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**George Baggett's Response to the Polystyrene Industry's Review of
"Styrene Migration Into Human Adipose Tissue"**

This *Facts to Act On* was prepared by George Baggett in response to *Facts to Act On* No. 22, "Polystyrene Food and Beverage Containers Are Not Health Hazards," written by the Technical Committee of the Styrene Information Research Center. The Institute for Local Self-Reliance (ILSR) has encouraged dialogue on this important issue at the National Citizens' Congress of the Grass Roots Alliance for Solid Waste Solutions in Indianapolis, Indiana (November 1990), and through the *Facts to Act On* series. *Facts to Act On* nos. 22 and 23 solely represent the opinions of their respective authors.

**Questions Remain About Health Impacts of Polystyrene
Food and Beverage Containers**

Once again, I must respectfully agree to disagree with those who represent the chemical and polystyrene industry. Our primary difference hinges on the impact of continuous exposure to low doses of toxins, namely styrene in the environment. However, we are in agreement that another major source of styrene in the environment is direct industrial discharges of styrene from the chemical and related industries. I am also pleased that the polystyrene industry admits that residual styrene monomer in its products is known to migrate into foods.

Considerable controversy over the impact of chemicals on the human population and the environment has resulted in two camps of thought in the field of toxicology. On one side, there are those who suggest that dose-response studies demonstrate that de minimus levels of exposure exist where there are "no detectable" results of exposure. The most quoted example for dose-response is the toxicity of selenium. Too much selenium will cause a toxic response, as will too little of this essential nutrient.

Among those representing the other side of this debate are health professionals treating patients who have been exposed to low levels of toxins. Their patients have symptoms of multiple chemical sensitivity, and problems with what some call environmental illness. This school of thought holds that it only takes one molecule of a mutagen to cause a cell to mutate and, given that numerous workplace studies have demonstrated chromosomal

aberrations in styrene exposed workers^{1,2,3,4} it is thought that there is no de minimus level of exposure. In this regard, it should be noted that styrene, a possible human carcinogen, is not an essential nutrient.

Posed as if it should ease our minds, are references to "natural" styrene and "styrene like" compounds in foods. These compounds and other toxic by-products are problems for manufacturers of artificial flavors, cosmetics, and perfumes from petroleum products. Allergens and neurotoxins in this industry have been a subject of considerable controversy. In fact, most references to "natural" styrene are from research conducted for the flavoring, cosmetic, perfume, and agricultural chemical industries,⁵ hardly an unbiased group with a credible history of concern about allergens and toxins in their products.

The plastics industry's point of view presented in Facts To Act On No. 22 notes that neurological symptoms "similar to the consumption of alcoholic beverages" occur at "very high exposures," and "there is full recovery within a short time after exposure is discontinued." Anesthetic reactions to a benzene-based neurotoxin, which manifest themselves "similar" to consumption of alcoholic beverages, are only the overt symptoms of severe exposure. "The accumulation of these highly lipid soluble materials [styrene or toluene] in the lipid rich tissues of the brain, spinal cord, and peripheral nerves was [is] apparently correlated with acute or chronic functional impairment of the nervous system.... suggesting that aromatic hydrocarbons had [have] unsuspected long lasting neurological effects."⁶ I also question what is meant by "very high exposure." According

¹Zetterberg, G., "Styrene - A Widespread Mutagen: Conclusions From the Results of Testing," Environmental Mutagens and Carcinogens, pages 315-322, 18 ref., 1982.

²Watanabe, T., A. Endo, M. Kumai, and M. Ikeda, "Chromosome Aberrations and Sister Chromatid Exchanges In Styrene Exposed Workers with Reference to Their Smoking Habits," Environmental Mutagenesis, Vol. 5, No. 3, pages 299-309, 54 ref., 1983.

³Vainio, H., M. Sorsa, and M. Hyvonen, "Chromosomal Aberrations In Workers and In Children of Women Exposed to Styrene in Reinforced Plastics Industry," Proceedings of the Second Finnish-Estonian Symposium on Early Effects of Toxic Substances, pages 20-30, 25 ref., 1981.

⁴Poncelet, F., M. Duverger-van Bogaert, M. Lambotte-Vandepaer, and C. de Meester, "Mutagenicity, and Teratogenicity of Industrially Important Monomers," Mutagenicity, Carcinogenicity, and Teratogenicity of Industrial Pollutants, M. Kirsch-Volders, Editor, New York, Plenum Press, pages 205-279, 389 ref., 1984.

⁵TNO-CIVO "Volatile Compounds in Food" reference and partial copy of document provided by SIRC, 1989.

⁶O'Donoghue, J.L. "Neurotoxicity of Industrial and Commercial Chemicals," J.L. O'Donoghue, Editor, CRC Press, Inc., Boca Raton, Florida, Vol. 2, pages 127-137, 96 ref., 1985.

to Stewart, at a vapor concentration of 375 ppm for 1 hour, the majority of individuals displayed definite objective signs of impairment of their neurological function.⁷

The Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology has recently distributed its draft for comment, "The Toxicological Profile for Styrene."⁸ The profile notes the limited availability of "natural" styrene in the environment. They also note major sources of styrene in the environment as well as peripheral sources like auto and truck emissions and smoke from cigarettes. According to ATSDR, the major source of potential styrene exposure is from the air, and is the result of industrial discharges of styrene as reported from the Toxic Release Inventory. Sources of these industrial discharges include the chemical, paint, and styrene industries. However, since styrene has an odor threshold of 0.1 ppm,⁹ it is likely that persons exposed to significant concentrations of styrene would be well aware of styrene in the air, and there are many parts of the United States where little or no styrene is discharged to the air.¹⁰ ATSDR also notes that the major source of styrene in foods is migration from polystyrene food containers and packaging materials.¹¹

After publication of my paper "Styrene Migration Into Human Adipose Tissue," a styrene industry representative pointed out that the National Human Adipose Tissue Survey (NHATS) was based on making composite samples of various groups of tissue. Therefore, the styrene industry representative reasoned, it is possible that a 100% frequency of observation of styrene in composite tissue samples does not necessarily indicate that 100% of the American public has detectable concentrations of styrene in its tissue. The styrene industry representative also noted that, in a composite sample, workplace-exposed persons could have skewed the data.

I am grateful to the styrene industry for providing me a copy of the NHATS report, and having reviewed its full text, I find the criticism on this point rather feeble. Statistical analysis and methods used to form the target subpopulation composite groups were extremely careful not to compromise interpretation of the results. Therefore, the conclusion that 100% of the American public has similar concentrations of styrene in their tissue has a high probability of being true, and the possibility of a styrene-negative tissue sample is remote.

⁷Stewart, R.D., "Human Exposure To Styrene Vapor," Archives of Environmental Health, Vol. 16, No. 5, pages 656-662, 7 ref., 1968.

⁸U.S. Agency for Toxic Substances and Disease Registry, "Toxicological Profile for Styrene" draft for public comment, Contract No. 205-88-0608, Oct. 1990.

⁹Cheminfo Data Bank, "Styrene," Record No. 43E, Canadian Center for Occupational Health and Safety, 2 ref., 1988.

¹⁰U.S. EPA, 1987 and 1988 Toxic Release Inventory, Summary Reports, 1988 and 1989.

¹¹Ibid., footnote number 4

However, if some of the samples in a composite contained no styrene, a subpopulation in the composite sample would have had higher concentrations in their tissues. Further, the tissue survey noted that the age group from 0-14 years had slightly higher concentrations of styrene in their fat tissue than ages 15-44. Unless the plastics industry can document otherwise, it is my understanding that child labor laws would prohibit the former age group from the workplace. Therefore, it is unlikely that workplace exposure is responsible for skewing the data. It would be my judgement that the age group 0-14 would be more likely to consume large quantities of foods from fast food concessions than a majority of the later age group. According to the study, the age group 45 and older had about 25% less styrene in their tissues than the younger age groups.¹² This would also fit the pattern of older people eating less fast food.

The polystyrene industry is also critical of Russian studies that associate styrene exposure with neuropathy. One such study of a workplace, "Styrene-Induced Peripheral Neuropathy," notes the case of a 45-year-old styrene-exposed worker. Among other symptoms, the worker complained of a burning sensation in his lower heels. Upon examination, the patient was found to be suffering severe demyelination of the peripheral nerves, evidence that "styrene affects the nervous system to a greater degree than normally thought."¹³ Therefore, chronic damage to the peripheral and central nervous systems has far-reaching implications for a society that has been shown to have low level exposure to this neuro-degenerative toxin. As is the case with most chemicals, physical attack to tissue is indiscriminate, an attack by a neuro-degenerative substance like styrene on the lipid-rich brain could result in encephalopathy, which would manifest itself in symptoms similar to Parkinson's or Alzheimer's disease.

The industry would prefer to use workplace exposure studies with control populations to demonstrate no detectable differences between populations who are known to have been exposed and those who are "known" not to be exposed. Just such an epidemiological study, "The Dioxin Workers Study" conducted by Monsanto, is currently the subject of a criminal investigation for being fraudulent.¹⁴ According to memorandums from Cate Jenkins, EPA, Washington D.C., numerous mechanisms were used in these studies to

¹²U.S. EPA, "National Human Adipose Tissue Survey, Broad Scan Analysis: Population Estimates from Fiscal Year 1982 Specimens," Office of Toxic Substances, Washington D.C., EPA 560/5-90-001, October 1989.

¹³Behari, M., C. Choudhary, S. Roy, and M.C. Maheshwari, "Styrene Induced Peripheral Neuropathy," *European Neurology*, Vol. 25, No. 6, pages 424-427, 16 ref., Nov. 1986.

¹⁴Jenkins, Cate, Ph.D., Chemist, Regulatory Development Branch, Characterization and Assessment Division, U.S. EPA, Washington D.C., in a memo to John West, Special Agent in Charge, Office of Criminal Investigations, National Enforcement Investigation Center, U.S. EPA, Denver, Colorado, "Subject: Criminal Investigation of Monsanto Corporation -- Cover-up of Health Studies," dated November 15, 1990.

distort results.¹⁵ In this case it is alleged that Monsanto supplied a list of workers for the control group knowing full well that the control group was not only exposed to dioxins but other carcinogens as well. The motive of this would be to obtain similar health profiles from each group. Given the extent of contamination of styrene in adipose tissue, it would be difficult, if not impossible, to find a control group in this country that is not contaminated by styrene.

I am pleased to note that the industry failed to criticize the discussion of enhanced migration of styrene monomer from ethyl alcohol-containing beverages. The kinetics of enhanced migration is such that the use of polystyrene cups to consume alcoholic beverages would provide a vehicle to transfer this neuro-degenerative toxin to lipid-rich parts of the body, like the brain. After careful thought, it is my opinion that migration of styrene into the brain could effect serious damage to humans, resulting in diminished quality of life.

The fact that the Food and Drug Administration (FDA) has approved a possible carcinogen and an established neurotoxin as a food additive also illustrates one of the more important points made in my paper. In my opinion, the 1987 determination by the International Agency for Research on Cancer to reclassify styrene from a group 3 (not classifiable as to its carcinogenicity to humans) to group 2B (possibly carcinogenic to humans)¹⁶ places the FDA in violation of the Delaney Clause of the Food and Drug Act. The Delaney Clause prohibits approval of any food additive that is found to cause cancer in humans or animals.

Finally, it is understandable that the polystyrene industry would attempt to undermine the credibility of anyone who would address concern about the growing issue of styrene in the environment and migration of styrene into food products. This industry has invaded the lives of most Americans with its products, and there is a lot at stake. It also has no desire to have polystyrene banned from use in food related products, as acrylonitrile and vinyl chloride have been. At the same time, the industry continues to dump thousands of tons of its products into the environment each year, and most, if not all of us, have styrene in the lipid-rich parts of our bodies.

In my opinion, the public should take all necessary measures to avoid ingesting styrene, especially given the growing evidence that neuro-degenerative ailments like Parkinson's disease are linked to low level exposure to man-made toxins. At the very least, the public should be given a choice at food outlets.

¹⁵Jenkins, Cate, in a memo to John West, "Subject: Impact of Falsified Monsanto Human Studies on Dioxin Regulations by EPA and Other Agencies -- January 24, 1991, NIOSH Study Reverses Monsanto Study Findings and Exposes Certain Fraudulent Methods," dated January 24, 1991.

¹⁶Grainville, Geophrey, Chairman, Science and Technology Task Group, Styrene Information and Research Center, "The SIRC Review: The Need, The Purpose," The SIRC REVIEW, Vol. 1, No. 1, pages 5-6, April 1990.

For a review of concerns about toxins released to the air by industry, please send \$5 to the Institute for Local Self-Reliance for a copy of my latest paper, "Toxins Released to the Air -- Neurotoxic, Carcinogenic, and Environmental Impact" (32 pages, 44 references), a presentation made to the 41st Environmental Engineering Conference at the University of Kansas, Lawrence, Kansas, February 6, 1991.

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