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Exposure-Response Analysis for Beryllium Sensitization and Chronic Beryllium Disease Among Workers in a Beryllium Metal Machining Plant

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The current occupational exposure limit (OEL) for beryllium has been in place for more than 50 years and was believed to be protective against chronic beryllium disease (CBD), until studies in the 1990s identified beryllium sensitization (BeS) and subclinical CBD in the absence of physical symptoms. Inconsistent sampling and exposure assessment methodologies have often prevented the characterization of a clear exposure-response relationship for BeS and CBD. Industrial hygiene (3831 personal lapel and 616 general area samples) and health surveillance data from a beryllium machining facility provided an opportunity to reconstruct worker exposures prior to the ascertainment of BeS or the diagnosis of CBD. Airborne beryllium concentrations for different job titles were evaluated; historical trends of beryllium levels were compared for pre- and post-engineering control measures; and mean and upper bound exposure estimates were developed for workers either identified as beryllium sensitized or diagnosed with subclinical or clinical CBD. Four methods were used to reconstruct historical exposures of each worker: Industrial hygiene data were pooled by year, job title, era of engineering controls, and the complete work history (lifetime weighted average) prior to diagnosis. Results showed that exposure metrics based on shorter averaging times (i.e., year vs. complete work history) better represented the upper-bound worker exposures that could

have contributed to the development of BeS or CBD. It was observed that all beryllium sensitized and CBD workers were likely exposed to beryllium concentrations greater than $0.2 \mu\text{g}/\text{m}^3$ (95th percentile), and 90% were exposed to concentrations greater than $0.4 \mu\text{g}/\text{m}^3$ (95th percentile) within a given year of their work history. Based on this analysis, it would appear that BeS and CBD generally occurred as a result of exposures greater than $0.4 \mu\text{g}/\text{m}^3$ and that maintaining exposures below $0.2 \mu\text{g}/\text{m}^3$ 95% of the time may prevent BeS and CBD in the workplace.