MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: File for Beryllium and compounds (CAS No. 7440-41-7)

FROM: Keisha Williams, Air Quality Division (AQD)

DATE: July 10, 2015

SUBJECT: Initial Threshold Screening Level and Initial Risk Screening Level

The initial threshold screening level (ITSL) for berryllium is 0.02 µg/m^3 (24-hour averaging time) based on the Environmental Protection Agency's (EPA's) reference concentration (RfC) (EPA, 1998). The initial risk screening level (IRSL) and secondary risk screening level (SRSL) are 0.0004 and 0.004 µg/m^3 (annual averaging time), respectively, based on the EPA (1998) unit risk estimate of 0.0024 per µg/m^3. The IRSL and SRSL were established by AQD on April 23, 1990 and the ITSL was established by AQD on March 26, 1998.

EPA's RfC is based on a lowest observable adverse effect level (LOAEL) from an occupational exposure that was estimated at 0.55 µg/m^3, and further supported by a no observable adverse effect level (NOAEL) that was estimated between 0.01- 0.1 µg/m^3 in an epidemiological study of a residential community located near a beryllium plant (EPA, 1998; Kreiss et al., 1996; Eisenbud et al., 1949). The occupational study was based on exposures in a beryllia ceramics plant, where 136 out of the the 139 plant workers participated. The critical effects were 1) beryllium sensitization as determined by a positive result in the beryllium lymphocyte transformation test which had to be confirmed by two, independent laboratories, and 2) progression to chronic beryllium disease (CBD) based on detection of granulomas in lung biopsy samples (EPA, 1998). Machinists were found to have some of the highest exposures in the plant, as well as the highest sensitization rates, 14.3%, as compared to other plant employees whose sensitization rates were approximately 1.2% (Kreiss et al., 1996). A combined uncertainty factor (UF) of 10 was used based on an UF of 3 for extrapolation from the LOAEL to the NOAEL and an UF of 3 for database uncertainty. As shown in Equation 1 and Equation 2, after duration adjustment for chronic exposure and application of uncertainty factors, the RfC was calculated to be 0.02 µg/m^3.

Equation 1.

$$RfC = \frac{LOAEL_{HEC}}{UFs}$$

Equation 2.

$$LOAEL_{HEC} = LOAEL\ x \frac{occupational\ inhalation\ rate}{daily\ inhalation\ rate} x \frac{days\ of\ occupational\ exposure\ per\ week}{7\ days\ per\ week}$$

where LOAEL =0.55 µg/m^3

Occupational inhalation rate=10 m^3 per workshift

Daily inhalation rate=20 m^3 per day

Days of occupational exposure per week=5 days

$$LOAEL_{HEC} = 0.55\frac{\mu g}{m^3}\ x\frac{10\ m^3 per\ workshift}{20\ m^3 per\ day}x\frac{5\ days}{7\ days} = 0.2\frac{\mu g}{m^3}$$

$$RfC = \frac{0.2\ \frac{\mu g}{m^3}}{10} = 0.02\ \frac{\mu g}{m^3}$$

The ITSL was originally established with an averaging time set at 24 hours, the default averaging time, per AQD Rule 232 (2). Although EPA's RfC values are established to target chronic exposure durations, the 24 hour averaging time for beryllium will be retained by AQD at this time, because it has been noted by EPA that "the onset of CBD from initial exposure (latency) ranges from a few months to an average of 23.7 years (Kreiss et al., 1993); however, at the present time there is no clear relationship between duration of exposure and the development of the disease" (EPA, 1998; Kreiss et al., 1996).

For quantitative cancer risk assessment, EPA (1998) used the Wagoner et al. (1980) occupational study that showed a dose-response relationship between beryllium exposures and increased lung cancer. They derived a unit risk value of 2.4 x 10^{-3} per µg/m^3. The IRSL and secondary risk screening level (SRSL) are calculated as shown in Equations 3 and 4.

Equation 3.

$$IRSL = \frac{1\ x\ 10^{-6}}{unit\ risk\ estimate} = \frac{1\ x\ 10^{-6}}{\frac{0.0024}{\frac{\mu g}{m^3}}} = 0.00042\frac{\mu g}{m^3} \approx 0.0004\ \frac{\mu g}{m^3}$$

Equation 4.

$$SRSL = \frac{1\ x\ 10^{-5}}{unit\ risk\ estimate} = \frac{1\ x\ 10^{-5}}{\frac{0.0024}{\frac{\mu g}{m^3}}} = 0.0042\frac{\mu g}{m^3} \approx 0.004\ \frac{\mu g}{m^3}$$

References

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