
Issues with Beryllium Dermal Sampling at DOE Sites

Fall Beryllium Health & Safety Committee Meeting
October 15, 2014

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Indications of a Beryllium Dermal Concern

Though not proven, there is significant evidence that dermal exposure to beryllium may be a concern. A 2005 communication by Day, et al, summarized relevant information:

- Soluble beryllium salts are known to cause dermal sensitization
- Poorly soluble, submicron particles may be able to penetrate intact skin.
- Skin contact with beryllium oxide particles can cause BeS in mice.
- Reducing airborne beryllium levels in the workplace does not necessarily reduce BeS rate.

In general, it is not a good idea to have any toxic material on your skin.

Possible Outcomes of Dermal Contamination

- Possible beryllium sensitization due to dermal exposure to sub-micron particles.
- Inhibited healing of cuts or wounds.
- Ingestion of beryllium. This may not be a significant concern as with lead or other toxic metals, but should be avoided.
- Dermal contamination as a vector for inhalation exposure.

There are enough concerns to warrant preventing dermal exposure. In some cases dermal sampling may be indicated.

Should we perform dermal sampling?

- Many CBDPPs require workers to wear gloves when handling beryllium or contaminated materials, so is it really an issue?
- What skin do you sample?
- If you get a hit, what does it mean?
- What level is acceptable?
 - Nanograms?
 - Micrograms?
 - Milligrams?
- How do you explain results to workers, managers, and auditors?

Considering the above, many industrial hygienists would recommend that you do not sample if there is no established OEL or guideline. However, there may be situations where dermal sampling for beryllium may be of value.

Value of Beryllium Dermal Sampling

While dermal sampling may not be of value in determining worker exposure, it can be of value in evaluating workplace conditions, controls, and work practices.

- Some studies have looked at face/neck or other exposed areas, but sampling of the hands may have most value.
- Sampling of the hands (both skin and glove surface) may help:
 - Identify points in operations where workers are contacting beryllium.
 - Identify sources of contamination spread.
 - Evaluate work practices to determine methods that might need changing or identify workers needing to improve work habits.
 - Identify vectors for transferring beryllium to the breathing zone.

Hands as a Vector for Contamination Spread

- Whatever the worker touches gets spread to everything else they touch.
- Gloves may protect the workers skin, but may actually increase risk of contamination spread:
 - Workers feel protected, so they may be less cautious about handling contaminated materials.
 - Some loss of dexterity and tactical sensation may result in clumsier hand movements that spread contamination.



Hand to Face Movements

- A study by Nicas and Best (2008) found that workers made hand to face contact an average of 15.7 times per hour. The rate was highly variable depending on the worker, ranging from 1 to 35 contacts per hour.
- Workers with allergies, glasses, or nervous habits may make more frequent hand to face contacts.
- Wearing gloves may remind workers that there is a contamination concern and limit the number of hand to face movements.
- Contamination on the hands may be a point source for inhalation exposure when the hands are moved to the face.



Hands as a Vector for Inhalation Exposure

We may sample a worker's breathing zone and not see anything. Brief hand to nose/mouth area may be a route of exposure not seen by breathing zone sampler. Nose/mouth may be acting as an LEV competing against the breathing zone sampler.

Consider:

- Hands two inches or less from the nose at 40 lpm (working at moderate to heavy level), vs.
- Breathing zone sampler six to nine inches from the nose at 2 to 4 lpm.
- At 40 LPM, velocity at nose might be 500 fpm or more. A good capture velocity.
- Inhaled breath could vacuum up particles off hand. Exhaled breath could re-entrain particles on hand surface.

What hand surface do you sample?

- Grip contact would indicate sampling surface of palms and fingers.
- Immersion would indicate the entire hand surface including the wrist. Not typically a beryllium workplace concern.
- Work practices would indicate that the palms and inner surface of the fingers make contact, but hand movement would spread contamination to entire hand surface.

If we are going to sample hands, we should wipe the entire surface of both hands up to the wrist crease.

Suggested Method

- Open a GhostWipe packet without touching the medium.
- Have worker remove and unfold the GhostWipe and wipe all surfaces of both hands for 15 seconds.
- Have worker fold or bunch-up GhostWipe and place in an open sample container.
- Do not measure or calculate hand surface area.
- Analyze for beryllium or other metals.
- Use total beryllium mass on hands as an indicator, **not** as a standard.



Keep it simple. Don't over collect data.

What would be an acceptable dermal limit?

Can an “acceptable” guideline for dermal contamination on the hands be determined based on established surface limits?

Assume an average surface area of 1000 cm² for the hands.

Sample the total surface of both hands.

- Based on the housekeeping limit of 3 ug/100 cm²; 30 ug of beryllium would be allowed on the hands.
- Based on the release limit of 0.2 ug/100 cm²; 2 ug of beryllium would be allowed on the hands.

Few industrial hygienists would be comfortable with using the housekeeping limit. The release limit might be overly conservative and not practical.

Comments and Recommendations

- Until the science of beryllium dermal exposure advances, there should not be a standard for dermal contamination.
- Gloves should be worn when handling beryllium or contaminated surfaces.
- Best practices should include a goal of no or minimal dermal contact with beryllium particulate and no contamination spread or re-entrainment via the hands.
- Sampling the surface of the hands, either the skin or glove surface, may have value as an indicator of the effectiveness of controls and work practices, but is not a direct indicator of exposure.
- For evaluation of controls or work practices, the absolute value of beryllium on the hands may not be as critical as changes in the level as controls or work practices are modified.

Comments and Recommendations (continued)

- If exposure is due to transfer of contaminants from the hands to the breathing zone, we should be sampling the surface of the glove.
- Sampling the surface of gloves/hands at various points in an operation may aid in identifying sources of contamination spread.
- Wearing gloves may prevent dermal exposure, but it would not eliminate the potential for hand to face movements as an inhalation exposure vector.
- Hand to face contact may contribute significantly to inhalation exposure and deserves further investigation.
- Contamination on the hands indicates a possible source for inhalation exposure, but does not mean that such an exposure occurred.

Sources

- EPA, Exposure Factors Handbook: 2011 Edition, Chapter 7, Dermal Exposure Factors, EPA/600/R-090/052F, September 2011.
- Day, G, et al., Beryllium Exposure: Dermal and Immunological Considerations, Int Arch Occup Environ Health (2006) 79: 161–164.
- Lee, J, et al, Determination of Hand Surface Area by Sex and Body Shape using Alginate, Physiol Anthropol, 26: 475–483, 2007
- Nicas, M & Best, D (2008) A Study Quantifying the Hand-to-Face Contact Rate and Its Potential Application to Predicting Respiratory Tract Infection, Journal of Occupational and Environmental Hygiene, 5:6, 347-352.
- Kaye, R & Konz, S, Volume and Surface Area of the Hand, Proceedings of the Human Factors and Ergonomics Society Annual Meeting September 1986 vol 30: 382-384.

Questions



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