

Toxics in Electronics Manufacturing –

Highlights from the Fight for Safe Jobs and
Healthy Families in Silicon Valley and beyond

Lessons learned, current campaigns, future challenges

Presentation by Amanda Hawes, JD to Electronics Watch meeting

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Freedom from toxic exposure at work should be an enforceable human right for all working families.

Toxic chemicals don't care why or where they're used. If its in a chemical's "nature" to be developmentally toxic, mutagenic and/or carcinogenic there is a health risk whether the exposure is Silicon Valley, Silicon Glen, Seoul, Sevilla, Senegal, Santiago or Singapore and whether it's at work or in the community.

Workers deserve but do not get as much protection from toxics as the community residents do. The discrepancy is enormous and the most vulnerable suffer the most: workers of child-bearing age, workers with pre-existing conditions, and the offspring of exposed workers.

Health Protective ACUTE Exposure Limits (RELS) vs. Cal--OSHA Occupational Exposure Limits (OELs) (in effect for some chemicals toxic to development, CNS, blood and/or reproduction)

Substance	OEHHA REL	Cal OSHA OEL	Health Impacts	How much better are the RELS
<u>Benzene</u>	.0084 ppm	1 ppm	developmental, immune, hematologic	119 times
<u>EGMEA</u>	.028 ppm	25 ppm	Repro, developmental CNS	882 times
<u>EGME</u>	.029 ppm	25 ppm	repro, developmental	862 times
<u>Mercury compounds</u>	0.00001 ppm	.016 ppm	Nervous system: devlpmt	1600 times
<u>Methanol</u>	21 ppm	200 ppm	nervous system	9.5 times
<u>Methylene chloride</u>	4.03 ppm	25 ppm	Cardiovascular system; CNS	6 times
<u>Toluene</u>	9.81 ppm	10 ppm	Respiratory, nervous systems;	equal
<u>Xylenes</u>	5.08 ppm	100 ppm	CNS< respiratory system	20 times

EGMEA: ethylene glycol monomethyl ether acetate; EGME ethylene glycol monomethyl ether)

(If its hard to think in terms of "parts per million" try kilometers per hour - a speed limit of 10 kilometers per hour is a lot better than 10,000 kilometers per hour agreed?)

For a detailed examination of the gap between workplace and environmental standards for a large array of toxics see

"Occupational Health Hazard Risk Assessment Project for California: Identification of chemicals of concern, possible risk assessment, and examples of health protective occupational air concentrations" December 2007
<https://www.cdph.ca.gov/Programs/CCDC/DEODC/OHB/HESIS/CDPH%20Document%20Library/riskreport.pdf>

CHRONIC Health Protective Exposure Limits (RELS) vs. CAL- OSHA Occupational Exposure Limits (“PELS”) now in effect in California for some chemicals toxic to development, CNS, blood and/or reproductive systems

Substance	REL	OEL	main effects	How much better are RELs
Manganese (7439-96-5) &	0.0001 ppm	0.89 ppm	Nervous system	890 times
Mercury (7439-97-6) & inorganic mercury compounds	.0000037 ppm	.00016	Nervous system, development, kidney	43 times
Methanol (87-56-1)	3 ppm	200 ppm	Development	65 times
Methylene chloride (75-09-2)	.12 ppm	25 ppm	Cardiovascular; nervous system	208 times
Styrene (100-42-5)	.21 ppm	100 ppm	Nervous system	602 times
Trichloroethylene (79-01-6)	0.111 ppm	25 ppm	nervous system	225 times
Toluene (108-88-3)	.079 ppm	100 ppm	Nervous system; development	1265 times
Xylenes: technical (1330-20-7) o-xylene (95-47-6), m-xylene (108-38-3) and p-xylene (106-42-3) isomers.	.16 ppm	100 ppm	Nervous & respiratory systems; eyes	625 times

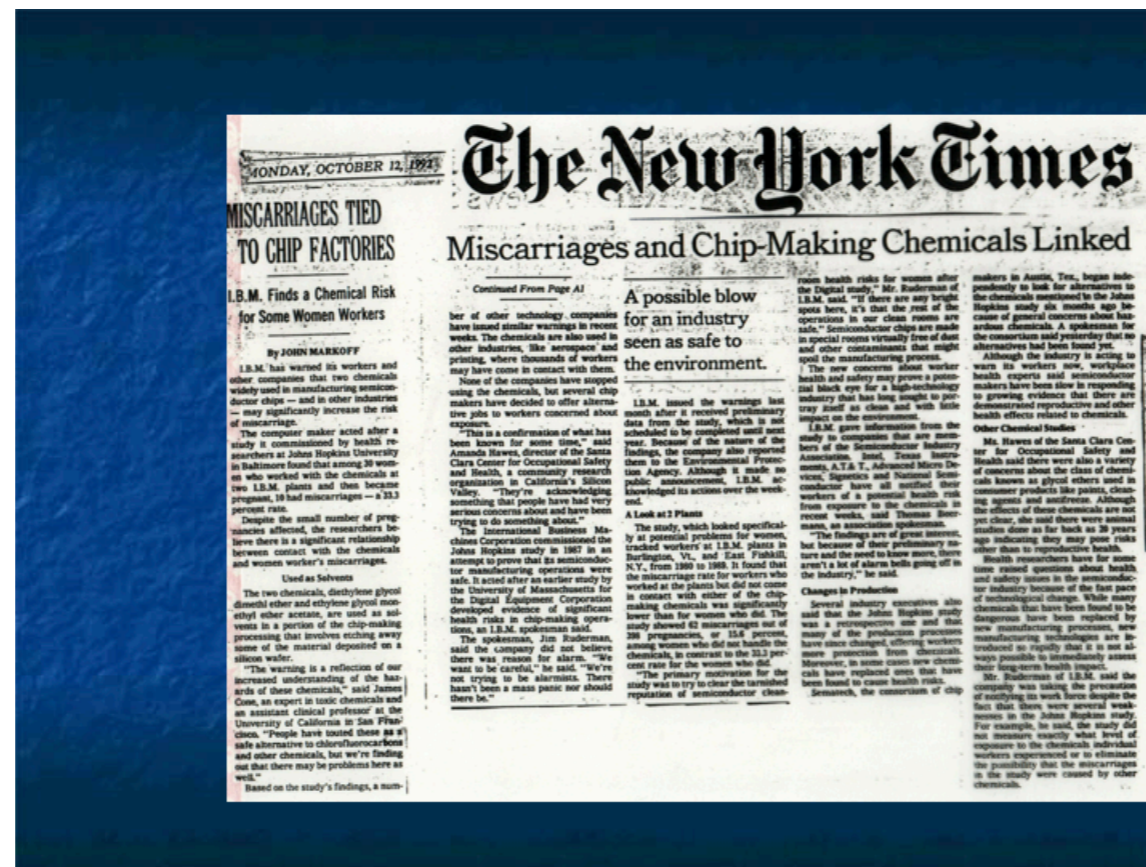
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The Consequences to electronics workers (1)

- This indefensible disparity has huge consequences in electronics and semiconductor manufacturing—as workers are routinely exposed to multiple toxics and effects are likely additive if not synergistic.
- A number of these toxics have long been known to pose reproductive and developmental threats at low levels. Rather than learn from history, the electronics industry has too often ignored the evidence and put trusting workers in harm's way



The Consequences to electronics workers (2)

- Two large US studies in the 1990's showed that compliance with OELS for toxics in semiconductor fabs provided no protection against high miscarriage rates. The miscarriage rate was significantly elevated even when exposure levels were barely 1% of the individual chemicals' OELS
- Worse, exposure capable of causing total fetal loss (miscarriage) is more than enough to cause devastating and irreparable birth defects in a fetus who survives gestation

THE USE OF TCE AS A DEGREASER IN ELECTRONICS ILLUSTRATES THESE CHALLENGES TO WORKERS AND THEIR OFFSPRING AND OFFERS GUIDELINES FOR PREVENTION

Years before TCE was used to degrease electronic components, it was a well-documented cause of miscarriages and adverse reproductive outcomes in operating room workers exposed to trace levels of TCE vapor escaping the intended audience: patients inhaling TCE to induce general anesthesia. In 1974 the Chief of Anesthesiology at Stanford University published a book on the adverse reproductive effects of TCE, fluorinated hydrocarbons and other anesthetic agents electronics firms were then using as degreasers. Though its workforce was (and still is) mainly women of child-bearing age, the electronics industry ignored Dr. Cohen's urgent warning and TCE and various so-called safe-substitutes continued as degreasers of electronic components that, once used, were then dumped into the environment--contaminating Silicon Valley drinking water and causing harm to children and adults. While outrage over the industry's role in creating horrific "superfund" sites brought swift and effective environmental sanctions, our efforts to secure real protection and just compensation for workers and their offspring harmed by TCE and other toxics has faced relentless industry resistance, intimidation, and funding fights – short-sighted tactics that prolong suffering and deprive workers of chances to avert harm to themselves and their offspring in the first place. We can do better .

SCCOSH campaign to Ban Trichloroethylene—lessons learned

- In 1977 when animal tests showed TCE was carcinogenic SCCOSH sought a workplace ban. In spite of huge industry protests, Cal-OSHA lowered the OEL from 100 to 25 ppm; many firms shifted to other cleaners. Our campaign was an early wake-up call to an industry known for touting its technological “genius” as some sort of twisted justification for ignoring workplace hazards.
- Meanwhile as workers fought headaches, nausea and dizziness as they used TCE and other solvents to degrease electronic components, their employers dumped the used toxics on the ground and into leaking storage tanks. Some got into water wells and sickened area residents; some migrated through porous soil and thru “vapor intrusion” penetrated occupied spaces posing a health threat that our EPA took very seriously, setting an action threshold of 5 ppb – **five thousand times tougher than Cal-OSHA’s history-making PEL of 25 ppm for workers.** But though 25 ppm has long been the toughest workplace standard for TCE in the world, it is nowhere close to any health-protective standards in effect for the community as a whole.
- ***Lessons learned*** Given the limitations of all OELs, the developmental toxicity of TCE and TCA, and that electronics workers are routinely exposed to multiple toxics, we knew from the start that our TCE campaign was just step one in the fight to secure safe jobs and healthy families.

The TCE Campaign - June 3, 1980

<https://icrtco.wpcomstaging.com/>

http://icrt.co/pdfs/1980_06_03_ECOSH%27s_next_goal_outright_ban_on_TCE.pdf



High birth defects rate in spill area

Los Paseos residents 'convinced' toxic leak caused birth defects

By Mitchell Benson
 and Pamela Kramer
 Mercury News Staff Writers

Wednesday after county and state health officials released a study of the Pajero neighborhood that showed an excess of miscarriages, congenital heart abnormalities and total birth defects in 1980 and 1981.

The officials couldn't say definitely that a chemical leak that contaminated the South San Jose neighborhood's water supply was responsible for the birth defects and miscarriages. But the Pajeros don't care. The couple is convinced it was that.

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Highlights of studies

- About twice as many miscarriages in the Los Paseos neighborhood in 1980-81 as in a nearby control neighborhood that has had no known water contamination.
- About three times as many birth defects in Los Paseos in 1980-81 as in the control neighborhood.
- More than twice as many major heart defects among infants born as a result of pregnancies in 1981 in the area served by the Great Oaks Water Co. as in the rest of Santa Clara County.
- The studies do not indicate the causes.

For the state health department's full summaries of the findings, see Page 6A.

Site near S.J.'s Fairchild plant shows cluster effect, state says

By Susan Yocum and Mitchell Benson

Staff Writers

A study released by the state Wednesday confirmed that an unusually high number of birth defects and miscarriages occurred in a South San Jose neighborhood near a contaminated Jose area served by the Great Oaks Water Co. than in the rest of Santa Clara County.

The study, conducted by the state Department of Health Services and the Santa Clara County Health Department, focused on pregnancies in the Los Paseos neighborhood, near the Fair-

child Camera and Instrument Corp. plant, in 1980 and 1981.

A related study by the same agencies that also was released Wednesday showed that the rate of a specific form of birth defect, congenital heart malformation, was higher in the South San Jose area served by the Great Oaks Water Co. than in the rest of Santa Clara County.

The unusually high cluster of miscarriages and birth defects is only the second that state officials have ever con-

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The huge disparity between levels of reproductive toxicants allowed for workers compared to levels deemed unsafe for the community, called out more than 30 years ago when researchers contrasted the solvent levels in drinking water with typical levels of toxic exposures for electronics workers, is one of the clean industry's dirtiest secrets. Here is what Drs. Rudolph and Swann tried to get doctors and others to understand in 1986:

“The contamination of well water by TCA (1,1,1 trichloroethane) in these studies occurred at levels substantially below the exposure levels likely for production work in the electronics industry. Electronics workers, exposed at the current standards, would be at risk of exposures at least 1000 times those received in the Great Oaks Water Company Service Area. In addition, electronics workers have many simultaneous exposures to other substances associated with adverse reproductive outcomes.”

— Drs. Linda Rudolph & Shanna Swan, in "Reproductive Hazards in the Microelectronics Industry". page 135-136 in The Microelectronics Industry, State of the Art Reviews, by Dr. Joseph LaDou, 1986

Neurotoxic chemicals and the Vulnerability of the developing brain

Granjean and Landrigan's "Developmental neurotoxicity of industrial chemicals" (The Lancet, Nov. 8, 2006) lays out the danger of exposing a fetal brain to toxics in succinct, graphic terms that are the driving force behind the [Friends of Mark](#) Campaign

The developing human brain is inherently much more susceptible to injury caused by toxic agents than the brain of an adult. This susceptibility stems from the fact that during the 9 months of prenatal life, the human brain must develop from a strip of cells along the dorsal ectoderm of the fetus into a complex organ consisting of billions of precisely located, highly interconnected, specialized cells. Optimum brain development requires that neurons move along precise pathways from their points of origin to their assigned locations, that they establish connections with other cells, nearby and distant, and that they learn to communicate with other cells via such connections. All these processes have to take place within a tightly controlled time frame, each developmental stage has to be reached on schedule and in the correct sequence.

Because of the extraordinary complexity of human brain development, windows of unique susceptibility to toxic interference arise that have no counterpart in the mature brain, or in any other organ. If a developmental process in the brain is halted or inhibited, there is little potential for later repair, and the consequences can therefore be permanent

The Case of Mark Flores

Yvette Iturralde Flores' first job was fusing laser tubes with "gunk" she made by mixing an odorless green powder with a clear liquid; she used a blow torch to speed up the fusing process; she got \$2.70/hr. Her small work area had no local ventilation; her paper mask did not keep the green powder out of her nose. Though she was never told what the green powder and the clear liquid were, her employer told her she was not just safe but actually fortunate to have this job.

In 1977 she miscarried in a company bathroom; though her employer knew of her miscarriage, it did not change her assignment or provide any effective respiratory protection, so Yvette did the same job while she was pregnant with Mark. Today, he doesn't know the difference between a toy truck and a real one. He knows his name and that his Mom loves him.

In 2013 Yvette's employer settled her claim for her son after I uncovered the ugly truth of the powder and liquid Yvette used throughout Mark's gestation with no respiratory protection: the liquid was **methanol**; the powder was "frit" and was **62% lead**. *

The Friends of Mark Campaign seeks to determine how many developmentally disabled adults in Silicon Valley (and beyond) are the children of electronics workers, to hold the industry accountable for the cost of their care and to share the findings with working families and their advocates so this devastating and preventable harm stops.

**** For further details on my work of identifying in utero toxic exposures as factors in developmental disability see eg***

<https://publicintegrity.org/workers-rights/the-impenetrable-world-of-mark-flores>

and

<https://www.aljazeera.com/indepth/features/2017/10/73-year-tech-giants-171019065859899.html>

Friends of Mark Campaign



Darryl and his clocks



**Additional References, Campaign Results and
rationales for Future Initiatives**

- **Background** The history of efforts in Silicon Valley to identify and reduce health hazards in electronics manufacturing can help researchers, health care providers, worker organizations, regulators, and non-governmental organizations in efforts to ensure that current and future electronics production work is safe for employees and their families.
- **Methods** Starting in the mid-1970s, occupational health professionals, non-governmental organizations, the Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health staff have tracked chemical use patterns and occupational exposures, advocated for strong “right to know” laws, supported hazard awareness training of both workers and general medical practitioners, supported epidemiologic research on cancer and reproductive impacts, and provided relevant expertise in compensation claims by workers and/or their children.
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What Exposure Level is Safe? What we Know, and Don't Know... Notes from Inside Standard Setting

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Conclusions

Despite the fact that these findings were later confirmed in an independent study by other researchers at a different company, OELs have not been appropriately revised.

Unfortunately, this inaction is not uncommon as exposures to “low concentrations” of chemicals are increasingly recognized as causing serious health effects, especially carcinogenic, immunologic, reproductive and developmental effects.

Regulating carcinogens and reproductive toxins in the workplace - some of the challenges and scope of work to be done

- A decade ago California's Office of Environmental Health Hazard Assessment OEHHA identified workplace chemicals listed on the state's Proposition 65 as "known to cause cancer or reproductive/ developmental harm" and found that **60% of workplace chemicals suspected of causing cancer or reproductive harm are high production volume chemicals** (produced or imported at more than one million pounds per year in the US) and **no California OELs have been established for 44 known carcinogens used in workplaces**. In addition, **of the workplace carcinogens with established California OELs, 62 are not regulated based on their carcinogenicity, but rather, for another health endpoint, e.g., irritation**.
- Finally, **the risk of cancer for six workplace chemicals was estimated to be greater than 10% for workers exposed at the California OEL**. The reasons for this inaction include protracted rule-making and active opposition by interested parties through available legal actions, as well as intimidation of nonprofit organizations such as the American Conference of Governmental Industrial Hygienists, which established the Threshold Limit Values®, which are the most widely used OELs on a global scale. More subtle approaches include encouraging both the European Union and the United States to discontinue efforts to establish lower OELs based on reported cessation of use, as occurred with ethylene based glycol ether solvents implicated in epidemiologic studies.

CAMPAIGN FOR TRANSPARENT WORKER HEALTH SURVEILLANCE

In the 1990s I discovered that IBM had a **Corporate Mortality File** that contained cause of death information for over 30,000 workers based on the death certificates family members applying for death benefits had to give IBM to qualify for survivor benefits. After a fight over data access and publication of epidemiologic analyses, manufacturing workers' significantly elevated rates of death from brain cancer, lymphoma, and breast cancer became public. Workers at several IBM sites pressed for protections denied them for decades including

- * **Health surveillance** of all workers with transparency of results
- * **Reduce exposures** to toxic substances NOW as part of **transition to non-toxic substances** in all processes
- * **Compile and publish cancer maps** of areas around computer manufacturing plants where employees are likely to reside.
- * **Fund to alleviate medical burden** on affected IBM employees and their families.

Lesson Learned The IBM CMF findings have provided an important precedent for electronics workers in Asia contending with similar disease patterns and recalcitrant employers. But IBM could and should have employed basic principles of health surveillance and regularly disclosed the patterns of mortality the data

Doing so would have afforded opportunities to change and improve working conditions in a good-faith effort to reduce high rates of cancer mortality not only at IBM in the US but beyond. As much as the families of IBM decedents appreciated legal help uncovering these data and holding IBM accountable they would have preferred that their loved ones' jobs did not condemn them to early and horrible deaths from cancer that sound health surveillance might have prevented. The families of young electronics workers in Asia exposed to similar conditions and succumbing to blood and brain cancers have expressed a similar wish.

Clean rooms and miscarriages

“new concerns ... may prove a potential black eye for a high technology industry that ... sought to portray itself as clean and with little impact on the environment. Women exposed to certain chemicals ... in the nation’s semiconductor factories face a significantly higher risk of miscarriage, a broad industry-financed study has found. The study is the 3rd in 4 years to find that glycol ethers have toxic effects. ” NY Times Oct 12 and Dec. 4, 1992

Quick Quiz – In the wake of the reproductive hazards these miscarriage studies revealed what did the electronics industry **NOT** tell its workforce of predominantly women of child-bearing age?

For starters, workers were not informed that the levels of exposure to glycol ethers and other toxics associated with these high miscarriage rates were barely 1% of their “permissible exposure limits” for the workplace OR that

toxic exposure that causes miscarriage can also cause a much worse effect - fetal damage that is not lethal but is irreparable – with damage to the fetal brain being among with worst such harm.

How the Friends of Mark Campaign can help

- Since 1978, the research version of all California birth certificates must list parental occupation and industry of the newborn child – so potential workplace exposures *in utero* can be part of any assessment of health issues in offspring – those apparent at birth and those emerging over time.
- Windham's "Use of Birth Certificates to Examine Maternal Occupational Exposures and Autism Spectrum Disorders in Offspring" (Autism Research 6:57-63 (2013) show the utility to etiologic investigations of having access to parental occupational data that can in turn be coded by exposure/chemical groups based on potential neurotoxicity or reprotoxicity.
- Ascertaining what portion of the population of developmentally disabled adults are electronics workers' offspring may open up a way to hold the industry instead of the public accountable for the cost of their lifetime care. (For precedents see actions against tobacco big pharma for the cost of care due to smoking and opiod addition.)
- The Campaign could also incentivize developing countries to set and enforce health-protective exposure standards for electronics manufacturing - compared to the lifetime cost of caring for folks like Mark replacing notorious toxics with safe alternatives seems pretty smart.

What will it take and how long will it take for the community as a whole to bring a health protective perspective to workplace toxics ? At this point most people who count on their family's drinking water being safe and also like smart phones and other consumer goods are unaware of the huge discrepancy in protection against toxics at work versus the general community

If made aware, would they try to help end the disparity and if so how?

What if making electronics production safe for workers raised the cost of a cell phone by 10%? **What if** some or all of the cost of care for workers and offspring harmed by workplace toxics becomes their burden as taxpayers ? Would it motivate them to push for (a) equal protection against toxics, (b) prevention of harm over profit and (c) holding cynical employers and chemical producers accountable?

Efforts to secure and enforce health based standards for workers continues and your support matters. This call by Swedish researchers for a Reach Mandate to manage groups of chemicals is one such measure

1. establishing a European toxic policy framework with a focus on mixture risks;
2. strengthening monitoring campaigns to take combination effects into account
3. regulatory framework to protect human health from exposure to chemicals;
4. a database on the use and emissions of chemicals;
5. acknowledging and acting on the fact that chemicals enter an already exposed environment or human body;
6. establishing the substitution principle in all relevant legislation;
7. strengthening the REACH mandate to manage groups of chemicals;