

Setting Administrative Guidelines and Standards



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Health Risk Management



Lorain, OH Neighborhood Study

⌘ NOAEL of 0.01 $\mu\text{g}/\text{m}^3$ – 10 week average

- ☒ Eisenbud, M.; Wanta, R.C.; Dustan, C.; et al.: Non-Occupational Berylliosis. *J Ind Hyg Toxicol* 31:282–294 (1949).
- ☒ Eisenbud, M.; Lisson, J.: Epidemiological Aspects of Beryllium-Induced Nonmalignant Lung Disease: A 30-Year Update. *J OccupMed* 25:196–202 (1983).

⌘ LOAEL of 0.2 $\mu\text{g}/\text{m}^3$ – 10 week average

- ☒ Eisenbud, M.: The Standard for Control of Chronic Beryllium Disease. *Appl Occup Environ Hyg* 13(1):25–31 (1998).

Ceramic Plant Occupational Study



⌘ LOAEL of $0.55 \mu\text{g}/\text{m}^3$ – Median of the Average Exposure Level for Six Cases

☒ Kreiss K, et al. Machining risk of beryllium disease and sensitization with median exposures below 2 micrograms/m³. Am J Ind Med. 1996 Jul;30(1):16-25

Beryllium Exposure Limits

Obsolete But Still On The Books



- ⌘ 25 $\mu\text{g}/\text{m}^3$ 30-Min TWA OSHA PEL
- ⌘ 10 $\mu\text{g}/\text{m}^3$ 15-Min TWA TLV-STEL
- ⌘ 5 $\mu\text{g}/\text{m}^3$ 8-Hr TWA OSHA "Ceiling"
- ⌘ 2 $\mu\text{g}/\text{m}^3$ 8-Hr TWA PEL and TLV

Beryllium Exposure Limits

Aimed At Preventing CBD



⌘ 0.01 $\mu\text{g}/\text{m}^3$ 30-Day TWA EPA NESHAP

⌘ 0.02 $\mu\text{g}/\text{m}^3$ 24-Hr TWA EPA RfC

☑ Based on LOAEL from occupational study

⌘ 0.2 $\mu\text{g}/\text{m}^3$ 8-Hr TWA DOE Action Level

☑ 1999 ACGIH Notice of Intended Change.


☑ Reduces previous limit by a factor of 10

Two EPA Standards?



- ⌘ EPA NESHAP is based on NOAEL from the neighborhood study
- ⌘ EPA RfC based on LOAEL from occupational study
- ⌘ Compliance with a daily limit assures that the 30 day average will be less than the daily limit.
- ⌘ The two standards provide approximately equivalent levels of protection.

EPA 0.02 $\mu\text{g}/\text{m}^3$
vs ACGIH 0.2 $\mu\text{g}/\text{m}^3$



⌘ EPA RFC Derived from occupational study

⌘ $(0.55 \mu\text{g}/\text{m}^3 \times 10\text{m}^3/20\text{m}^3 \times 5\text{days}/7\text{days})/10$
 $= 0.02 \mu\text{g}/\text{m}^3$

⌘ Leaving out the 8 to 24-Hr conversion
 $0.55 \mu\text{g}/\text{m}^3/10 = 0.055 \mu\text{g}/\text{m}^3$

Mean vs Limit

⌘ 95th Percentile $< 4 \times$ Mean in any distribution

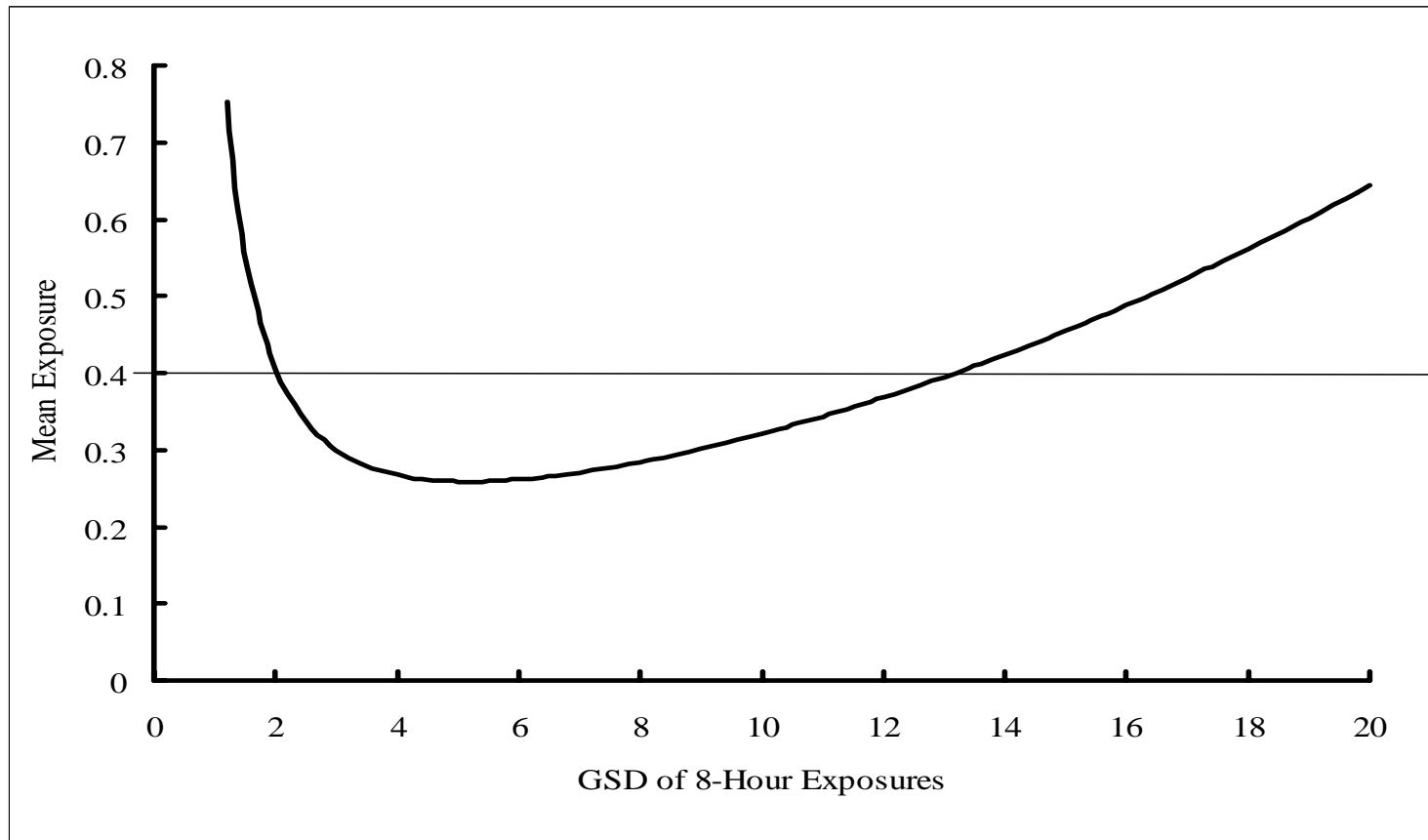
☒ Rappaport SM. “Assessment of long-term exposures to toxic substances in air.” *Ann Occup Hyg.* 1991 Feb;35(1):61-121.

⌘ Mean $< 95^{\text{th}}$ Percentile/2.5 when the GSD is between 2 and 14

☒ Wambach PF, Tuggle RM, “Development of an eight-hour occupational exposure limit for beryllium.” *Appl Occup Environ Hyg.* 2000 Jul;15(7):581-7

Mean vs GSD

When 5% of 8-hour TWAs Exceed the OEL



Estimated Geometric Standard Deviations (GSD)



- ⌘ Y-12 in 2002 – 10.5
- ⌘ Rocky Flats in 1986 – 3.2
- ⌘ Sandia – 4.6
- ⌘ Speedring - 6.1
- ⌘ Elmore Pebbles Plant - 3.8

What About Particle Size?



⌘ NIOSH 76-201 – 32% respirable

☑ Compares 714 samples

☑ Range: 3% - 345%

☑ Coefficient of determination (R^2) = 0.94

⌘ Cholak 1967 – 30% respirable

⌘ Kent 2001 – 33% respirable

What About Skin Exposure?



- ⌘ Beryllium causes immune system mediated skin disease
- ⌘ CBD can be prevalent in workplaces where skin disease is not
- ⌘ Do aerosols penetrate the skin?
- ⌘ Does re-suspension of surface contamination create inhalation exposure?

Beryllium Surface Limits



- ⌘ 3 micrograms per 100 square centimeters
 - ☑ AIHA Hygienic guide 25 micrograms per square foot

- ⌘ 0.2 micrograms per 100 square centimeters
 - ☑ Consensus from rulemaking

Empirical Standards

⌘ Different from background

☒ B1 First Floor, Mean = $0.254 \mu\text{g}/100\text{cm}^2$
90% CI (0.173 - 0.373)

☒ Other Units, Mean = $0.031 \mu\text{g}/100\text{cm}^2$
90% CI (0.024 - 0.041)

⌘ Outlier: $75^{\text{th}}\% + 1.5 \times (75^{\text{th}}\% - 25^{\text{th}}\%)$

☒ $25^{\text{th}}\% = 0.0042$ $75^{\text{th}}\% = 0.0442$

☒ Outlier $> 0.1 \mu\text{g}/100\text{cm}^2$

Conclusions



- ⌘ The available health effects data support lower occupational exposure limits
- ⌘ Standards for contamination control can be developed from experience
- ⌘ Improvement in beryllium health risk management requires setting internal standards