with thorax burden counts the prevalence of low counts was across all exposure categories. This suggests that monocyte production is sensitive to levels of radioisotope absorption lower than those experienced by CGE workers. This evidence confirmed the hypothesis that absorbed radioactive particles has a detectable effect on the white blood cells (monocytes). According to Dr. Chase…"Therefore, there are valid and persuasive reasons to suspect

Production Process	Chemical Exposure Risk
	that workers are being affected by their exposure to uranium.” **Uranium over exposures:** Inspection reports from the Department of Health indicate instances where biometric monitoring results for uranium in urine far exceeded the allowable concentration of 16.0 ug/L. In one case, worker levels were 1.5, 1.5, 10.6 and 195.0 ug/L for 4 employees **(MOL: Building 21, June 16, 1965)**. **Beryllium dust over exposures:** MOL reports in 1979, reported high beryllium dust readings in the beryllium room requiring remediation and use of respirators until dust readings were within TLV limits **(MOL: March 1, March 9, and June 1, 1979)**. Other considerations: In performing the above tasks, workers position the bundles at groin level. Some of the other procedures potentially expose workers to other hazardous dust from metal cutting zirconium tubing and silica from sand blasting. Participants described an incident where an explosion occurred during brazing, resulting in heavy beryllium contamination.

BUILDING: #22 **DEPARTMENT: WIRE AND CABLE**

General Description

Banbury Mixer Operation

Tuber Operation

3 inch Lead Press

Cotton Braiders

Lacquer Processes

Open Saturation Tank

Tar Pots

Carding Machines

Asbestos, Water and Enamel Carding Machine

Glass Machines

Winding Area

Chemicals used or produced:

Asbestos

Coal Tar volatiles

Creasol, Benzol

Dromus Oil

Dusts/fibres: Asbestos, Mica, Cotton, Jute,

Epoxy Resins: Vinyl Chloride, “lacquer,” “varnish”

Metals: lead, mercury, copper, antimony,

MWFs

Okum

Rubber ingredients: clay, silica, lampblack, fatty acids, red lead, Vulkene,

Thermal Decomposition By-products: lead, phthalates, benzene, formaldehyde, BPA,

butyl perbenzoate, dibutyl phlthalate, dimethyl anline, methyl methacrylate, trichlorahexane, cyclo hexanone, styrene,

Thinners: TCE, Toluene, Acetone, Xylene, varsol

Vinyl ester resins

Building #22

Department: Wire and Cable

Sources: Sonya Lal, 2006 (OHCOW retrospective) and Advisory Committee

Production Process	Chemical Exposure Risk
General Description: The Wire and Cable department (1945-80) built conductors capable of carrying heavier currents at increased voltages. It was a large department employing between 200-300 people working 4 shifts. Formex, a magnet wire, was also built to support insulated wire for the windings of motors and numerous outside clients. It is important to note that between 1957-1960 many GE employees transferred between the Wire and Cable and Armature Departments as an alternative to layoffs. (Source: Lal, 2005 OCHOW report)	**Exposure sources:** dermal/lung exposures to various ingredients. Fumes from hot mix. Reports of health issues: heart attacks, cancers, COPD. Fumes traveled south throughout building then re-circulated. No exhaust system so fumes trapped within bldg. area (all windows required to be closed due to fume complaints to other areas/buildings, e.g., cafeteria).
Production Processes:	1,3 butadiene used in rubber production process.
Banbury Mixer Operation: This machine produces semi-liquid rubber for external coatings. Ingredients include: clay, silica, lampblack, fatty acids, and red lead (OCHOW has detailed list). It operates at 400 degrees C for 20-30 minutes per batch. Ingredients manually added to hopper by workers from platform (70 to 80 lb. bags of the different ingredients are opened with a knife then poured in). It has an exhaust canopy but is often not used.	Significant exposures to fumes from both heated ingredients and thermal decomposition by-products. For rubber, ingredients included: clay, silica, lampblack, fatty acids, and red lead. For by-products, query 1,3 butadiene?
Tuber Operations: There were two types of tuber production: Rubber tubers and PVC tubers. 40 employees (plus 12 on stranding machines) worked between the two operations loading semi-soft rubber or PVC pellets into hoppers. 1. Rubber Tubers: Finished product acted as extruders to insulate cables which consisted of three coated wires covered with a rubber tube. Insulation between wires included: fiberglass to 50s, asbestos to 60s and jute fillers with oakum in 70s. Exhaust fans in area often turned off by workers because it interfered with piecework 2. PVC Tubers: There were 7 PBC extruding machines. PVC pellets were poured into hopper of machine, stranded then vinyl chloride insulation (Vulkene) used as insulation in cables.	**JHSC: 8/24/78: re: Banbury mixer:** “The present ventilation is next to useless. A strong suggestion has been made to operators to wear filter masks. This means a hot and uncomfortable work environment and we hope to expedite installation of ventilation to remove the pollution at source.” **JHSC: 8/10/78: Banbury mixer:** “Dust samples (Mercapto Imidazoline?) were taken and registered very high.” **JHSC: 8/24/78: re: Banbury mixer:** “Hazard is reduced (re chemical Mercapto Imidazoline) by having material in solid form rather than powder but there are still dangers involved if precautions not followed. Operators have been asked to avoid barehand contact at all times yet they don’t seem to recognize the importance of this precaution.” **JHSC: 9/21/78: Banbury mixer:** “Mercapto Imidazaline still being used. It is imperative we get a resolve immediately.” **MOL:06/2/77:** Workers ignoring safety precautions.
3-Inch Lead Press: (located alongside tubing area): Copper wire is run through troughs of molten lead (up to 20’ in length) heated to 1300 degrees centigrade. One worker operated press that pulled wire through dies in lead-filled trough while a second	

Production Process	Chemical Exposure Risk
worker wound the wire (1/2” coating of lead on wire) onto reels. Winder wore asbestos gloves, breaking off excess lead. Dromus oil often applied to avoid sticking in winding process. Lead Pots manually fed 80 lb. ingots with bare hands. Exhaust fans usually kept off due to cooling effect, which slowed down the process (thus was costly to piece workers). Before winding onto reel, wire went through water bath that produced steam and mist.	For PVC, breakdown products included: lead, phthalates, vinyl chloride, benzene, formaldehyde. Same as above.
Cotton Braiders: (10 workers per shift, 3 shifts): These included 80 cotton and 18 asbestos braiding machines, the purpose of which was to spindle braids of cotton or asbestos over wire. Worker first dipped asbestos fibers into isopropyl alcohol to ease through machine (each worker had own 5-gallon pail of isopropyl alcohol at workspace). After cotton or asbestos was braided, hot wax was applied to prevent fraying of braid.	Both workers exposed to lead fumes, with dermal and inhalation routes of exposure. Additional exposures: The stripped off pieces of oil coated lead were returned to pot where oil would react, creating heavy fumes. Workers ate their lunches in area with lead-covered hands. It was difficult for workers to wash their hands during the day for a number of reasons: 1. They were paid by piecework, thus taking time off the floor could significantly cut their pay. 2. Washrooms and cafeteria were both located a significant distance away (only 20 minutes were allotted for lunch). 3. For a number of years water available to workers was recycled (gray water from the plant and later from well on the plant property. Signage throughout stated water was not potable).
Lacquer processes: Newly braided (cotton, asbestos) wires were heated in oven then run through rubber dies and coated with lacquer, then baked. Exhaust system used consistently as aided in process (unlike other areas where it was considered an impediment).	
Open Saturation Tank: This contained creosol mix to soak cotton used for braiding which was then allowed to drip-dry (the area was heavy with fumes).	
Tar Pots (molten tar): There were four pots, with one worker per pot. Cotton wire (Braidex) was dipped in hot tar (by hand or machine?) then run through die, sprayed with wax and rolled onto reel.	Dusty, noisy work area. Asbestos was raw material, no protective equipment to prevent inhalation of dust. Workers handled asbestos daily. Compressed air system used to blow dust off equipment, causing asbestos to be air borne and to travel throughout building and other departments because of negative air pressure.
Carding Machines (#31, #32): Employed rolls of asbestos on reel- to-reel machines (25ft long, 5ft apart). A ten-inch roll of asbestos covered 600 ft. of wire. Speed varied between 30 and 40 feet per minute, depending on wire. Carding #31: was set up like bunk beds with 2 lines moving at the same time. Process involved Wire taken off reel and run through ball of asbestos (6ft long x 8 ft. wide). Combs run across ball of asbestos spreading the fibers over moving wire. (Excess Fibers from top line exhausted into bins on roof while excess fibers from lower line dropped into bins underneath). Fiber coated wire	Bake oven emitted heavy fumes of lacquer plus fumes from varsol and toluene (added to thin the lacquer).

Production Process

was then run through wax pot and onto 2nd reel. (The paraffin wax process was exhausted to roof). Carding #32: consisted of 2 “dry run” machines (no waxing process) consisting of one line which carded 10 to 12 inch balls of asbestos in one line operation with excess fibers vented to roof bins. These bin vents often got plugged due to the amount of fibers causing more fibers to be dispersed at the process level. (The 10” roll of asbestos covered 6000ft of wire).

Asbestos, water and enamel carding machine: This machine coated wire with asbestos, then a coating of varnish. Combs spread asbestos on wire then wires sent through heated pot of varnish, then baked at 80°F and drawn through water pot to cool. The wire was then drawn onto a reel.

Glass Machines: Varnish treated fiberglass rolls wrapped around copper, run through heated pot of varnish, then baked.

Winding Area: Three shifts: 26-day workers; 15 in afternoon; 15 at night. Finished and tested copper wire put on rolls to meet product orders. Doors left often in summer (across from asbestos filled carding area).

Chemical Exposure Risk

Area heavy with fumes from the creosol mix coming from open tank. Inhalation (and possibly dermal exposure to chemicals) exposure risk to fumes which could include creosol, varsol, treated wax, and coal tar volatiles.

Air was filled with fibers, exposures further exacerbated by: large overhead cranes and machines shaking dust loose, open windows and large amount of pedestrian and truck traffic.

Maintenance workers emptied (through doors on side of bins) the loose asbestos fiber into bags by hand with no protection. (Sometimes they had “snowball” fights; the company sold bags of loose asbestos to workers or the broader community as “insulation”).

Lung and dermal exposure to asbestos and cotton fibers. Same maintenance procedure as above. 4-6 workers, usually on weekends, would clean the asbestos bins with no protective equipment. Entire cleaning of 8’x8’ bin took entire shift. Asbestos fiber handled by hand and stuffed into bags or boxes. Observation by a supervisor was that these workers “looked like snowmen.” No shower or change room available, asbestos likely taken home in cars, on clothes and carried throughout the plant.

Asbestos exposure; machine vented to roof. Additional exposure to fumes from heated varnish (likely a resin-based product and its by-products).

Fumes from thermal decomposition by-products. Workers used compressed air to disperse dust, also dry swept, shoveled fiber waste into barrels, then dumped in landfill sites.

Workers exposed to various types of fibers -- but fibers also further dispersed by them.

MOL reports:

MOL: 12/27/45: Introduction of synthetic resin with formaldehyde as a major component for electrical insulation. Also noted plans to expand porcelain

Production Process	Chemical Exposure Risk
	manufacturing. Need to change ventilation to handle silica dust exposure. **MOL:5/11/53:** Identified use of benzol, butyl perbenzoate, dibutyl phthalate, dimethyl aniline, methyl methacrylate, styrene, trichlorohexane, cyclohexanone, and phosphate. Inspector notes these are hazardous. **MOL:3/24/68:** Housekeeping very poor. Thick layers of dust noted. Workers eating and drinking and smoking at workstation; overfilled dross bucket. 8 melting units with no exhaust. **MOL:01/5-6/71:** ”asbestos handling considered to be worst in the entire plant. It was realized that the company not fully aware of hazard associated with asbestos dust” “Workers in 22 SW corner are unnecessarily exposed to asbestos fibres produced in this area.” Suggested area…”should be segregated from the rest of the building.” **MOL:03/27/71:**Pyrax samples are above the TLV. Inspector recommends workers wear respirators. **MOL:07/7/71:** Follow up visit on asbestos in SW corner. Levels at one of the carding machines was the worst recorded at the laboratory. While housekeeping improved there were still large amounts of fibre on the machines and floors. **MOL:07/19/72:** Five of six Asbestos fibre counts are above the TLV. **MOL:09/20/72:** Mica dust from machines is very high. The only machine with exhaust Is above the TLV. So one can “expect higher level at machines not exhausted. Order issued for proper enclosure and adequate exhaust. **MOL:02/6/73:** lead concentrations at lead pots and extruders above the TLV of 0.15mg/m^3. Housekeeping in lead handling area poor. Workers not wearing respirators. Exposures need to be assessed. **MOL:06/7/73:** Inspection re: mercury, lead and epoxy use. Mercury spills are apparent; lead levels above

Production Process	Chemical Exposure Risk
	TLV/inadequate exhaust ventilation; workers handling epoxy resins without gloves or respirators. Evidence of epoxy related dermatitis noted. **MOL:08/13/73:** air sampling and visual inspection "demonstrate that a significant exposure to mercury still exists." Asbestos clean up not complete and area not fully enclosed. **MOL:08/8/75:** Union complaint concerning exposure to vinyl chloride and the death of 6 workers who worked with the PVC production and extruding. Samples taken, but no exposure risk found. Union questioned sampling, e.g. accuracy of draeger tubes, not test for thermal decomposition by-products. **MOL:09/17/75:** Asbestos and mercury—exhaust system for asbestos not working. Asbestos fibre counts close to the TLV. All mercury areas are "….heavily contaminated with mercury." **MOL:10/16/75:** Asbestos levels in drive systems exceed the TLV. **MOL:05/4/77:** Asbestos claim investigated. Asbestos exposure minimized by the wcb because the claimant was an office worker at the time he became ill. However, his employment records show he had significant exposures at the plant in departments heavily contaminated with asbestos. **MOL:06/2/77:** Investigation of exposures to dusts, solvent vapors and gases. Inspector notes heavy odors around blister pack machine; need to advise workers of hazard of antimony and lead in the Banbury area; preventive maintenance on machines using toxic substances; practice good hygiene. **MOL:05/11/79:** Workers' complaint of eye and throat irritation. The new CEECO machine works at faster speed and increase in exposure to oil mist during machine operation and possible exposure confirmed. **MOL:09/6/79:** air sampling for oil mists aborted because of machine breakdown. Inspector concludes all tests under TLV.

Production Process	Chemical Exposure Risk
	MOL:06/22/80: Asbestos assessment; possible exposure confirmed. See comments made regarding numerous asbestos exposures observed. **MOL:03/25/80:** Asbestos paper used as insulation being removed with wire brush exposes workers to asbestos fibre. **MOL:08/12/80:** Lead exposure confirmed in the PVC compounding area. Although urine lead-levels did not exceed the TLV, inspector notes need for better housekeeping for cleaning up the compounding area with a vacuum cleaner rather than sweeping.

BUILDING: #22, 24, 26 **DEPARTMENT: TRACTION MOTORS**

General Description

Metal Machining

Resin Coating

Baking Resin Coated Parts

Brazing and Welding

Cleaning and Degreasing

Cleaning and Grinding

Sand Blasting

Power Washing

Powder Painting

Induction Brazing

Known Chemicals used or produced:

Arsenic

Decomposition by-products: BPAs, benzene, formaldehyde

Resins: vinyl toluene, glyptol

Detergents

Welding/Brazing fumes: flux core, hard wire, lead, silver, steel, silflex

Degreasers: MEK, TCE

Silica, sand

Dust/particles: asbestos, resins, metals, epoxy paint, silica, sand,

Building #22 (CIR. 1994-2004) **Department: Traction Motor Production**

Production Process	Chemical Exposure Risk
General Description: Traction motors is essentially an assembly operation of traction motors used to run locomotives and heavy equipment in mining operations. The operation ran 24/7 with 3 shifts, employing many employees. The operation produced 2 motors per hour—approximately 80 per week. This was a very intense operation that ran from 1995 to 2013 (18 years). The operation occupied the three buildings #s 22,24,26 that housed the wire and cable operation until 1980, and drive systems until1994. **The operation involved:** large scale machining, epoxy resin coating and oven curing, brazing and welding, cleaning, degreasing and grinding of parts, sand blasting, power washing and epoxy painting.	Summary: Inhalation and absorption of MWF (biocides) mists, metal dusts, degreasers, epoxy resins and thermal decomposition by-products such as BPA, formaldehyde, benzene, complex mixtures in welding fumes, brazing fumes such as lead, silver, silica dust, detergents, epoxy powder paints.
Metal Machining: Metal machining involved large scale drilling, boring, machining, cutting utilizing large amounts of cutting oils, cooling fluids collectively known as Metal Working Fluids (MWF). These vary in composition, e.g. some contain toxic biocides to prevent bacterial growth. The machining process generates large amounts of metal particulate as well as aerosols and mists of MWF. Heated fluids will also produce thermal decomposition by-products in the form of smoke. Focus group participants confirm that these were the conditions during the machine operations.	Inhalation and skin absorption of MWF mists and aerosols (some with biocide). Inhalation of metal dusts of fine airborne metal particulate. Inhalation and skin absorption of degreaser fumes. Risk factors include: poor local exhaust, heavy production schedule, poor PPE, poor PM. Symptoms: worker complaints and treatment for irritated eye, nose and throat, dermatitis. Atmosphere visibly saturated with mist and aerosol.
Resin Coating: Vinyl Toluene Resin coating of parts in Vacuum Pressure Infusion Tanks. These tanks were equipped with automated lids that slowly opened when process was complete and was provided with a lip exhaust system to capture vapours and fumes from the resin tanks. While an improvement over the older models, workers in distant departments would complain about the fumes from Fractional Motors reaching as far as buildings 16 and 14. Workers in Fractional frequently complained and experienced symptoms—headache, eye, nose and throat irritation sign exposure taking place.	Inhalation of uncured epoxy resin fumes during dipping process even though local exhaust provided at the lid lip of the VPI tanks. Fumes from wet parts being transported to the ovens for curing and baking. Odours were very strong from this operation and could be detected in other areas of the building as well as building 22. The strong odours were detected as far as buildings 14 and 16, indicating that fumes

Production Process	Chemical Exposure Risk
	were very dense during the dipping and curing operations. Exposure risk was high.
Baking resin-coated parts: Resin-coated parts were baked in ovens for 7.5 hours twice. These were large ovens that were not totally enclosed. During the baking process workers would squeegee resin around the parts to ensure resin penetrated thoroughly and evenly.	Inhalation of resins and thermal decomposition by-products from the baking process, e.g. BPA, formaldehyde, benzene, et all. Both the MOL and MOE investigated this operation frequently because of complaints. Workers symptoms: irritated eye, nose throat, dermatitis.
Brazing and Welding: Both brazing and welding were extensive. Welders would braze 20” long bars of copper using silver solder—“Silflex”. This produced large amounts of solder fumes throughout the area. Induction brazing would produce large amounts of fumes and smoke.	Inhalation of welding fumes from brazing. Inconsistent local exhaust ventilation. Poor general ventilation. Building was under negative pressure and low ceilings which, in combination with negative air pressure, tended to disperse contaminants to other areas.
Cleaning and Degreasing: Cables were cleaned and degreased with MEK and TCE. Residues would produce various decomposition by-products during the brazing process. There was the possibility of the formation of phosgene gas. Great amounts of vapour, fumes, and strong solvent odours reported by workers during cleaning process.	Inhalation and skin absorption of degreaser fumes and vapours as well as thermal decomposition by-products. Frequent complaints by workers of this degreasing operation.
Welding: There was extensive welding of various types in traction production. This involved MIG, TIG, Flux-Core, Hard wire, torch cutting of heavy steel. The welding area in building 22 involved welding braces to stators and balancing weights to rotors before machining. Cutting torches used to remove bridges from stators before machining. Extensive “torch brazing” was carried out at the “Brazing Tower.” These areas had heavy welding fumes and inadequate exhaust ventilation and frequent complaints. Safety inspectors conducted numerous investigations of worker complaints.	Inhalation of large amounts of brazing and welding process fumes. Likelihood of exposure high given the amount of brazing and welding and the lack of adequate local exhaust ventilation and general ventilation. While some ventilation hoods were provided they were not adequate to draw the fumes away from the welders. Consequently, the MOL was called in many times to investigate the “Brazing Tower” operations.
Cleaning and Grinding of Parts: Bore cleaning operations were subject of concern and complaints from workers about exposures to fine cured resin dust produced by the grinding and buffing operation to reduce high spots caused by excess cured resin in the bores. Workers would also sand and buff “spigots” and “tap holes.” This process produced great amounts of “brown powder” dust from cured resins. Workers were only provided paper dust masks.	Inhalation of very fine powdered resin dust from grinding, sanding and buffing of bores, surfaces, and tap holes. Powdered resins would also be ingested and absorbed through the skin. There was no adequate exhaust ventilation. Workers were provided with paper dust masks. Over the years workers ate their lunch at the workstations.

Production Process	Chemical Exposure Risk
Sand Blasting: Sand blasting with Silica of parts in enclosed cabinet was to prep parts for fitting. Parts were placed in automated blasting cabinet. When blast was complete the workers would open the door to remove the part. The workers would use compressed air to blow off dust from the part and surrounding surfaces and clothing. Workers describe this as a very messy process with grit and dust all over. This was difficult to maintain and they would have to continually add silica to keep the operation working as sand would become contaminated with other substances on the parts.	Inhalation of fine silica dust and other contaminants in the contaminated silica. Likelihood of inhalation and exposure is high given the volume of silica used, lack of exposure control and the use of compressed air to blow of dust on parts, machines and clothing, and the lack of adequate PPE.
Power Washing: Power washing of parts with a mix of detergent was done after machining and fitting. This produced a great deal of aerosol of detergent and degreasers. This work was done in preparation for powder painting with epoxy.	Inhalation, absorption and ingestion of aerosols containing detergents and other degreasing agents high.
Powder Painting: Parts were painted with epoxy powdered paint. Powdered epoxy paint was sprayed on heated parts (rotors) and then baked in an oven. This produced great amount of paint particulate as well as fumes from the baking process—thermal decomposition by-products from epoxy paints. Workers did not have adequate respiratory protection or local exhaust ventilation.	Inhalation, absorption and ingestion of powdered epoxy paint particulate as well as thermal decomposition by-products from the baking process. This latter issue might involve BPA, formaldehyde and benzene, et al.
Induction Brazing: Induction brazing in the “winding area” involved electrical fusing of solder with an induction current. This operation produced a great amount of smoke from the melted solder. While “smoke eaters” were provided they were fraught with frequent problems with clogged filters. Cleaning the smoke eater filters exposed workers to large amounts of residues from the smoke produced by the brazing process.	Inhalation of solder fumes and other degreasing residues on parts. Workers report frequent symptoms and complaints of irritated eye, nose and throat and headache. Workers also reported bad taste in mouth when cleaning ‘smoke eater’ filters.

BUILDING: #23 **DEPARTMENT: ELECTROPLATING**

General Description

General Work Tasks:

1. **Preparation of Tanks**
2. **Dipping and Racking**
3. **Periodic Monitoring**

Specific Process:

1. **Metal Pre-Treatment**
2. **Electroplating**
3. **De-plating or Stripping Process**
4. **Plating, Cleaning and Maintenance**

State of Industrial Hygiene Controls

Known Chemicals used or produced:

Beryllium
Degreasers
Detergents (caustic soda)
Graphite
Silica
Uranium Oxides
Zirconium (Nickel Zinc, Tin)

Building #23/16N **Department: Electroplating**

Production Process **Chemical Exposure Risk**

General Description: GE operated several electroplating operations (1950-95) over the years. Initially, plating took place at the NE corner of building 16 (25 years) then in 1974 moved to #23, a newly constructed building which was separate from the main GE buildings. Electroplating was closed down in 1995.

The building (#23) was approximately 25,000 sq. ft. with a basement waste treatment facility of 6000 sq. ft. The department employed 10 - 12 employees on one shift, 5 days per week.

There were between 5 and 6 large plating lines depending on client demand. These plating lines utilized approximately 85 dipping tanks with plating solutions of cyanide acid and various metal salts -- including two large vapour degreasing tanks containing trichloroethylene for various metals, and trichloroethane for aluminum. Additionally, the process included several acid and caustic soda baths for cleaning and etching, as well as rinsing tanks.

Each plating line used tanks of 100 to 300 gallon capacity. The small automatic plating line had eleven 30-gallon tanks and one 200-gallon tank. The automatic lines did not require operators to approach the cyanide tanks.

During its early operation, the plating department provided in-house plating services to GE's various departments. In the latter period, production increased as the plating department served a variety of customers requiring specialized plating for their products.

The various lines included: brass plating, zinc plating, chrome plating, nickel plating, and silver plating. Plating solutions contain various metal salts and acids, alkaline materials, and other additives to impart stability or functional properties to the solutions.

General Work Tasks:

1. Preparation of tanks:

General Description of Exposure Risks in the Plating Operation:

Pre-Plating Stages:

Exposure risks in the plating department were high, both daily and routinely given the following risk factors: Workers directly handled toxic solution ingredients in large containers pouring and mixing in the plating tanks (various forms of cyanide acids, mixed with various metal salts, formed the plating solutions). The risk of inhaling dusts, while pouring and making skin contact with powders and liquids during mixing and from spills was high.

Eating and smoking at the workstation put workers at risk of ingesting various toxins.

Workers also handled solvents, acids and alkaline solutions for pre-treatments of metals. There is risk of inhalation and skin absorption as well as ingestion due to the practice of eating and smoking at the workstation. Not having access to washing facilities increases the risk of ingestion of these toxins (See MOL inspection reports, 1986).

Workers were also exposed through inhalation and absorption, when leaning over plating tanks while retrieving baskets and racks with parts being plated.

Finally, it is important to consider the large volumes handled by these workers and the frequency of these mixing tasks as well as the provision of inadequate protective equipment (Audit, 1984, wearing of cotton not rubber gloves, not wearing eye protection).

Exposures During Plating

The following routine exposures are highly likely given the risk factors concerning inadequate local exhaust ventilation reported, the build- up of various salts caked on surfaces and exhaust systems, routine direct contact with the plating tanks and solution and identified poor housekeeping practices:

1. Metal salt mists generated above the electroplating baths containing chromium, nickel, zinc, silver, brass compounds;

Production Process	Chemical Exposure Risk

direct handling and preparation of degreaser and acid solutions for pre-plating; preparation of plating solutions to be dispensed from large drums into the tanks;

2. Dipping and racking:
This involved manual loading and unloading of racks or baskets; moving the (racked) parts from tank to tank -- usually with the help of an overhead hoist;

3. Periodic monitoring of operation:
Employees were required to enter the plating tank area to check on operating conditions of the plating baths and maintain level of solutions as required.

Note: Cyanides were purchased in 10 to 100kg containers, (e.g. silver cyanide in 10kg, zinc and sodium in 100kg). These chemicals were handled manually by workers while pouring into tanks to make, or maintain, plating solutions.

Dust and splashes during manual handling of powder frequently occur resulting in contamination on skin and clothing.

Note: several MOL reports and environmental assessments available identify this risk. Workers ate lunch and smoked at work- stations. No easily accessible washing facilities were available and no lockers to change clothing.

Specific Processes:

1. Metal Pre-treatment: Prior to plating, base metals were thoroughly cleaned to ensure adherence. This involved use of solvents, acids, and alkaline solutions. Degreasing solvents were used to remove grease, oils, etc. The plating shop had two large vapour degreasing tanks 8'x4'x6', one for trichloroethylene and one for trichloroethane. According to GE retirees, benzene was used to degrease in the plating laboratory area. Acid solutions used to remove metal oxides were referred to as pickling. Alkaline solutions were used to remove oils and solid soils through detergent action. These were sometimes agitated by the infusion of gas bubbles. These pre-treatment solutions were usually located at the beginning of the plating lines. Water

2. Acid/alkaline mists generated in the pre-treatment phase were very much present in the atmosphere as viewed as likely cause of severe corrosion of structural beams in the building itself. These were also indicated by workers' symptoms of eye, nose and throat irritation;
3. Cyanide mists, both cyanide salt mists and hydrogen cyanide mists, were likely air contaminants, given that both were naturally generated by the electrolysis process;
4. Organic Solvent vapours and mists were highly likely given that both solvents were contained in very large (8'x6'x4') vapour degreasing tanks. Both trichloroethylene and trichloroethane were present in the atmosphere.

In assessing exposure one must consider not only air concentrations, but also the fact that these solvents will be deposited on the skin and clothing, thus absorbed through the skin. And since workers were smoking and eating at the workstation, they also ingested these contaminants. One must look at the total burden and the chronicity of these exposures.

Given the conditions of workplace, the routineness of exposures, the direct handling and volume handled daily, then toxic exposures must be considered high from an industrial hygiene perspective.

The other contributing factor re: exposure risks has to do with the serious issues of poor housekeeping and maintenance, the improper storage of acids and cyanide, leaking tanks and drums of cyanide and acids, and improper labeling. The 1984 audit notes: "Allowing chemical salts to build-up on tanks, side shields, and in exhaust ducts openings. This accumulation of materials adds to the internal environment and increases employee exposure to hazardous substances See P. 4, consultants "Audit", 1984. (See: Briggs, 1984 below).

Maintenance and cleaning tasks increased the risk of exposure. Removing caked on metal and acid salts involves scraping and grinding which increases

Production Process

rinse-tanks were usually located between the various pre-treatment tanks.

Vapours and mists from the various treatment tanks were readily apparent, including a toxic mix of solvent vapours and both acid and alkaline mists and vapours. Workers reported heavy odours of solvents. According to workers, eye, nose and throat irritations were prevalent in the department.

Note: An engineering report indicated that structural beams in the building were significantly corroded from exposure to the various acid and alkaline vapours generated by both the pre-treatment and plating processes (reason for closure of plating).

2. Electroplating Process: During the electroplating process, an electric current passes through the plating solution resulting in the deposition of the plated metal on the cathode.

The electroplating process results in the release of hydrogen and oxygen gas bubbles, which, as they rise, entrain plating solution droplets. These are carried into the atmosphere and form a mist containing: cyanide; metal salts such as chromium, nickel, zinc, arsenic and cadmium; and acids, including hydrochloric acid, nitric acid, sulfuric acid, and chromic acid mists.

The generation and emission of these contaminants in the atmosphere depend on the current efficiency associated with the different plating solution, e.g. chromium plating is low efficiency of 12 to 15% resulting in severe misting, while nickel plating is high efficiency resulting in much less misting. Solvent emissions are also part of the environmental mix, particularly trichloroethylene below the TLV (See MOL report).

Asbestos:
Insulation on Crown plates frayed in some areas. Likely exposure to asbestos.

3. De-plating or Stripping Process: This involves stripping the base metal of previous coatings by dipping the metals in solutions of cyanide acid. This

Chemical Exposure Risk

dispersion of contaminants and risk of inhalation, absorption, and ingestion.

Potential exposure to cadmium, tungsten and cobalt noted by inspector (MOL:8/5/81). Recommendations made for good housekeeping and local exhaust ventilation and/or appropriate respiratory protection.

MOL:5/28/82: Toxic inhalation/absorption hazards noted and orders issued. Order#119 noted build up of cyanide waste over dyke under merry-go-round.

Given the lack of local exhaust ventilation noted in the MOL report cited below, it is highly likely that the workers inhaled cadmium fumes from the silver brazing operation.

Further evidence of exposure is the respiratory symptoms reported to the Ministry of Labour in 1981 and the subsequent issuance of orders to protect the worker from exposure to a toxic substance i.e. silver solder fumes and cadmium (See MOL:4/15/81).

Given the deficient state of engineering controls and the frequency and duration of exposure in tending to plating tanks, e.g., sampling solutions, dipping and removing plated materials from plating tanks, there was significant risk of inhalation and absorption of contaminants.

Production Process	Chemical Exposure Risk
is a hazardous process since it can readily generate hydrogen-cyanide gas (HCN).	

4. Plating Cleaning and Maintenance: Maintenance tasks included cleaning out slurry from clarifiers, removing various caked on plating salts from tanks and exhaust systems. These tasks were a significant source of exposure. Since an Audit called for increased cleaning and maintenance, the risk of exposure increased substantially.

5. Silver Brazing: The silver brazing area was located in the SW corner of Bldg. #23 and measured about 20'x12'x20' and shared the general ventilation system of electroplating department. There was no local exhaust ventilation. A pedestal fan was used to blow the fumes away from the worker.

One employee worked 40 hrs/wk. The work consisted of joining various metal parts (stainless steel, copper, brass, bronze, elkonite, etc.) with a natural gas torch at temperatures between 1300 to 1800°F. Most commonly used solders were: easy flow 45 (silver, copper, zinc, nickel and cadmium [24%]) and Easy Flow 3 (silver, copper, zinc, nickel and cadmium [17%]). Up to 50' of 1/16th used per shift. Fluxes included: Handy Flux A1 and Johnson Matthey Flux and Mattiflux 3A. The former contains fluorides and zinc chloride while the latter contains fluorides.

State of Industrial Hygiene Controls:

1. Engineering Controls: Local exhaust ventilation was provided, but an environmental assessment indicated serious deficiencies in exhaust ventilation including inadequate capture velocities and insufficient make-up air, starving exhaust from extracting contaminants.

Note: See several plating department reports identifying deficiencies in the local exhaust systems.

Examples include: Nitrous Oxide fumes from nitric acid because nitric acid tank exhaust not functioning properly; plating chemicals leaching out of exhaust ducts; exhaust ducts plugged with chemical salts; exhaust ducts partially blocked by chemical salts

Production Process	Chemical Exposure Risk
resulting in plating fumes and mists to contaminate the area (Harvey Briggs, Associated Environmental Consultants, "Environmental, Health and Safety Audit, Peterborough Plating Shop, Canadian General Electric Company, Peterborough, Canada, 1984).	
2. PPE/Housekeeping: Reports indicate that housekeeping and cleaning were not routinely performed. Evidence of improper storage of hazardous materials; staff wearing cotton, instead of rubber, gloves; not wearing safety glasses; employees smoking and eating in plating shop; workers leaning over plating tanks to remove plating baskets or racks while mist are being emitted all indicate poor housekeeping and safety practices. Briggs states: "Housekeeping and preventive maintenance at plating facility is a full time job and will require more than a Friday afternoon wash down" (P. 9, Briggs, 1984).	
(Harvey Briggs, Associated Environmental Consultants, "Environmental, Health and Safety Audit, Peterborough Plating Shop, Canadian General Electric Company, Peterborough, Canada, 1984).	

BUILDING: #24 **DEPARTMENT: FORMEX**

Formex Operation

Process:

Steps: 1-6

Known Chemicals used or produced:

Asbestos

Acetone

Enamels: Alkenex, Formex, Formes, Formex A1, HLM, ML, MLR

Fumes: enamel, degreasers, copper/enamel

Degreasers/Thinners: Toluene, MEK, Varsol, Acetone

Metals: copper

Thermal Decomposition By-Products: BPA, formaldehyde, benzene

February 5, 2017

Building # 24 **Department: Wire and Cable (Formex)**

Production Process	Chemical Exposure Risk
Formex Operation: Refers to applying enamel coating on copper wire. End product is Formex wire with varnish (enamel) on it. No MSDS available on "varnish" epoxies which included: Straight Formex enamel, Alkenex, Formex A1, MLR, Formes, ML, and HLM which were contained in 45 gallon containers and thinned with Toluene or MEK. "Alkenex" described as "the worst" was supplied by Davenport (likely the GE plant in Toronto on Davenport Ave). Operation involves 26 machines and 16 reels.	Inhalation of potent fumes linked to a number of brand epoxy "varnishes" including uncured epoxy fumes and decomposition by-products such as BPA, formaldehyde, benzene et al.
Process:	
1. Copper wire drawn through gas converter, which creates atmosphere of carbon monoxide circulation until proper thickness (diameter) is achieved.	Inhalation of copper fumes linked to heating and drawing through dies.
2. Next, wire goes through annealing oven to soften wire prior to coating stage. Gas coming off annealing is exhausted outside (system changed from water exhaust to catalytic converter due to neighbor's complaints of brown film on their windows).	**JHSC: 8/14/79: re: asbestos:** "Asbestos is used to stuff openings on annealing oven in formex. Alternative materials available!"
3. Wire then goes through vertical dipping process. Pump placed in 45 gallon drum containing heated (30°F) varnish which travels up and down a series of loops while coating copper wire -- excess varnish drips into large troughs.	Inhalation of both copper and varnish fumes during dipping and heating operations.
4. Wires then travel along vertical ovens at 3 different temperatures (150, 175, and 200 degrees). Three-inch gap between vertical ovens allows fumes to disperse.	
5. Workers regularly maintained sheaves (part of machine) from a catwalk above the varnish coating operation, by scraping excess varnish off the vertical "sheaves" 10-12 times per shift applying varsol and acetone by brush to clean them. They would "trouble shoot" by cleaning sheaves 1-3 times per hour without personal protection.	Inhalation and dermal (face, eyes, arms, hands) exposures to varnish, varsol, acetone, and muriatic acid, and perhaps other chemicals during maintenance activities.
6. Involved dipping sheaves in muriatic acid bath in 6'x5' open troughs, then drip-drying the sheaves for 5-6 hours. This later process created heavy vapours and led to frequent complaints of severe eye irritation.	

BUILDING: #26 **DEPARTMENT: WIRE AND CABLE**

Shaved Mill Operation

Butt Welding

Tin Pot Operation

Tar Pot Operation

Mercury Test Area

5-Inch Lead Press

Hassel Machine PVC Mixing Operation

Known Chemicals used or produced:

Asbestos

Coal Tar

Degreasers: TCE

Dromus Oil

Dusts: copper, asbestos, silica, flame retardants,

Fumes: brominated/chlorinated flame retardants, welding, degreaser

Granulated resin

Metals: Copper, Tin, Lead, Mercury, other heavy metals

Muriatic Acid

Pigments

Thermal Decomposition By-Products: phthalates

Building # 26 **Department: Wire and Cable**

Production Process	Chemical Exposure Risk
Shaved Mill Operations: Wire reels delivered to shaved mills (#131 and #132) by crane and lift trucks. Then Degreasing/cleaning of wire prior to and during shaving done in solution of TCE and "soap." Pails of solution is poured into large troughs and handled with cotton gloves.	Risk of daily exposure of workers to exhaust from lift trucks. Fine copper dust visible (from shaving process) that was swept or blown with compressed air. Workers noted dust up to 2" thick. Shaved mill and crane operators both exposed to copper dust and TCE solution. Bodies and clothes covered in copper dust that turned green. Complaints of burning skin and eyes. Workers often ate in work area.
Butt Welding: Welders spot-weld end of one reel of copper wire to another creating an "endless" reel. Process involved fusing of wire ends with electrical injection. Welders fused between 60 and 3000 lbs. of copper daily.	Daily exposure to welding fumes, and copper fumes. Butt-welding generated significant smoke and fumes. Vapour residue of degreasers on wire being fused.
Tin Pot Operations: Tinning of wire employed three pots of tin, with 6 copper wire reels on each side of pot. Wire was run through muriatic acid and a die and then run through a water bath to cool (done by machine). Process ran at 300' per minute. Note: when fumes exhausted through roof, trees in surrounding area were damaged as reported by supervisor in OCHOW report.	Significant chemical exposures from fumes from acid bath and tinning pots. Exhaust system shut down most of the time for "more efficient" cooling.
Tar Pot Operations: (one employee per shift dedicated to this job) Coal tar pitch applied to mining cables (cables used in mining operations). BX armour wrapped around cable then interlocked. Jute burlap treated with coal tar pitch applied and wrapped around the wires. Cables were 4"-5" in diameter. 10,000 feet of tarred cable produced per year.	Exposure to coal tar volatiles (molten tar pots). Exhaust system usually shut off (interfered with maintaining temperature of coal pots). Workers identified that "no respiratory equipment was provided." Numerous employees complained of, and were diagnosed with, lung complications in this work area (likely related to muriatic acid exposures and coal tar fumes). Lack of ventilation resulted in heavy accumulation of odors throughout the area.
Mercury Test Area: 4-5 operators per shift tested Formex wire for continuity. Wire was run through open mercury filled trough (10"x12"x1 ½). Workers used bare hands to draw hot wire through trough (wire was slippery). Noted neurological symptoms and thickening of nails in workers signs of mercury poisoning.	Biological monitoring carried out on workers in mercury test area. Those with high levels of mercury transferred to other departments. **MOL:06/7/73:** "large mercury globules noticed under machines." Mercury vapour measured at 0.04 to 0.05 mg/m³ at breathing zone; 0.01 to 0.02mg/m³ at floor level. TLV=0.05mg/m³. Urine analysis little or no absorption. Orders issued for: no eating, housekeeping, personal hygiene and urine test every 3 months. **MOL:09/17/75:** High mercury concentrations—0.06, 0.08,0.05,0.08,0.04 mg/m³ exceeded TLV. Employer failed to comply with previous order regarding mercury exposure. Recommend to re-issue order 3-month compliance deadline. No charges filed for non-compliance.
5 Inch Lead Press: Copper wire is run through troughs of molten lead (up to 20' in length) heated to 1300 degrees Centigrade. One worker-operated press that pulled wire through dies in lead filled trough while a second worker winds the wire (1/2 coating of lead on wire) onto reels. Winder wore asbestos gloves, breaking off excess lead. Dromus oil applied to avoid sticking in winding process. Lead pots manually fed	

Production Process	Chemical Exposure Risk
80 lb. ingots with bare hands. Exhaust usually kept off due to cooling which slowed down the process (which was costly to piece workers). Before winding onto reel, wire went through water bath that produced steam and mist.	**MOL:06/7/73:** Inspection re: mercury, lead and epoxy use. Mercury spills are apparent; lead levels above TLV/inadequate exhaust ventilation; workers handling epoxy resins without gloves or respirators. Evidence of epoxy related dermatitis noted. **MOL:08/13/73:** Air sampling and visual inspection "demonstrate that a significant exposure to mercury still exists." Asbestos cleanup not complete and area not fully enclosed. (Re: 5 inch lead press) Both workers exposed to lead fumes. Dermal and inhalation routes of exposure. Exposure Notes: The stripped off pieces of oil coated lead returned to pot where oil would react, creating heavy fumes. Workers ate their lunch in area with lead-covered hands.
Hansel Machine (1975) PVC Mixing Operation: Nine different colours and mixes used. Hopper (4'-5') manually filled with granulated resin. Machine extruded strips of PVC that were diced to form pellets. Dicer produced a lot of dust with heavy fumes created during the mixing process. This was a heavy PVC production area. In addition to vinyl chloride monomer this process used several tons of lead per month as well as phthalates, pigments, asbestos, silica, brominated/chlorinated flame-retardants, and various other heavy metals depending on the specified recipes	Exposure to chemical fumes and dust including: PVC fumes, VC fumes, phthalate fumes, silica, lead, flame-retardants, asbestos (up to 20 or more ingredients depending on product specifications). Dicer produced a lot of dust, as did loading the hopper. Workers exposed to heavy fumes during mixing process. Accumulated dust dry-swept and/or blown by compressed air. Exhaust system usually turned off. No gloves, safety glasses used by workers who often ate at their workstations. Exposure risks occurred during ingredient handling by opening bags, handling material, pouring material into hoppers, and during mixing and heating phase, during the extrusion phase, and during the purging and maintenance procedures. **JHSC: 12/1/78: re: PVC mixer malfunction:** Mixer unit overheated causing rapid decomposition of materials in process. Reaction gave off HCL acid fumes, which engulfed (worker) and partially incapacitated him. He managed to evacuate area and sent out for treatment. Letter sent to manufacturer re: installing of backup system to sense excessive temperature build-up with automatic cutoffs. **MOL:01/21/47:** "Girl Fettling Area"- located at west end of bldg.#26 noted high silica dust counts approaching TLV. Also, 8 of 9 air samples above the mercury TLV.

Production Process	Chemical Exposure Risk
	MOL:01/27/47: Overdue exams regarding employee examination for lead poisoning. Levels at lead pots: 1.0 and 0.3 mg/10m³ noted to be lower than TLV.
	MOL:05/05/47: "ideally, testing should be enclosed booth as spray painting." Need to keep close check on amount of mercury used. High loss (of mercury) indicates further checking necessary.
	MOL:10/31/47: Update on company's clean up of mercury: "some progress has been made". Request for toxicity information on PCBs but no information "found".
	MOL:02/24/49: Pyranol sampling: "amount found is higher in spots that we like."09/12/55: review of varnish coating process during the Formex process. Smoking in the workplace acceptable 10 and 20 feet from the varnish area. Name of varnishes difficult to read eroded print—'formex, invarek'.
	MOL:06/04/63: Mercury exposures in condenser checking area and formex testing area. Globules of mercury on switch boxes and floor. Evidence of continued mercury problem.
	MOL:12/16/68: Fluoride fumes from welding flux in brazing area using silver solder. Recommendation to test the air for fluoride fumes.
	MOL:05/31/68: Lead in the PVC pelletizing area. Test for lead fumes, but not results shown in building 26.
	MOL:10/16/69: Analysis of epoxy paint by MOL identified it contained uncured epoxy resin, pigment and solvent. Catalyst consisted of epoxy resin modified with amine and solvent. Epoxy paint contents: toluene, xylene, ethyl cello solve, and unidentified keytone. Catalyst contents: normal butyl alcohol, toluene and xylene.
	MOL:08/12/80: Tinning section identified as a confirmed area for lead exposure.

BUILDING: #30 **DEPARTMENT: BUS DUCT**

General Description

General Working Conditions

Cutting and Rolling Aluminum Sheets

Bus Duct Assembly

MOCA Production

Known Chemicals used or produced:

Asbestos

Chromate paint

Fibreglass

Welding fumes MIG, TIG

MWF

Ozone

Fire retardants

Etching chemicals

Vinyl wash,

Yellow zinc chromates

Green zinc chromates

Dasco tap

Epoxies: green and orange epoxy enamels, MOCA

Fumes: enamel paint, degreasers, aluminum/stainless steel/copper welding

Metal Dusts: aluminum, stainless steel, copper, tungsten

Solvents: TCE, 1,1,1-Trichloroethane, toluene

Thermal decomposition by-products: aluminum alloy, tungsten, magnesium, hexavalent chromium

Black fibreglass tape irathene tape

Building: #30 **Department: Bus Ducts**

Production Process **Chemical Exposure Risk**

General Description: The Bus Duct department was essentially devoted to the construction of 'bus ducts' which were electrical conduits housing copper bus bar conductors for high voltage transmission constructed with electrical grade aluminum alloy and copper bars. It employed 15 to 20 workers per shift.

This involved primarily aluminum welding and copper brazing as well as some stainless steel welding. It also required metal grinding, sanding, and planing -- as well as degreasing in preparation for painting. Upper levels of the building contained: machining, painting, degreasing, MOCA production, aluminum cutting, sawing, drilling and rolling.

General Working Conditions: There was little local exhaust ventilation particularly in the aluminum welding operation. Atmosphere was dusty, smoky and contained solvent odours and vapour. Housekeeping was described as poor. MWF use was high during aluminum machining and planing. MOCA production process was poorly ventilated. Ventilation was blown downward and was also affected by the negative pressure in the GE complex. Fumes (MOCA, MWF, welding) from the operation on the 3rd floor were sucked down the elevator shaft to the ground floor.

Cutting and rolling aluminum sheets: Aluminum plates were cut to size using band saws and hand held circular saws. Aluminum was treated with MWF. The cut sheets were then rolled with large rolling machines shaping them into bus ducts. The sheets were next deburred, bevelled and sanded. After cutting and shaping, aluminum was degreased by hand and prepared for welding.

Bus Duct Assembly: welding individual ducts together, using TIG and MIG electric arc welding assembled the bus ducts. 5 to 6 welders on each shift carried this out. This work produced large amounts of aluminum welding fumes as well as high concentrations of ozone gas and residues from degreasers. Welders were provided with 20" oscillating fans to blow the ozone away from the welders. This was problematic because it caused dust

Workers in this department were regularly exposed directly or as by-standers to the welding processes. This led to inhalation of aluminum and stainless steel welding fumes as well as fumes from copper brazing operations and vapours from solvents.

Welding Fumes and Gases: The aluminum arc welding operation involved TIG and MIG welding that produced heavy concentrations of aluminum alloy as well as tungsten and magnesium by-products from the intense heat. Aluminum also produced heavy concentrations of ozone gas. These emissions were not well controlled since there was a lack of local exhaust ventilation and no adequate PPE. Ozone gas is classified as a group 1 carcinogen by IARC. The operation of 20" fans to address the ozone gas only dispersed fumes and other contaminants to other areas of the building to be inhaled by other workers. Exposure to ozone gas was a frequent complaint from by-stander workers and welders. Consequently, welding fumes and ozone were blown around the building and sucked into the paint shop.

JHSC: 3/19/81: re: ozone: "Extremely high ozone reading. [It took] one pull when usually 5 pulls on drageur [test tube] and ozone reading went off the scale."

JHSC: 3/23/82: re: ozone fumes: "Air filtering system was installed but not enough masks for all workers. Airflow in bldg. causes heavy concentration of ozone at east end of bldg. where paint booth located. One worker constantly wears an air supply mask when welding is being done, even though he himself doesn't work on welding, saying 'he feels better since he started wearing it'."

Solvent Exposures: Workers were also exposed to various solvents that were used to degrease in preparation for welding or painting. These solvents such as 1,1,1 - Trichloroethane, toluene were applied by hand with soaked rags. These were inhaled in close quarters as well as being absorbed through the skin since they were applied with bare hands.

Production Process

and ozone to migrate to other workers. Respirators were optional and were rarely worn by welders.

Asbestos blankets were used during welding to protect plated parts from welding splatter. Welders lay on these blankets during welding and would be covered with asbestos fibres upon completion.

Solvent degreasers were trichloroethane, 1,1,1-trichloroethane, and toluene applied by hand cloth.

After welding bus ducts were cleaned in a Vinyl wash containing acid. These were then painted with zinc chromate yellow or green enamel paint as a finish coating. Paint spray generated heavy paint odours and vapours. A vertical exhaust fan was provided.

The paint booth used 5-gallon pails of acetone, lacquer thinner, naphtha gas, MEK and isocyanate paints.

It was noted in plant documents that the west end loading bay of bldg. #30 contained unlabeled 45 g drums of PCBs stored for shipping to Montreal.

Work conditions: Ventilation was poor. During winter, the air was heavily contaminated because natural ventilation from windows and doors was sealed shut. There was no local exhaust ventilation.

MOCA Production: MOCA was mixed and produced on the third floor of bldg. #30. This involved mixing the MOCA epoxy catalyst by hand in small batches to produce 6”x4” rectangular pucks. The MOCA catalyst came in drums in powdered granule form, which produced dust in the mixing process. These pucks were used and fashioned by hand to fit onto mining hoist drums in Bldg.# 10 south. MOCA is classified by IARC as a group 1 carcinogen.

Chemical Exposure Risk

Paint Exposures: These workers also painted bus ducts with chromate yellow and green paints along with pre-treatments with solvents. Chromate paints contain hexavalent chromium, which is highly toxic and classified by IARC as a group 1 carcinogen.

Exposure to asbestos dust was also a part of regular welding activity since asbestos blankets were used to protect plated parts from welding splatter. Welder exposed to asbestos fibre from lying on the blankets during welding process.

Metal Dusts: Exposure to aluminum and other metal dusts was also prevalent because of the major sawing and grinding of aluminum sheets for creating bus duct structures. The process of cutting, machining and grinding produced inhalable metal dusts throughout the department.

MOCA Exposure: The MOCA mixing and curing process exposed workers to a highly toxic polymer that is classified by IARC as a group 1 carcinogen. This was mixed without any exposure controls. Mixers as well as by-standers were exposed to this highly toxic material. Because they were handling this so intimately, mixers would be at greater risk of exposures. Management personnel were either unaware of its toxicity or were giving false information to employees. One worker described how a foreman took a handful of MOCA powder and stuck it in his face and saying, “you could put this on your breakfast cereal in the morning, and it wouldn’t do you any harm.”

JHSC: 10/11/79: re: MOCA hazards: “In an instruction sheet from OG White, Industrial Hygienist of GE Schenectady, (MOCA) workers are instructed to shower before changing to street clothes. Also, company to supply freshly laundered clothing for workers each shift. It is obvious that our fears regarding MOCA dangers were well founded.”

MOL: 12/13/78: Worker complaints regarding the generation of ozone gas during the MIG/TIG welding of aluminum. Ozone levels detected at 0.3ppm exceeded the TLV for ozone gas. MOL:05/28/82: No exhaust ventilation during pouring of molten metal operation on 3rd floor.

BUILDING: #34 **DEPARTMENT: STEEL CUTTING**

General Description

Steel Cutting

Steel Welding

Layoff Painting

Known Chemicals used or produced:

Asbestos

Cutting Oils

Glyptol white lead paint

Fumes: metallic silicate fluride (from flux), lead oxide (lead primer paint) ozone, carbon dioxide/monoxide (welding) varsol, cutting oils (MWFs)

Degreasers: TCE, Toluene

Dust: Metals: carbon, magnesium,sulphur, phosphorus, iron, silica, lead; Other: epoxy

Rust Inhibitors

Thermal Decomposition By-Products: phosgene, silicate fluride, zinc oxide

Varsol

Building: # 34 **Department: Steel Cutting**

Production Process **Chemical Exposure Risk**

General description: This department, employing 50-100 people working 2 or 3 shifts, was dedicated to cutting mild-steel plates with oxy-acetylene torches, which were then fit by grinding and assembled using electric welding. Plates could vary in dimension but were anywhere from ¾” to 4” thick and as large as 10’x20’. As well, these sheets were pressed into shape. The department had very large shears, a 100-ton press and a large rolling mill used to roll steel. This operation was moved into bldg. 34 in 1984 from bldg.14.

Steel Cutting: The steel was cut with large shears and a series of very large oxy–acetylene cutting torches (referred to as burners) that were mechanically maneuvered in a pre-determined pattern. Cutting oil, varsol, and rust inhibitors could be used in the shear cutting process resulting in chemical exposures in the form of vapours, fumes, and dust.

The building measured about 400x100x30 feet and was ventilated by doors and windows and a powered roof fan. Approximately 30 production workers were employed for 40 hours per week.

Steel Welding: The welding area measured about 30x40x25 feet. It is not separated from building 34 by walls and shares the general ventilation with this building. Smoke eaters were provided for welders but do not provide complete welding fume extraction.

Stick welding using flux-coated mild steel rod and shielded arc welding using uncoated steel wire and 75-25 argon-carbon dioxide are welding methods used. In the latter method, a flow of 30 to 45 cubic feet per hour of shielding gas is used.

Eight workers worked in this area and welding comprised at least half of their day. No respiratory protection was worn.

With up to three welding operations going on in addition to the large oxy-acetylene cutting, very heavy welding fumes were generated throughout the department. These fumes would migrate to other areas of the plant. Degreasing was also extensive for the preparation of sheets for assembly welding.

Workers in this department were chronically exposed to various welding fumes, primarily through inhalation.

Since workers ate at their workstations, dusts containing various metal compounds were also ingested. Evidence of accumulated dust on surfaces in the work area and on adjacent work surfaces in offices would indicate wide spread contamination and exposure to welding dusts and fumes.

Upper respiratory tract symptoms reported by workers indicate major inhalation of welding fumes and dusts. This is also supported by the fact that workers did not wear respiratory protection and that housekeeping was poor.

Local exhaust with smoke eaters provided limited protection and simply dispersed welding fumes into the general atmosphere of the workplace.

Mild steel alloys include carbon, magnesium, suphur, phosphorus, iron, and silica which are contained in both welding fumes and dusts in addition to by-products related to degreasers (TCE) and MWFs (e.g., varsol, cutting oil) used. Additional materials that create by-product fumes/vapours/dusts are linked to epoxy products such as the lead oxide primer paint used in layoff painting. There is strong evidence of significant exposures to these products because of the large size of materials used, thus large amounts of chemical products used/produced in work processes as the following MOL reports substantiate. Participants recalled a cluster of heart attacks among personnel.

MOL:09/03/82: investigation of worker complaint regarding upper respiratory tract irritation from welding fumes. Inspector confirmed over exposure to welding fumes but no specific component identified. CO test performed but no welding fumes tested. Recommended consistent use of portable local exhaust.

Production Process	Chemical Exposure Risk
There was inadequate local exhaust ventilation with smoke eaters providing limited exhaust ventilation; necessary respiratory equipment was not provided. Workers reported irritated eyes, nose and throat as well as headaches. A great many visits to the company hospital by the workers were for severe headaches. There was no ventilation in this building. It was always smoky, depending on the number of welders. Fumes would travel to the GPC area. This was a 200’ long building with welding and cutting soot on all surfaces. The office desks in the area would be covered in soot throughout the day. **Layoff Painting:** Lead paint was used to mark steel pieces where cutting was to be done. Painting was done by hand on layoff tables. Lead paint was thinned with naphtha. There were great quantities of lead paint, burners creating fumes, and major welding with MIG and ‘stick’ welding in bldg. 34. Asbestos blankets used where parts needed protection from welding operations.	**MOL: 11/18/82:** Investigation of worker complaint regarding welding fumes. Air concentration for welding fumes exceeded the TLV of 5mg/m³. Concentrations ranged from 1.2 to 6.5 mg/m³. **MOL: 12/6/82:** Investigation of excessive smoke and fumes from large burners cutting steel. No local exhaust ventilation. In fact, the smoke was not exhausted at all. No orders issued. Employer indicated it would provide smoke eaters in future. Worker health symptoms indicative of problems of over-exposure to welding dusts and fumes were identified in Joint Health and Safety Minutes In addition there was evidence of significant dermal exposure to lead paint and fumes, as large amounts of lead primer was used on steel pieces that could be upwards of 25-40 ft. in size. **JHSC: 12/8/81: Re: dust control in burner area:** “Write a letter to manager and ask him to experiment with next precipitator that comes in and see if we can come up with some sort of exhaust for burners area.” **JHSC: 12/8/81: Re: dermatitis:** “Report that employee working at layoff table has serious dermatitis from working with white lead paint. Notes Glyptol paint contains 2% lead.”
Balcony 2nd floor: This area carried out assembly and wiring, packing and shipping as well it had a small paint booth. Fumes and dusts from the operations below would migrate up to this area thus creating serious by stander exposures to these contaminants. This together with paint fumes from the paint booth and the production of Flamonal and other wires contributed significantly to these by stander exposures.	**Significant stand by exposures through inhalation.**

February 5, 2017

ADDENDUM 1

EXPANDED DISCUSSION OF THE QUALITATIVE METHODS USED IN THE GE RETROSPECTIVE EXPOSURE PROFILE STUDY

The purpose of this study was to develop retrospective exposure profiles of production processes at the GE plant in Peterborough, Ontario. This was prompted by what was perceived as an extraordinarily high rate of cancer among GE employees and the concerns of the former GE workers that the information gathered to date about exposures was not comprehensive and did not reflect the true extent of exposures and actual work conditions at the plant during their tenure at the plant. With the exception of a very comprehensive retrospective exposure profile study of two departments by Occupational Health Clinics for Ontario Workers (OHCOW) industrial hygienist, Sonya Lal, there was little information about exposure conditions. Up to that point what was relied upon were company work records, some company hygiene data and a narrowly based exposure matrix developed by the company industrial hygiene staff. In effect, there was little or no information gathered in a comprehensive manner to get an accurate picture of the day to day operations of the various production processes and the extent of exposures.

It was the view of the researchers that a comprehensive retrospective exposure profile of the plant's major production activity could be carried out utilizing a mixed qualitative research methodology. The researchers chose qualitative research design and methodologies because this approach would best provide a deep and rich understanding of the day to day operations by reconstructing the major production processes as experienced by the employees themselves (Brown 2003).

In essence, by reconstructing the production processes/product being produced, materials/chemicals used, detailed tasks carried out, and available exposure controls a "measure" of the extent of exposure could be developed via inferences based on identified risk factors for exposure (Brown 2003; Brophy et al. 2012). Increasingly, researchers in public and occupational health are turning to qualitative methods either on their own, or in conjunction with quantitative methods, to determine the impact of environmental and workplace contamination on human health (Brown 2003; Brown et al. 2006).

This option is most appropriate because it is able to account for the complex context in which exposures take place in the work environment such as work organization, work regimes, and power relations at the point of production, exposures to complex chemical mixtures and recognition of all routes of entry, and the functioning and availability of exposure controls (Keith et al. 2015; DeMatteo et al. 2012; Simcox et al. 2012; Boice et al. 1999; Steward et al. 1991). In contrast, much of the exposure context is left out of quantitative data related to the extent and probability of exposures.

The published works of many environmental and occupational health researchers using qualitative methods offer a compelling argument for the validity of qualitative approaches in health research. Qualitative research is context-dependent and up-close with the people and the phenomena being studied; it uses expository techniques and works to create an interactive dialogue between, and among, the participants, which acts as a check against bias and error. In this sense, the on-going social dialogue with participants provides a self-correcting process leading to verified knowledge (Brown, 2003). Additional relevant references consulted on qualitative methods include: MacEachen et al. 2016; Marano et al. 2000; McDonald et al. 2004; Morgan et al. 1998; Needleman and Needleman 1996; and Patton 1990.

Verification Methods Used in Qualitative Research:

This retrospective exposure profile study was designed and conducted in accord with validated qualitative research methods to ensure the generation of reliable and credible information about the GE production process -- and the interaction of workers with those processes. This was undertaken in an effort to construct exposure profiles for major production processes in each department.

The strength, or "rigor" of scientific research is achieved by meeting the conditions of both reliability and validity. This is true in both quantitative and qualitative research, but the route each takes is different (Kvale 1989). In quantitative research this is primarily achieved post hoc through statistical analysis of study results (i.e., calculating "p-values"). In contrast, qualitative research relies on the continual use of verification strategies from beginning to end because of the dynamic, interactive nature of this type of research. In practice this requires researchers to continually move between research "design and implementation to ensure congruence [i.e., a "good fit"] among question formation, recruitment, data collection strategies, and analysis" (Morse et al. 2002 p.10). Not surprisingly "investigator responsiveness" is viewed as essential, if not the most important strategy to ensure reliability and validity because it is the mechanism by which researchers identify and correct errors before they are built into a developing model. Other significant verification strategies or mechanisms used in qualitative research include: methodological cohesion, an active analytical stance, adequate sampling, and saturation (Cresswell 1997; Morse et al. 2002).

Participant Recruitment Process and the Formation of a Permanent Focus Group: The GE Retiree Advisory Committee:

An example of the investigators' efforts to achieve congruence among the various components of methodology mentioned above is reflected in the shift from the original research design of conducting 15 or more "one off" focus groups to a permanent, on-going working focus group and purposeful recruitment of other GE workers with special knowledge and experience. Based on pre-testing of the focus group approach, the investigators recognized the need to make adjustments to ensure that group composition and structure were appropriate in the context of a complex industrial operation as well as the nature of our information sources, and theoretical framework. Throughout the researchers were mindful of the need to follow a responsive/"iterative" process (Lincoln and Guba 1985).

In March 2016, an initial attempt to develop a retrospective exposure profile study of the GE plant was undertaken by a group of GE retirees and researchers using focus group methods organized around individual departments or areas. In an effort to recruit informants, the researchers and research coordinator made numerous presentations to retirees groups and provided signup posters that were displayed at community and retiree meetings to recruit GE workers according to the department or area where they had worked. Two trial or "pre-test" focus group sessions were held to test the questionnaire and data collection sheet. It was immediately evident that this "one-off" method of focus group interviews would not lead to an accurate and detailed documentation of work exposures in the GE plant due to the complexity and number of products developed and work processes employed over time.

Several meetings ensued among the GE retiree/research team to discuss problems encountered and whether there were other ways to conduct a more in-depth and detailed exposure profile study. After considerable discussion, a consensus was reached that a "permanent focus group" be formed made up of retirees and researchers who would commit to the time required to retrospectively document the work processes, chemicals and physical exposures, department by department, with the intention of inviting other GE retirees, with significant and additional information, to these group meetings.

It was also decided that alternate sources of information would be required in addition to what was to be provided by the focus group and key informants. These sources included Ministry of Labour (MOL) health and safety inspection reports, joint health and safety committee minutes, internal health and safety reports, material safety data sheets (MSDSs), technical production manuals . Many of these were provided by the former Local 524 union health and safety committee representative, John Ball, and supplemented by additional MOL reports via a Freedom of Information request. Subsequently, the union deconstructed these reports and placed the original documents and summary information on a database for these and other documents. This also included joint health and safety committee reports, MSDSs and internal memoranda and report. The process was aided by a set of hazard maps that were developed by OHCOW a few years prior and those developed by deceased retiree, Gary Lane and his colleagues, Jim Dufresne and Roger Fowler. These various documents would play a crucial role in the process of triangulation of the different sources of information in confirming the accuracy and reliability of informant information.

Securing a meeting space where the Advisory Committee was free to set its own hours and display the large GE departmental reference maps (and other materials associated with the project) was a major breakthrough. Once a local meeting site was established, the commitment was made to meet twice a week on Mondays and Thursdays from 1-4 pm (and as it turned out often as late as 6 pm) for the purpose of carefully documenting, building by building, the work processes and exposure risk factors at Peterborough GE.

Initially, the retiree component consisted of 3 women and 5 men, who had each worked at GE between 35 and 45 years. As a group, they were highly knowledgeable about many, and for some, nearly all departments (several as mobile welders, one as a job dispatcher who moved throughout the plant, another as part of a roving labour gang, and most having worked at multiple job categories throughout the GE facility over their work lives). In addition to these eight GE retirees, two retired health researchers acted as facilitators and quickly became immersed in the “GE environment” themselves. One of the retiree members served as study coordinator, taking responsibility for communications and minutes.

The framework for the group’s functioning was that it be open to other retirees or community members who might express interest and that as we progressed in our work we would seek out retirees with expertise in particular departments and/or work processes to ensure as complete and accurate information as possible would be documented. At one of the early meetings, a number (4) of GE retirees who had worked in the maintenance department were invited specifically because of their plant-wide experience and knowledge of numerous work processes as well as various maintenance processes that were relevant to exposures. During the process additional retirees joined the Advisory Committee.

For the first month or so, meetings became “educational sessions” for the two researchers to establish a “common knowledge” about GE, as retirees patiently described the basics of motor and electrical components production; introduced researchers to the physical and cultural environment of the GE plant through pictures, stories, and GE documents; shared generic videos of specific work processes; and sensitized researchers to the tremendous variation and number of motor/electrical-related products that were produced at GE over the period of time they worked there.

At the same time, retirees received an orientation into the basic principles of industrial hygiene, to ensure a common meaning to the structured and open-ended questions that guided the discussions of focus group meetings. This included concepts of (chemical) routes of entry into the body, the basic body systems and points of vulnerability to toxic chemicals and physical agents, and the hierarchy of exposure controls.

Over time, our “mainstay” Advisory Committee grew to 13 people as several other retirees joined. During the course of 8 months spent documenting work exposures at the GE plant, the meetings were attended by no less than 8 and as many as 15 participants for special sessions. Most meetings included 8-10 Advisory committee members. In addition to inviting other GE workers to meetings, information was obtained from retirees on a person-to-person basis and by phone. Meetings were focused, lively, and participatory and while there were some with greater scientific knowledge or experience related to the topic at hand, discussions were inclusive based on the high level of shared work experience among retirees.

Perhaps the most important characteristic of all who comprised the research team was a shared commitment to take whatever time was required to produce a high quality and accurate representation of GE work processes and the exposure risks these posed to employees. With this sense of dedication to accurately depicting the production process at GE, the Advisory Committee became a highly functioning research team. Team members soon became proficient in the methods of qualitative research -- in their mode of questioning, attention to detail, doggedness in getting the complete picture, sensitivity to negative or contradictory information, and importance of pursuing information through a variety of avenues. In all, more than 75 GE workers and/or family members contributed to this project. Their names are listed in Appendix 1. We approximate that together, those who participated represent between 2000 and 2500 work years at Peterborough GE. This was truly participatory research in action.

Theoretical Framework and Concepts:

This research design was guided by a theoretical framework that was based on concepts derived from the discipline of industrial hygiene with particular emphasis on risk factors affecting exposures. Our approach was a risk-based approach. That is, all efforts were directed to determining: the probability or risk of exposure given the manner in which production was carried out at the plant; steps or tasks involved in the production process; the materials used, how they were used; the quantity used, its physical state(s); the size of the products being produced; the existence and functioning of exposure controls; odours/smoke, symptoms; work practices; housekeeping; provision of protective equipment; health and safety training; knowledge of the hazards; work organization; the general atmosphere and work regimes. All of these factors contribute to the risk and probability of exposure.

In conjunction with the limited hygiene data available, these risk factors provided indirect measures in our efforts to reconstruct the exposure histories of the industrial processes. By "indirect" is meant that inferences about the extent of exposure could be made from detailed descriptive information about the interaction between the worker and the work process and the identification of risk factors. The researchers also took measures to account for the long latency period for cancer ranging from several years to several decades between first exposure and diagnosis. This involved profiling exposures dating back thirty or more years by exploring processes as they existed many years ago and tracing their evolution over time. In this latter regard, the investigators were fortunate because the GE work experience of the participants ranged between 35 and 45 years.

Conduct of Advisory Group Discussions:

Focus group discussions were guided by a series of both structured and open-ended questions on a department-by-department basis – which in turn were also guided by, and consistent with, the theoretical framework that informed the study design. As time went on discussion became less formalized as everyone knew what information was required and a more naturalistic dialogue took place, unless we had a visiting participant and then we reverted to the more structured approach. This process of group discussion went on twice a week for nearly 8 months, usually with the addition of other invited retirees because of their in-depth experience with certain processes within a department. The general set of questions asked of retiree informants included:

How many years did you work at GE?

How many years did you work in this department?

What was produced in your department?

Describe the major production activities in this department?

Give us a breakdown of the processes required to complete each of these products?

What materials and chemical were used in production?

What form did these take, e.g. liquid, mist, vapor, gas, dust or solid?

How much of the chemical was used, e.g. pint, quart, gallon(s), tanks?

How was the chemical applied, directly handled, by hand, close by, confined space, isolation?

How long did you use this chemical?

Describe how the product was applied?

Were there any odors, fumes or smoke?

Did worker show any adverse symptoms?

Was the government inspector called in, work refusal, complaints?

Was protective equipment provided, what type, was it used?

Was there local exhaust ventilation provided?

If so, was it working to remove contaminants?

What was the state of housekeeping?

What was the general impression of the work environment?

What were some of the obstacles to getting safety problems addressed?

Did workers eat, drink or smoke at their workstation?

INFORMATION GATHERING, DATA ANALYSIS, VERIFICATION METHODS

Advisory group discussions were documented through written notes taken by two researchers and the (GE worker) project coordinator. This was a practical decision due to economic and time constraints but was found to be advantageous. The notes generated were regularly compared for accuracy and clarification after committee meetings; often this would be done through phone conferencing. Discussions on the information gathered would focus on accuracy and what were felt to be gaps or inconsistencies in the accounts. These issues would be noted and brought up at the beginning of the next meeting for clarification, or the project coordinator would email members requesting further information or a review of relevant industrial hygiene literature prior to the next meeting. Upon reflection both research facilitators found the note taking to be valuable since it required active and focused listening at all times, and reinforced through repetition and sensory input complicated and detailed information about GE production processes to which the facilitators had only recently been introduced. In the course of documenting the meetings there emerged a growing "parallel" list of exposure risks that came to be viewed as "common" to all GE workers.

The dynamic of focus group discussions was lively and argumentative at times, with members often raising question about factual accuracy. Discussions were open, frank but respectful. The tenor of discussion produced a cross checking of facts and eventual agreement and consensus. This was a major strength of the focus group dynamic in that it was a check against error and personal bias—an important part of the verification process that went on throughout. A shared commitment to produce an accurate report on the work conditions in the GE plant underlie and tempered the desire to achieve consensus.

Attribution:

The descriptions of the production processes and work conditions are not attributed to any one individual. The information gleaned from the focus group process is attributed to the focus group as a whole including those who participated from time to time. The names of all participants are listed in Appendix 1.

Dynamic Interaction and Verification:

The nature of the dynamic interaction among participants contained its own verification process which acted as a check for accuracy and bias. There were occasions in which participants disagreed with another's account which would bring forward a lengthy discussion until the issue was resolved leading to consensus. Also, the researchers found that different participants often described similar accounts of exposure conditions or events independent of one another, serving to reinforce confidence in the accuracy of participants' recollections and descriptions of production processes.

Hazard Mapping Process:

The research methods incorporated hazard mapping techniques (Keith 2001; Keith 2004) in the utilization of several large 3'x4' block diagram maps with a floor plan of the locations of all departments. These maps depicted the layout of the plant, identifying various production processes and the location and use of various chemicals and other hazardous materials. They were posted on the walls around the room with two others placed on the conference table where we worked. Three types of maps were used to aid discussion. These included: A map locating major carcinogens used at GE, which was developed by OHCOW via participatory mapping sessions around 2004. Two other maps produced under the leadership of GE employee, Gary Lane with Roger Fowler and Jim Dufresne in 2015-16 identifying the departmental or area location of chemicals used, including solvent and resin tanks and certain production workstations. These latter (Gary Lane) maps represented two different periods of time and provided the location of major chemicals used in different production processes for these different time periods. These maps were vital to discussion and documentation throughout the conduct of the study.

With these maps as backdrop we asked focus group participants to describe the work flow, job tasks, chemicals used and how they used them, the quantities used, the sources of ventilation, etc. (See research questions above). Importantly, the researchers found that the graphic representation helped participants recall details and more clearly describe conditions.

Other Sources of Verification:

Another element of the research process that assisted in data verification was the addition of available documentation of conditions in the plant from external and internal sources. Included among these, was a collection of official GE reports, minutes and internal memos that were deconstructed for identification purposes and then inputted into Unifor's RAWC database.   Documents included: over 700 Ministry of Labour/ Department of Health inspection reports, Joint Health and Safety Committee Minutes, internal company correspondences, MSDSs, all of which have been entered into storage and retrieval data base by UNIFOR, the union representing GE workers.   These documents were used to provide additional information about the production process and to confirm or challenge conditions described by meeting participants.

Advisory Committee members also consulted the industrial hygiene literature for additional information on specific industrial processes. For example, we reviewed, in depth, the scientific industrial hygiene literature on electroplating processes, plastics production and welding operations. This could form the basis for discussion of similar processes in the GE plant to note similarities and differences. Despite claims by the company that chemicals were contained within "departments", memos from the company safety managers revealed and confirmed that the ventilation system was under negative pressure, causing substantial cross contamination between departments and processes. MOL inspection reports confirmed consistently poor housekeeping, and poor to non-existent local exhaust ventilation. These are noted in the main body of the report and the full inspection reports, memos, or MSDS can be easily retrieved from the Unifor RAWC database.

Issues Related to Adequate Sampling and Saturation:

Despite limited resources, other than Advisory Committee members themselves, a robust and methodologically strong resource for assessing workplace exposures was produced. The breadth and depth of the work lies in the fact that there were not two researchers on the committee but thirteen. In effect, the Advisory Committee "lived and breathed" this project for months, with individual members spending many additional hours on the phone, visiting people, searching the Internet, visiting local libraries, tracking down known sources of information that others held or might have access to, all to ensure that the information generated was as accurate and complete as possible -- given the complicated and continually changing workplace that was GE.

During the months spent writing up the report, the authors would often send out a request to the coordinator for confirmation or additional information and she would immediately email our request to other committee members. We were never disappointed and usually received more information or documentation than we asked for. For the most part those who participated were front-line workers; a few managers/leaders participated (though more were asked) and had first worked many years at GE outside of their management roles. There were areas and departments with fewer employees where it was difficult to locate past workers; they had died, moved, were ill, or not able or want to come to a meeting -- though some consented to phone interviews. Among committee members and invited participants were a number of workers with in-depth knowledge of the GE plant through their work experiences who were integral to work developing risk profiles.

The research facilitators were continually amazed at the high level of discussion and sophisticated knowledge exhibited by GE workers. They all viewed their years at GE as having been a tremendous education and knew they had been involved in work that reflected the "cutting edge" of the modern electrical age. As workers, they proudly described being "trouble shooters" that worked out problems in production or even developed new techniques that then served as a template for work processes at other GE plants.

The participants were scientifically astute and took personal interest in the work they and their co-workers did and could discuss the work processes of most other departments from a place of knowledge and interest. The work "ticket" system at GE allowed, and even encouraged, training in other departments, as a personal insurance policy against unemployment or as the opportunity to try something new, or seek higher pay. The majority took advantage by obtaining these additional "tickets" and their work records reflected positions throughout the plant.

There is a mistaken tendency to view "blue collar" workers as less informed and less thoughtful than the professionalized sector of society. While this could be no further from the truth given the dynamic encounter experienced in this study, this prejudice remains a major impediment for having their workplace health concerns addressed by government and company officials. Given the human and temporal limitations associated with this project, other than having access to GE's own detailed information on the Peterborough plant, the advisory committee believes they have done all that was possible to meet the requirements of "sampling adequacy" and data "saturation."

Sample Adequacy: In total, over 75 participants contributed information about plant operations generally, and details about individual departments or work processes. They represented every part of the GE facility and represented work experiences spanning 35 to 45 years and were thus able to give a dynamic picture of the plant over the years. This is a more than adequate sample to provide a comprehensive and accurate account of the production operations.

Saturation: The investigative group processes which took place over approximately 3 years and intensely for 8 months provided exceptionally rich, comprehensive and detailed information about the major production processes at GE. Researchers will always desire more information and never feel satisfied that they have "everything." However, it is without hesitation that the authors assert that the information gleaned from all sources—focus groups, one on one interviews, reviews of records, reports, etc. provided this investigation with sufficient information to provide a reliable and validated picture of the exposure conditions at the GE facility between 1945 and 2000.

Issues Related to Methodological Coherence:

Methodological coherence refers to the fit of the various components of qualitative research (sampling, interview questions, analytical procedures, specific audience or purpose) with the data. Morse et al. (2002 p. 12) note that "to meet analytical goals, the fit of these different components must be coherent, with each verifying the previous component and the methodological assumptions as a whole." Throughout this work the investigators remained sensitive to the fit between the various aspects of data collection and the purpose of this work which was to provide an alternative source of information on the risk of exposure to chemical and physical agents for workers at the GE facility (1945-2000). In addition, consideration was given to how this information could best be presented to provide a detailed but accessible exposure assessment that would provide a more realistic picture of workplace conditions. The final report and its structure can be viewed as an "organic" result of the methods of inquiry employed and industrial hygiene science viewed through a broad, historical, social science lens. By contextualizing work and work processes, we believe a richer and more robust picture emerges of the actual work experience of those employed at Peterborough GE during the years 1945-2000.

(March 29, 2017) Robert DeMatteo and Dale DeMatteo

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ADDENDUM 2

THE LIMITATIONS OF THE SCIENCE

In considering the retrospective exposure profiles some perspective is in order with regard to current interpretations attached to numerical exposure levels to various chemicals as well as the results of epidemiological studies. Firstly, there is the assumption that no harm should have come to workers if exposure levels were below the regulated occupational exposure limits or Threshold Limit Values set by the American Conference of Government Industrial Hygienist (ACGIH). Secondly, there can be the interpretation of negative epidemiological studies as indicating that there is no association between the disease and the chemical exposures studied.

In response to these assumptions it is important to recognize that the validity of these approaches is being challenged by a large and growing number of researchers in the field of occupational and environmental medicine. In what follows the authors present a summary of those critical findings that raise serious questions about the reliability of occupational exposure limits and TLVs for assessing exposures as well as the misuses and misinterpretation of epidemiological findings. While epidemiological study is a powerful tool in studying the relationship between disease and its causes, its methods must be carefully scrutinized to avoid misinterpretation of the results.

ARE THE OELS/TLVS PROTECTIVE?

General Background on ACGIH TLVs:

The American Conference of Government Industrial Hygienists (ACGIH) was established in 1938 at a meeting in Washington, D.C. This organization is known worldwide for the annual publication of its list of Threshold Limit Values for Chemical Substances (TLV-CS), developed by the TLV-CS Committee. Many governments have adopted these TLV guidelines as legal exposure limits.

Briefly, TLVs "refer to airborne concentrations of chemical substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working life time, without adverse effects. TLVs are developed to protect "workers who are normal, healthy adults" (ACGIH 2016). According to the ACGIH, TLVs are "developed as guidelines to assist in the control of health hazards" (ACGIH 2016). They are claimed to be the result of reviews of scientific literature by the TLV-CS Committee. While they are not legal limits, many have been adopted as such by governments around the world, including Ontario.

Early Criticism of the ACGIH/TLVs:

In a study published in 1988, Barry Castleman and Grace Ziem described the corporate influence on the development of TLVs. They explored the incentives for the chemical industry's promotion of higher TLVs allowing them to reduce regulatory and liability costs. Their research showed that the TLVs for numerous substances depended largely, and in some instances entirely, on unpublished corporate communications and reports which contained scientifically unreliable or unsound information. Their studies also document the industry connections of TLV committee members (Castleman and Ziem 1988; Ziem and Castleman 1989; Castleman and Ziem 1994).

Roach and Rappaport have also criticized the validity of the assertion that TLVs are health-based limits. In reviewing the annual (1976 and 1986) Documentation of the TLVs, produced by the TLV-CS Committee, only a minority of studies showed no adverse effects below the TLV. The authors observed that, to some extent, many TLVs represent what industry perceives to be technically feasible rather than health related (Roach and Rappaport 1990).

In a 1993 follow-up article, Rappaport argued that the Occupational Safety and Health Administration (OSHA) should adopt a speedier permissible exposure limit (PEL) approval process, so that unreliable/invalid ACGIH TLVs need not be relied upon as default limits. The author noted that the ACGIH TLVs are slowly being lowered, but more for carcinogens than chemicals that cause other serious health effects (Rappaport 1993).

Additional Studies:

Additional studies have been published that build on the themes put forward by Castleman, Ziem, Rappaport, and Roach. What follows is a small sample of the finding of these works: A quantitative international comparative study of exposure limits by Linda Schenk et al, identified the tendency for limits to decrease over time, but noted the wide variability between limits for the same chemical in different countries (Schenk et al. 2008). Another article described the Netherland's reassessment of exposure limits in the mid-2000s. While originally having adopted the ACGIH TLVs, the government's reassessment determined that over half the values were either too high -- or not scientifically supported as a health-based limit (Stouten et al. 2008).

Rappaport also identified that many occupational exposure studies have very small sizes or do not include exposure measurements at all. He identified that exposure measurements were most often included in studies that dated from the 1920s to the1960s (Rappaport 2009). Another article, co-authored by the same author (Rappaport and Kupper 2008), discusses the origins of, and debates surrounding, occupational exposure assessments, including the ACGIH TLVs and the US federal government's OSHA standards. The authors noted that following the critical articles of Castleman and Ziem, and Roach and Rappaport, the ACGIH changed its approach to TLVs, applying "more stringent health criteria as evidenced by the increased rate of reduction of TLVs, especially for carcinogens" (Rappaport and Kupper 2008). For example, the TLV for Benzene decreased 2.5 fold from 1957 to 1974, and then 20 fold from 1974-1997. The authors remain critical of the OSHA standard setting process on the grounds that it is interpreted as an average and not a limit, and that feasibility is sometimes judged by the standards of heavily polluting industries, even though the majority of industry could feasibly achieve a much lower PEL (Rappaport and Kupper 2008).

A short article by Castleman (2006) reviewed the adoption of the TLV for trichloroethylene (TCE). Illustrating a legacy of corporate influence on TLV development, he noted that the minutes of a 1981 meeting regarding the TLV for TCE were recorded on DOW stationary -- and that DOW was a major manufacturer of TCE (Castleman 2006). Importantly, with respect to reform of the ACGIH, Castleman further argues that: "even with the best motivations, it is simply beyond the resources of a volunteer committee, with little financial support…to repair the accumulated damage of so many years of flawed TLVs on the list" (Castleman 2006 p.308).

The other aspect of the impact of corporate influence is what renowned endocrinologists Frederick vom Saal called the "funding effect." In an extensive review of 115 in vivo and in vitro studies of the effects of Bisphenol A, 94 studies found significant effects. Thirty-one found significant effects at doses below the "safe" threshold. While no industry-funded studies have reported significant effects, over 90% of government funded studies did report significant effects. According to vom Saal and Hughes, some industry-funded studies used experimental rats that were not appropriate for studying estrogenic response and others ignored the results of positive controls (vom Saal and Hughes 2005). Nonetheless, chemical manufacturers continue to discount these published finding of positive studies because no industry studies have reported significant effects. Similarly, the work of Gennaro and Tomatic explores "business bias" in epidemiological studies and its influence on study outcomes (Gennaro and Tomatic 2005).

LIMITATIONS OF REGULATORY TOXICOLOGY AND ITS IMPACT ON STANDARD SETTING

Regulatory toxicology suffers similar tendencies to understate adverse effects as a result of questionable paradigms used for testing for adverse effects -- and is also vulnerable to corporate influence. This is played out in the current rift in the scientific community between regulatory toxicologists who rely on computer simulations called "physiologically based pharmacokinetics" (PBPK) modeling and health effects researchers, including endocrinologists, developmental biologists and epidemiologists, who draw their conclusions from direct observations of how chemicals actually affect living things. While the debate may seem esoteric, the outcome will have a significant impact on environmental and occupational health. It is shaping how government regulates environmental and occupational health and how workers are protected (or not) from toxic exposures -- as well as how we assess disease causation from these exposures (Brown and Grossman 2015; Huff 2007; Rappaport and Kupper 2008).

The origins of the PBPK testing paradigm (that uses computer simulations to track how chemicals move through the body) began in the mid-1980 among scientists at the Wright-Patterson Toxic Hazards Research Unit (a Department of Defense facility) at the Wright-Patterson U.S. Airforce Base in Dayton, Ohio. Known as in silico, these computer models are presented as an alternative to testing chemical in vivo (in live animals) or in vitro (in a test tube). They allow scientists to estimate what concentrations of a chemical (or its breakdown products) end up in particular organs or tissue, and how long they take to exit the body. This information can be correlated with experimental data, but sometimes is not. The simulation model testing is faster and cheaper for both industry and regulators, but it has serious drawbacks. A major problem is that, by itself, PBPK testing does not provide a picture of the health impact. In contrast, biological studies and experiments are designed to discover how chemicals interact and affect biological processes. Supporters of PBPK acknowledge that the method is always limited by the quality of the data that goes into the model. The problem is that modelling is vulnerable to the manipulation of data input as well as the final risk assessment, as both are subject to influence because of financial or other ties toxicologists may have with industry (Brown and Grossman 2015).

The literature is replete with instances where PBPK studies were used to make chemicals appear safer. For example, industry funded/associated research institutes such as CIIT/Hamner, utilizing PBPK modelling methods, have down played the risk and delayed regulation or implementation of more rigorous exposure limits for a number of widely used and commercially lucrative chemicals. These include formaldehyde, trichloroethylene, BPA, methylene chloride, styrene, acrylonitrile, and the pesticide chlorpyrifos (Brown and Grossman 2015).

Studies somewhat critical of current practices in occupational medicine and public health were published in a 2008 issue of New Solutions: A Journal of Environmental and Occupational Health Policy. Included was an article by Bohme-Rankin and Egilman identifying that "corporate science" is becoming more widespread, characterized by "manipulation of evidence, data and analysis [and], ultimately designed to maintain favourable conditions for industry" (Bohme-Rankin and Egilman 2008). In a similar expose/advocacy piece entitled "Industry Influence on Occupational and Environmental Public Health," James Huff provides numerous examples of the impact of industry influence on occupational and environmental and public health research by not only funding research, but in creating its own infrastructure for health research (Huff 2007). Similar observations have been made in medicine with respect to the pharmaceutical and medical technology industries (Angell 2009; Lexchin et al. 2003).

LIMITATIONS OF REGULATORY EPIDEMIOLOGY

In considering these different approaches to a comprehensive understanding of the health impact of exposures in complex industrial processes, a word about the inherent limitations of epidemiology and toxicology is in order. For example, epidemiological studies often suffer from poor research design, misclassification of exposures and insufficient statistical power to detect a risk to health. Together these factors are largely responsible for understating the extent of risk and premature conclusions for lack of association. For example, numerous studies reviewed by Goldberg and Lebrecht found non-significant excess risk because there was insufficient statistical power to detect a risk of a particular magnitude. In their review of 115 occupational breast cancer studies, these authors found that the median number of breast cancer cases was 19 with an average of only 64 cases. Only five studies had more than 100 cases. They note that even though 75% of studies had statistical power above 80% the small number of cases seriously limited the ability to detect risks in subgroups and test for exposure trends (Goldberg and Lebrecht 1996). The challenge for researchers lies in overcoming the inherent limitations of the dominant scientific paradigm for establishing causation.

The Case of the Peterborough GE Health Study:

These same scientific problems are associated with the Peterborough GE Health Study by Hosein and Ghiculete, which in its "Phase II" case control exploration, concluded that there was no association between the lung cancers identified among GE workers and the toxic chemical exposures at the plant, when in truth the study lacked the statistical power to detect such an increased risk. In this study the authors admit on page 47:

"From the table below we see that for an exposure variable with a prevalence of about 45%, in this study would have more than 80% power of detecting a relative risk of 2 or greater.

However, for an exposure variable with prevalence in the range of 5 to 10 percent we would have 80% power of detecting relative risk in the range of 2.5 to 3.0". (Hosein and Ghiculete 2003)

Thus one of the serious problems with the above study is its small samples size. Although the authors state the lack of statistical power accurately in the above quote, they do not identify this serious limitation in their conclusions. In effect, a true relative risk of less than 2 could not be detected as statistically significant. To detect a risk lower than two fold the study would require a considerable larger sample size.

The authors conclusion on page 78 stating that "…there was no association between lung cancer deaths and any of the carcinogens…" is misleading (Hosein and Ghiculete 2003). It would be more correct to state that there was no statistically significant association observed between lung cancer and any of the carcinogens. And it should further be explained that this result could arise because, in fact, there was no association or because there was an association that could not be detected due to the small sample size.   This is what, in epidemiology is referred to as a negative error—a study that (by design) cannot find an elevated risk that is, in fact, present.

Also, the GE health study likely suffers from serious misclassification of exposures, which is a major source of systematic error that can bias the study towards the null hypothesis. This assessment is based on the resulting retrospective exposure profiles of work processes and exposure conditions constructed in our study. This methodological problem has been explored in the epidemiological literature indicating that such errors can seriously understate the true relative risk (Dosemici et al. 1990; dos Santos 1999).

Making Cancer Clusters Disappear:

Making cancer clusters disappear is not unique to the Peterborough GE cancer cluster. A similar situation arose in 1979 when the U.S. Occupational Safety and Health Administration discovered a cluster of 23 primary brain cancers called glioblastomas among workers who worked at vinyl chloride plant owned by Union Carbide/Dow Chemical in Texas City, Texas. The main suspect was vinyl chloride (VC). According to OSHA, after investigating the cluster for 3 years, this was the largest cluster of brain cancers ever reported. During this time, industry studies were finding higher than expected occurrences of brain cancers at vinyl chloride plants, and in 1979 the International Agency of Research on Cancer had taken the unequivocal position that vinyl chloride causes brain cancer (Heath 2016).

Yet today, according to the Center for Public Integrity, “the scientific literature largely exonerates vinyl chloride.” After a second IARC review in 1987 which supported the brain/VC connection (IARC 1987), the Chemical Manufacturers Association (CMA) commissioned Sir Richard Doll to review published VC epidemiological studies (Doll 1988). While Doll found an elevated rate of brain cancers, he reported that these were not statistically significant, but did not report the confidence intervals (Doll 1988). Also Doll did not acknowledge his funding source, which was the Chemical Manufacturers Association (Sass et al. 2005). It is important to note that prior to this, evidence of a brain cancer association with vinyl chloride exposure continued to mount after 1988. For example, a 1991 study by industry researcher Otto Wong reported significant excess deaths from brain cancer and concluded that “this update confirms the excess in cancer of the brain and [central nervous system]” (Wong et al. 1991). Wong’s study was among four such studies to find excess of brain cancers among vinyl chloride workers (Doll 1988; Tabershaw and Gaffey 1974; Mundt et al. 2000; Wong et al. 1991).

However, two years later Wong published a retraction saying, “we conclude that our finding of an excess of brain cancer among U.S. vinyl chloride workers reported earlier was not likely related to the chemical” (Wong and Whorton 1993). It was noted that Wong was under heavy pressure from the Chemical Manufacturers Association to recant since he had not received permission to publish the study from the CMA (Sass et al. 2005).

To cast further doubt on the brain cancer connection, a 2000 industry review of brain cancer deaths at vinyl chloride plants found that the relationship between brain cancer and vinyl chloride “remains unclear” (Mundt et al. 2000). Based on that industry study and others, IARC reversed its position on vinyl chloride and brain cancer in 2008. It was apparent that misclassification of exposure played a significant role in suppressing the true elevated work-related mortality rate by manipulating the exposure criteria thus excluding most of the brain cancer deaths (Sass et al. 2005; dos Santos 1999).

According to David Heath of the Center for Public Integrity, “a Center for Public Integrity review of thousands of once-confidential documents shows that the industry study cited by IARC was flawed, if not rigged" (Heath 2016). According to their review, the study relied upon by IARC did not report all brain cancer deaths. In fact, they only included one of the 23 brain cancers in the original Texas City cluster, thus eliminating the cluster.

These flawed industry-sponsored studies, as well as the use of industry supported PBPK modelling for the U.S. EPA risk assessment process, played a large role in lowering the cancer risk from vinyl chloride exposures. The industry supported PBPK model estimated that the VC risk was 150-fold less than originally set by the EPA. In the final analysis, industry pressure and the intrusion of industry funded research as well as industry’s participation in both risk assessment and peer review processes was largely responsible for the lowering of the VC cancer risk assessment and elimination of the EPA regulatory protective adjustment factor (Sass et al. 2005).

Egilman and Howe demonstrate, through a critical review of a number of crucial industry funded studies, the vulnerability of epidemiological study to purposeful manipulation through systematic misclassification of exposures, questionable statistical analysis, and the misinterpretation of epidemiological results. They also note how the over valuation and reliance on epidemiology in determining causation has been at the expense of other types of scientific information such as case reports, analogy and pathology. They point out that both Bradford Hill guidelines and Koch's postulates do not make "…. epidemiology a requisite component in the process of determining that there is a risk" and neither espouses the superiority of epidemiology (Egilman and Howe 2007).

According to these same authors, "Epidemiological studies often suffer from design limitations that do not account for the inconstant nature of workplace conditions and exposure levels, the often delayed expression of disease, which can remain latent for 50 years or longer, and the fact that studies often omit minorities and women" (Egilman and Howe 2007). The authors warn that industry insistence that epidemiological evidence be paramount in determining health risk, and thus regulatory initiatives as well as tort and workers' compensation litigation, would represent a major setback for public and occupational health.

It is essential for those involved in the application of science to be sensitive to the ethical and methodological problems with science as well as its limitations. Science, at its best, is only as good as the current knowledge available and the quality and independence of research that informs that knowledge.

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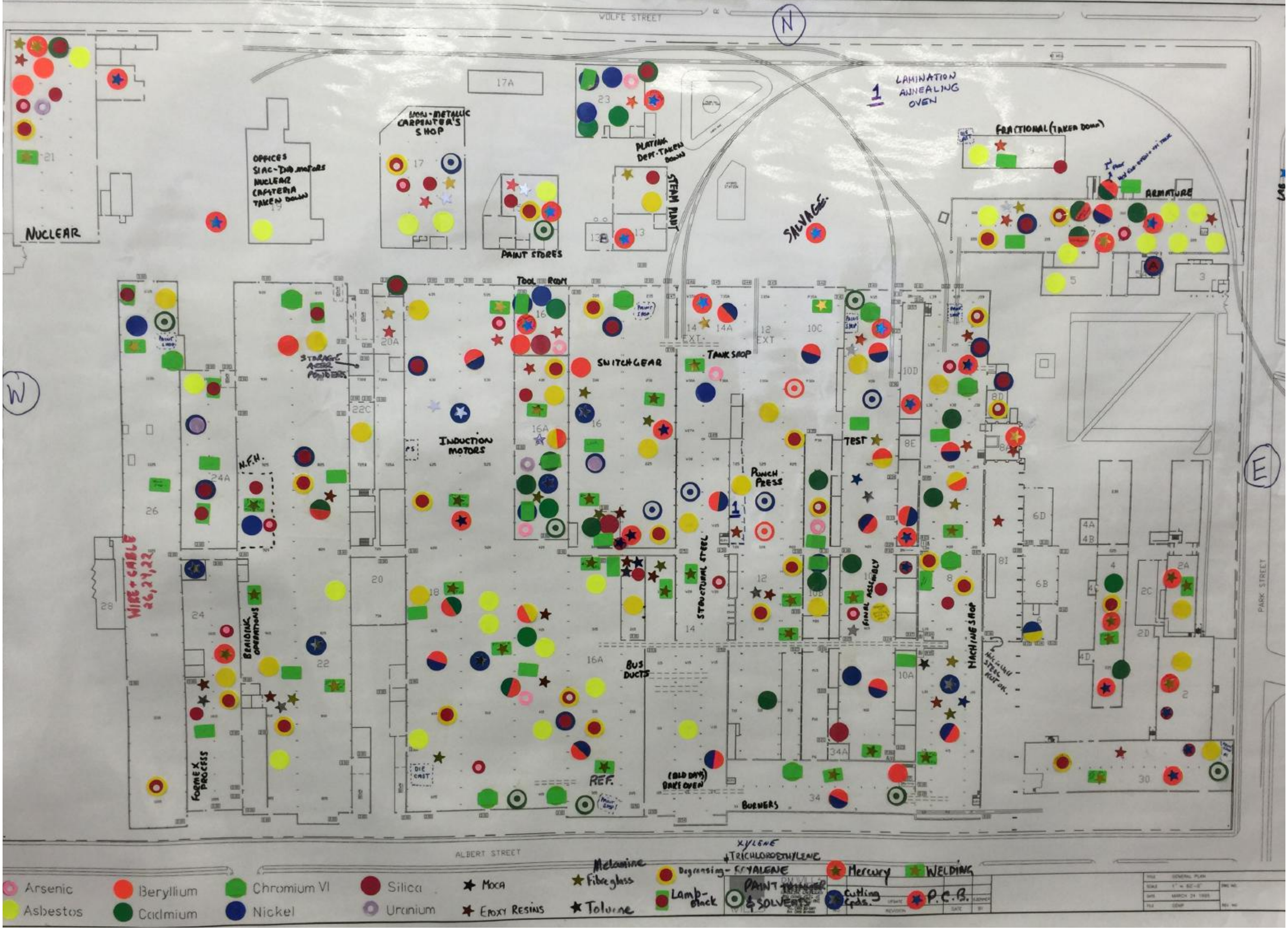
Intake Clinic Hazard Map: 2014



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