



Styrene Information and Research Center (SIRC)

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Backgrounder: Worldwide Styrene Industry Recommendation for Workplace Exposure Limit of 20 Parts Per Million

Background:

When industrial hygienists began to establish workplace exposure limits for various substances, the main concern was to prevent deaths and acute toxicity in the workplace. As exposures were reduced to eliminate these concerns, focus shifted to prevention of major chronic toxicity, such as liver or kidney malfunction. Included in these concerns was prevention of neuropathy, blindness, cataracts and complete loss of hearing. More recently, it has been recognized that exposure to some substances may cause more subtle neurological changes that affect quality of life.

Questions & Answers

Q: How does this pertain to styrene exposure and hearing?

A: Performance in the human senses usually peaks in early adulthood and begins to diminish starting about age 40. Among the subtle changes research about long-term styrene exposure has identified is a potential mild degree of hearing loss that is somewhat greater than occurs through normal aging. Accordingly, there is a concern about preventing accelerated hearing loss due to styrene exposure.

Q: What research supports this concern?

A: A number of studies have indicated an effect on hearing from styrene exposure. For example, studies using laboratory rats have shown permanent damage to the hair cells in the inner ear from short-term high exposure to styrene. These are the sensory cells that detect sound.

This damage has occurred at levels above 250 parts per million (ppm). Applying normal scientific conversion factors to these findings to account for differences in length of exposure,

breathing frequency, and so forth, one derives a “No Observable Effect Level (NOEL)” for styrene of 40 ppm in humans.

Also, a large study of workers in the reinforced plastics industry¹ found a reduction in hearing ability slightly beyond what would normally be expected in a group of workers exposed to 25-33 ppm styrene for more than 10 years. This change was indicated by an increased threshold (requires louder tone to be heard) in ability to hear tones. This research indicated a NOEL of 30 ppm.

Q: What is the current U.S. Occupational Safety and Health Administration (OSHA) permissible exposure level (PEL) for styrene?

A: The current OSHA PEL for styrene is 100 ppm based on an 8-hour time-weighted average (TWA). However, since the late 1990s the styrene industry has had a voluntary agreement with OSHA for a U.S. workplace exposure level of half of that – 50 ppm based on an 8-hour TWA. And it is worth noting that since 1994 the American Conference of Governmental Industrial Hygienists has recommended a styrene threshold limit value (TLV) of 20 ppm based on an 8-hour TWA.

Q: How and why did the styrene industry settle on a 20 ppm worker exposure level?

A: The worldwide styrene industry is committed to the health and wellbeing of its employees. Because the hearing effect reported is very mild, the Styrene Information and Research Center’s (SIRC’s) Science and Technology Task Group (STTG), Europe’s Styrene Producers Association (SPA), and the Japan Styrene Industry Association (JSIA) have proposed – based on their best scientific judgment -- an Occupational Exposure Limit (OEL) that is only slightly lower than the 30 ppm NOEL for decreased hearing; their recommendation is for an occupational exposure limit of 20 ppm based on an 8-hour time-weighted average (TWA), and a short-term exposure limit (STEL) of 70 ppm.

Q: Are there other human neurological effects from long-term styrene exposure?

A: Yes, but the research does not indicate effects below 50 ppm. Eye irritation has been reported at 60 ppm. Increased reaction time has been reported in some studies at exposures of 50 ppm, but not in all studies, with no effects being found at 25 ppm. Decreased ability to discern subtle differences in colors has been reported at exposures above 50 ppm, but no effects have been reported between 30 and 50 ppm.

¹ “Occupational styrene exposure and hearing loss: A cohort study with repeated measurements” by Gerhard Triebig, M.D., M.Sc., and two other authors, published in the *International Archives of Occupational and Environmental Health*, 2008. This study was commissioned by SIRC and European styrene producers.

Wrap Up

Recent efforts at setting workplace exposures have focused on prevention of eye, nose and throat irritation, small reductions of visual acuity or color discrimination, small reductions in hearing ability, and small changes in behavioral responses. Performance in many endpoints peaks naturally in early adulthood and begins to diminish from about 40 years of age. Therefore, industry is taking this step to address the potential for styrene exposure to accelerate these effects.

Animal studies have shown permanent damage to the hearing structures in the inner ear from short-term high exposures to styrene. Applying normal conversion factors, one derives a “No Observable Effect Level (NOEL)” of 40 ppm. A large study of reinforced plastics workers found a slight reduction in hearing ability in a group of workers who had been exposed to 25-33 ppm for more than 10 years. Because the effect reported is very mild, the proposed Occupational Exposure Level (OEL) is only slightly lower than the NOEL for decreased hearing. SIRC’s STTG, Europe’s SPA and the JSIA recommend an OEL of 20 ppm based on an 8-hour TWA and a short-term exposure limit (STEL) of 70 ppm.