# Prevention of risks related to surface contamination by metals

## CoSec Meeting – Continuing Education
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# Surface contamination, what are we talking about?

**Substances with low volatility, therefore persistent without effective cleaning.**

**Associated risks:**

- **Resuspension of dust**
- **Skin contamination**
- **Hand-to-mouth transfer**
- **Spreading in the surrounding space**

⇨ **Increased risk of chronic exposure, with a possible time lag.**

# Metals and their derivatives, dangerous?

# … some examples!

**Lead**
C2, $R1_{AD}$ , $R2_{F}$ , $SS_{B}$
VME: 100 µg/m³

**Arsenic**
$C1_{A}$ , M2, R
VME: 10 µg/m³

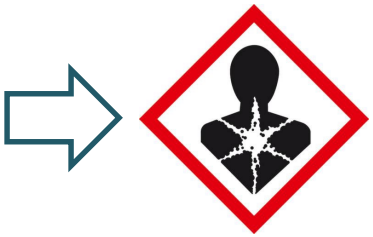
**Cobalt**
$C1_{B}$ , $R1_{BF}$ , M2, R, S
VME: 100 µg/m³

**Nickel**
$C1_{A}$, S
VME: 50 µg/m³

**Beryllium**
$C1^{\#}{}_{A}$ , S
VME: 0.6 µg/m³

**Chromium(VI)**
$C1_{A}$, R, S
VME: 5 µg/m³

…



**Carcinogenic, mutagenic, reprotoxic; more or less certain**

*VME: exposure limit value for exposure 8h/day, 42h/week over a long period (inhalation).*
*$C1_{A}$: known carcinogen; $C1^{\#}{}_{A}$: known carcinogen with threshold; $C1_{B}$: probable carcinogen; C2 potential carcinogen; M2: potential mutagen; $R1_{AD}$ : known reprotoxic for the fetus in utero; $R1_{BF}$ : probable reprotoxic affecting fertility; $R2_{F}$ : potential reprotoxic affecting fertility; S: sensitizer; $SS_{B}$: damage to the fœtus can not be excluded even if VME has been respected; R: transcutaneous resorption.*

# Surface Contamination Assessment Criteria

No stardard limits, because it is difficult to make a direct link between the contamination of a surface and the risk of exposure of the person.

By analogy with VMEs and OSHA Technical Manual:

*Inhalation exposure limit value for 8h/d, 42h/wk.*

VME $\mu g / m^3$ — *10 $m^3$/8h* → DIL = 10x VME — *"daily intake limit"* → Result $\left[\frac{\mu g}{100\ cm^2}\right]$ — *analysis* → Sample 100 $cm^2$

≈

**4 levels**

- > DIL/100 $cm^2$
- ≤ DIL/100 $cm^2$
- ≤ 10% DIL/100 $cm^2$
- ≤ 1% DIL/100 $cm^2$

- < 1
- 1
- 10
- 100

**Acceptable incorporation**

## Surface sampling: Criteria for the evaluation of surface contamination


≥ DIL

- **High contamination**
  - Acceptable for *enclosed working surfaces*: e.g. interior of glove boxes, reactors. Controls: PPE, regular cleaning, etc.
  - If level ≥ 10x DIL : cleaning necessary

< DIL
≥ 10% DIL

- **Medium contamination**
  - Acceptable for *semi-open working surfaces*: e.g. fume hoods and transfer units, sample storage cabinets
  - Controls: PPE, regular cleaning, etc.

< 10% DIL[a]
≥ 1% DIL

- **Low contamination**
  - Acceptable for *open working surfaces*: e.g. laboratory benches, inner side of gloves from glove-boxes, material/phones/keyboards/tables/floors within contaminated areas
  - Controls: PPE, regular cleaning

< 1% DIL[b]

- **No contamination**
  - Required for *non-contaminated areas*: e.g. equipment to be taken out of contaminated areas, clearance levels for declassification of an specific area
  - No specific exposure controls needed

[a] 10% of the total daily intake limit (DIL = 10x VME) based on the Swiss VMEs and the OSHA Technical Manual; Section II: Chapter 2 – paragraph III.A
[b] 1% of DIL ="clearance level"

# Metal sampling methods

## Quantitative


Analysis:

- Digestion/mineralization by $HNO_3$ aq.
- Quantification by ICP/MS
- Approx. costs 100.- CHF/sample
  (paid by the Unit)

## Qualitative

(only for certain metals)

# Example: lead – ball mixer

Request from a Unit to control the possible dispersion of lead perovskite linked to the use of a ball mixer.

| Samples | | Pb Concentration [µg/100 cm$^2$] |
|---|---|---|
| Wet Lab | Blank | 0.01 |
| | fume hood - front | 2.00 |
| | fume hood - back | 163.64 |
| | bench in front ball milling | 8.37 |
| | bench in front furnace | 3.57 |
| | top of furnace | 2.45 |
| | ball milling supports | 40.92 |
| Office 1 | desk+keyboard | 0.63 |
| Office 2 | desk+keyboard | 0.06 |
| Control room | desk | 0.05 |
| Analytical lab | table for sample prep | 0.81 |

Lead: <4.3 <22 <50 ≥ 50 µg/100 cm$^2$
(*Brookhaven National Laboratory and US EPA*)

**Limited lead dispersion in the lab**

**Cleaning "peripheral" areas**

# Example: arsenic – impregnation reactor

Request from the Unit to assess the residual contamination after the inappropriate use of a material containing arsenic sulphide inside a high temperature impregnation reactor (600°C, 100 bar).

All internal insulation has been eliminated.

The lid is the area with a highest risk of contamination:

- Insulation was degraded
- Cooler zone (more condensation)
- Most accessible area during future manipulations

Arsenic: VME= 10 µg/m$^3$ → DIL 100 µg

● <1 ● <10 ● <100 ● >100 µg/100 cm$^2$

1st cleaning (iPrOH): **570 µg/100 cm$^2$**

2nd cleaning (abrasive): 1.5 µg/100 cm$^2$

# Conclusions

- Metals are persistent contaminants that can accumulate and generate significant chronic exposure.

⇨ Effective and regular cleaning procedure.

- The effectiveness of the cleaning procedure must be checked by regular surface sampling to prevent a possible drift of the contamination.

- In case of this type of activities with a risk of regular exposure (>200 hrs/ year), an announcement to Occupational Medicine is necessary via the medical form on the *Health at Work* website from OHS.
https://www.epfl.ch/campus/security-safety/en/health/health-at-work/

# Thank you for your attention.
# Any questions ?