

## **A Comparison and Critique of Historical and Current Exposure Assessment Methods for Beryllium: Implications for Evaluating Risk of Chronic Beryllium Disease**

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The primary beryllium industry has generated a large amount of data on airborne beryllium concentrations that has been used to characterize exposure by task-specific activities, job category, individual worker, and processing area using a variety of methods. These methods have included high-volume breathing zone sampling, high-volume process sampling, high- and low-volume respirable and area sampling, real-time monitoring, and personal sampling. Many of the beryllium studies have used these air sampling methods to assess inhalation exposure and chronic beryllium disease (CBD) risk to beryllium; however, available data do not show a consistent dose-response relationship between airborne concentrations of beryllium and the incidence of CBD. In this article, we describe the air sampling and exposure assessment methods that have been used, review the studies that have estimated worker exposures, discuss the uncertainties associated with the level of beryllium for which these studies have reported an increased risk of CBD, and identify future investigative exposure assessment strategies. Our evaluation indicated that studies of beryllium workers are often not directly comparable because they (1) used a variety of exposure assessment methods that are not necessarily representative of individual worker exposures, (2) rarely considered respirator use, and (3) have not evaluated changes in work practices. It appears that the current exposure metric for beryllium, total beryllium mass, may not be an appropriate measurement to predict the risk of CBD. Other exposure metrics such as mass of respirable particles, chemical form, and particle surface chemistry may be more related to the prevalence of CBD than total mass of airborne beryllium mass. In addition, assessing beryllium exposure by all routes of exposure (e.g., inhalation, dermal uptake, and ingestion) rather than only inhalation exposure in future studies may prove useful.