Date: December 23, 2016

To: John Vance
   Policy Chief
   National Office, DEEOIC

cc: Jeff Kotsch

From: Lynette D. Stokes, PhD, MPH
   Toxicologist, DEEOIC

Re: White Paper
   Hearing Loss (Noise and Solvent Exposure)

The Division of Energy Employees Occupational Illness Compensation Program (DEEOIC) made the policy decision to compensate employees for bilateral hearing loss on November 6, 2008. The policy decision was based on the available scientific literature and results from the population-based occupational epidemiology and biomedical studies published in peer reviewed scientific journals regarding hearing loss.

Based on the review of the scientific literature published in peer reviewed journals identified during the approximate period of 1993 to 2008, the DEEOIC concluded that a consistent relationship between bilateral hearing loss and occupational exposure to organic solvents such as toluene with simultaneous exposure to noise in the workplace had been established in the population-based epidemiologic literature.1-13

The results of occupational studies published by Sliwinska-Kowalska10 in 2004 confirm the observations of previously published studies by Morata a decade earlier.7-8 In the report by Hodgkinson and Prasher11 who summarized the last forty years of “ototoxic” effects of industrial solvents, it was concluded that “the combined exposure to solvents and noise has been observed in humans resulting in greater hearing losses than would be expected from exposure to noise and solvents alone.” Further, the conclusions from an international conference12 held to specifically review the existing science regarding “ototoxicity” of organic solvents alone and in combination with noise concluded “an additive or synergistic effect occurs in the case of the combined exposure to noise and solvents, significantly increasing the odds ratio of developing hearing loss.”
Permanent hearing loss has been observed in both ears of workers, but the specific frequency (low, moderate or high) has not been established nor has the threshold level of exposure required of organic solvents and noise to produce the hearing deficit. The duration of exposure to both organic solvents and noise required in some studies appears to be twenty years.\(^\text{10}\) Hearing deficits were observed at levels of exposure between 75-365 ppm for toluene among printing workers.\(^\text{13}\)

In order to compensate as many workers as possible the DEEOIC reviewed the available studies to determine the minimum level of exposure to both noise and solvents necessary to result in additional bilateral hearing loss over and above noise exposure alone:

- Effects were not observed following noise & solvent exposure at 5-years (average) \([\text{toluene exposure} < 50\text{ppm}]\) Ann Occp Hyg 47:493-502, 2003

- Effects were not observed following noise & solvent exposure at 7-years (average) \([\text{toluene exposure} < 50\text{ppm}]\) Scand J Work Envir Health 23:289-298, 1997

- Effects were not observed following noise & solvent exposure at 8-years (average) \([\text{toluene exposure} 208\text{ppm}]\) Inter J Occ Med Envir Health 21(3):191-200, 2008

- Effects were observed following noise & solvent exposure with an average of 12.3 years (average) \([\text{toluene exposure up to} 164\text{ppm}]\) Envir Health Perspective 114(8): 1283-1286, 2006

\(^a\) The review of the studies above is based on the human epidemiologic scientific literature that was evaluated using the principles of relative risk (RR) and testing hypotheses by determining appropriate statistical significance calculated using 95% confidence intervals (CI).

---

\(^a\) Gordis states both case-control and cohort studies are designed to determine whether there is an association between exposure to a factor and development of a disease.\(^\text{14}\) In cohort studies the definition of relative risk (RR) can be defined as follows; what is the ratio of the risk of disease in exposed individuals to the risk of disease in non-exposed individuals. The ratio is called the relative risk. Interpreting the statistical significance of the relative risk can be determined by testing the null hypothesis with p values or confidence intervals. The definition of the confidence interval and confidence limits can be defined as a range of values determined by the degree of presumed random variability in the data, within which the value of a parameter (i.e., RR) is thought to lie, with the specified level of confidence (i.e., 95%).\(^\text{15}\) The boundaries of a confidence interval are the confidence limits. Lilienfeld et al., states if the confidence interval does not contain the value 1.0, the hypothesis that there is no difference in the risk between the two groups (i.e., cases and controls) is statistically rejected.\(^\text{16}\) The human epidemiologic scientific literature can be evaluated using the principles of relative risk, and testing hypotheses by determining statistical significance.\(^\text{14-16}\)
The DEEOIC policy decision to compensate employees with 10-years of continuous exposure to solvents and simultaneous exposure to noise is based on the specific review of the studies referenced above for the minimal level of both exposures (i.e., solvents and noise levels above 85 dB).

- The assumption is made that the hypothesized mechanism of action (i.e., damage to the outer hair cells in the ear) is the same for all solvents included in the policy directive. The DEEOIC considers this policy and assumption is extremely clamant favorable to compensate employees.

- The mechanism of action of hearing loss based on simultaneous exposure to both solvents and noise is hypothesized in the publication below:

  Sliwinska – Kowalska, M


