# Beryllium & Compounds

| CAS number: | 7440-41-7 (elemental) |
| --- | --- |
| Synonyms: | Glucinum, glucinium |
| Chemical formula: | Be (elemental) |
| Structural formula: | — |

Workplace exposure standard (amended)

| TWA: | **0.02 µg/m3** |
| --- | --- |
| STEL: | **0.2 µg/m3** |
| Peak limitation: | **—** |
| Notations: | **Carc. 1B, RSEN, DSEN, Sk.** |
| IDLH: | **4 mg/m3** |
| Sampling and analysis: | There is uncertainty regarding quantification of the recommended value with available sampling and/or analysis techniques. |

## Recommendation and basis for workplace exposure standard

A TWA of 0.02 µg/m3 is recommended to protect for beryllium sensitisation in exposed workers and consequently to protect for chronic beryllium disease (CBD) in sensitised individuals. This TWA is also expected to protect for potential cancers of the lung and respiratory tract.

As there is evidence to support a link between acute beryllium disease and CBD, a STEL of 0.2 µg/m3 is recommended to reduce the risk developing of CBD after acute exposures.

## Discussion and conclusions

Beryllium is extensively used in electrodes, tools and in structural material for the aerospace industries. Beryllium and its compounds may cause allergic contact dermatitis, allergic skin reactions and allergic response in the respiratory tract in humans. Preventing sensitisation minimises the likelihood of chronic health effects including CBD (also known as berylliosis).

There is insufficient data to conclude that the mode of action for carcinogenic effects of beryllium in humans and animals is due to genotoxicity.

A NOAEC of 0.02 µg/m3 for beryllium sensitivity (respirable dust fraction) is reported (SCOEL, 2017) and LOAEL reported for CBD range from 0.52 to 1.2 µg/m3. There is no reported NOAEL for cancer in humans. However, carcinogenic effects are generally associated with higher concentrations (greater than 10 µg/m3). The recommended TWA is considered to reduce the risk of cancer and BeS and consequently protecting for CBD.

The STEL is recommended based on evidence of CBD in workers that develop acute beryllium disease at short-term concentrations greater than 0.2 µg/m3.

## Recommendation for notations

Classified as a category 1B carcinogen according to the Globally Harmonized System of Classification and Labelling on Chemicals (GHS).

Classified as a skin sensitiser and respiratory sensitiser according to the GHS.

A skin notation is recommended based on evidence of systemic effects after dermal exposure.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1991 TWA: 0.002 mg/m3 | |
|  |
| ACGIH 2014 TLV-TWA: 0.05 µg/m3 |
| TLV-TWA recommended to minimise critical effects associated with beryllium sensitivity in sensitive populations, leading to CBD in sensitised individuals. There is inadequate data to confirm the contribution of peak exposures during a full shift to disease outcomes.  Beryllium sensitivity is a type IV cell-mediated immune response. RSEN and DSEN notations applied based on the weight of evidence with noted lymphocytic sensitisation in blood and lungs of sensitised individuals.  A skin notation is applied based on sensitisation of individuals from dermal exposure to soluble Be, penetration of insoluble Be through cadaver skin and positive evidence in sensitisation studies in mice.  The ‘A1 Confirmed Human Carcinogen’ notation assigned based on animal studies. Human carcinogenicity data associated with historically high exposures.  Summary of data:  Human data:   * Acute Beryllium Disease (ABD) affects the respiratory tract including rhinitis, pharyngitis, pneumonitis, shortness of breath, malaise, anorexia, cyanosis and tachycardia and it can be fatal; ABD can result in CBD * Sensitisation identified (1/27 subjects) in a study with lifetime weighted (LTW) average exposures at < 0.2 µg/m3; there were no strong relationship between dose and LTW average exposures to differentiate between sensitised and non-sensitised populations; some indication of a genetic susceptibility * Limited (or no) evidence of sensitisation or CBD below 0.05 µg/m3 * Non-occupational exposure studies of residents near Be facilities suggest CBD symptoms following average ambient concentrations of 0.0155–0.028 µg/m3 * Carcinogenicity studies demonstrated increased SMR for lung cancer (both significant and non-significant); studies generally not well controlled for confounding factors including smoking and co-exposure to sulfuric mist.   Animal data:   * ‘Limited value’ in animal studies on murine of single or repeated high dose (20‑60 µg/m3); more relevant for ABD; no appropriate human model for CBD identified * Mice sensitisation reported following dermal exposure to poorly soluble Be particles * Carcinogenicity demonstrated in various species of animals and to various forms of Be: * 18/19 rats exposed to 0.62 mg/m3 beryl ore developed lung tumours * 64% of tested rats developed lung tumours after 14 mo (single Be metal exposure of 410–80 mg/m3 for 8–48 min) * increased cancer rates reported in rats exposed at 0.35 mg/m3 BeS for 180 d * lung tumours in all rats exposed at 0.034 mg/m3 BeS for 13 mo * lung tumours reported in rats after 9 mo exposed at 0.006 or 0.0545 mg/m3 BeO.   Negative in genotoxicity studies and most mutagenicity studies; soluble Be compounds can induce forward mutations in mammalian cell lines and provides evidence that Be can induce malignant changes within these cells. |
| DFG 2005 Not assigned |
| No MAK value assigned as human carcinogenicity is demonstrated.  Summary of data:   * Recognised increased mortality related to lung cancer identified in workers disproportional to those with ABD * Exposure to inhaled concentrations in guinea pigs (10 mg/m3; 8 h and 16 h) presented urinary response and elimination commencing after 2 h * Excretion primarily via urine with blood elimination occurring in two identified rates (rapid response biological half-time between 1–60 d and slow rate between 0.6–2.3 yr). |
| SCOEL 2017 8-hour TWA: 0.02 µg/m3; STEL (15 mins): 0.2 µg/m3 |
| TWA and STEL are recommended based on toxicity of Be ion. Relevant critical effects are carcinogenicity, beryllium sensitivity and CBD.  Summary of data:   * Beryllium sensitivity reported at total dust concentration ≈0.1 µg/m3 * NOAEC: 0.02 µg/m3 (respirable dust fraction) for Beryllium sensitivity and CBD derived from LTW median exposure (as ACGIH); supported by LOAEC of 0.04 µg/m3 (respirable dust fraction) * carcinogenic effects associated with higher concentrations (≥10 µg/m3); with no clear NOAEL for cancer effects identified * Systemic effects considered a consequence of respiratory restrictive effects * Notation for sensitisation recommended for both skin and respiratory tract; no skin notation recommended * Inconsistent genotoxic results for soluble compounds in SCE, chromosomal aberrations and gene mutation in mammalian *in vitro* studies; negative *in vivo* studies * Carcinogenicity mode of action not clearly identified; appears indirectly genotoxic with cell transformation * ABD reported after single, high doses (>100 µg/m3) with symptoms ranging from mild inflammation to tracheo-bronchitis and severe pneumonitis * STEL based on study of sensitive workers exposed to >0.2 µg/m3.and possible correlation between high, short-term exposures with CBD * Limited studies available to support skin notation. |
| OARS/AIHA NA NA |
| No report |
| HCOTN NA NA |
| No report |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| NICNAS |  | 2014 | * Listed in Schedule 10 (prohibited carcinogens, restricted carcinogens and restricted hazardous chemicals); restricted use as 'for abrasive blasting at a concentration of greater than 0.1% as beryllium'. |
| IARC |  | 2012 | * Sufficient evidence in humans for the carcinogenicity of causing cancer in the lung – Be and compounds. |
| NTP |  | 1999 | * Sufficient evidence of Be and compounds causing cancer in humans * Highest exposures are through occupational exposures of inhalable dust or dermal contact with products. |
| US EPA |  | 1998 | * No additional data. |

### Carcinogenicity — non-threshold based genotoxic carcinogens

| Is the chemical mutagenic? | Insufficient data |
| --- | --- |
| Is the chemical carcinogenic with a mutagenic mechanism of action? | Insufficient data |
| **Insufficient data are available to determine if the chemical is a non-threshold based genotoxic carcinogen.** | |

## Notations

| Source | Notations |
| --- | --- |
| SWA | — |
| HCIS | Carcinogenicity – category 1B; Skin sensitisation – category 1 |
| NICNAS | Carcinogenicity – category 1B; Skin sensitisation – category 1 |
| EU Annex | Carcinogenicity – category 1B; Skin sensitisation – category 1 |
| ECHA | Carcinogenicity – category 1B |
| ACGIH | Carcinogenicity – A1; DSEN; RSEN |
| DFG | Carcinogenicity – 1; Sah (dermal sensitiser; respiratory sensitiser) |
| SCOEL | Carcinogenicity – C; Sensitisation (dermal); Sensitisation (respiratory) |
| HCOTN | — |
| IARC | Carcinogenicity – Group 1 |
| US NIOSH | — |

NA = not applicable (a recommendation has not been made by this Agency); — = the Agency has assessed available data for this chemical but has not recommended any notations

### Skin notation assessment

| Calculation |
| --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Conclusion:** |  |  |  |  | |  | Adverse effects in human case study: | yes | 4.00 |  | |  | Dermal LD50 ≤1000 mg/kg: |  |  |  | |  | Dermal repeat-dose NOAEL ≤200 mg/kg: |  |  |  | |  | Dermal LD50/Inhalation LD50 <10: |  |  |  | |  | *In vivo* dermal absorption rate >10%: |  |  |  | |  | Estimated dermal exposure at WES >10%: |  |  |  | |  |  |  |  | **a skin notation is warranted** | |

### IDLH

| Is there a suitable IDLH value available? | Yes |
| --- | --- |

## Additional information

| Molecular weight: | 9.01 (elemental) |
| --- | --- |
| Conversion factors at 25°C and 101.3 kPa: | 1 ppm = Number mg/m3; 1 mg/m3 = Number ppm |
| This chemical is used as a pesticide: |  |
| This chemical is a biological product: |  |
| This chemical is a by-product of a process: |  |
| A biological exposure index has been recommended by these agencies: | ACGIH  DFG  SCOEL |

## Workplace exposure standard history

| Year | Standard |
| --- | --- |
| Click here to enter year |  |

## References

American Conference of Industrial Hygienists (ACGIH®) (2018) TLVs® and BEIs® with 7th Edition Documentation, CD-ROM, Single User Version. Copyright 2018. Reprinted with permission. See the [*TLVs® and BEIs® Guidelines section*](http://www.acgih.org/tlv-bei-guidelines/policies-procedures-presentations) on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2005) Beryllium and its inorganic compounds – BAT value documentation.

Deutsche Forschungsgemeinschaft (DFG) (2005) Beryllium and its inorganic compounds – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2017) Recommendation from the Scientific Committee on Occupational Exposure Limits for Beryllium and Inorganic Beryllium Compounds. SCOEL/REC/175.

European Chemicals Agency (ECHA) (2014) Beryllium – REACH assessment. International Agency for Research on Cancer (IARC) (2012) 100C Beryllium and Beryllium Compounds. IARC Monographs on the evaluation of the carcinogenic risk to humans.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2014) Beryllium metal and Beryllium oxide: Human health tier II assessment – IMAP report.

National Toxicology Program (NTP) (1999) NTP-RoC: Beryllium and Beryllium Compounds.

Tenth Adaptation to Technical Progress Commission Regulation (EU) No 2017/776 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (the CLP Regulation).

US Environmental Protection Authority (US EPA) (1998) Integrated Risk Information System (IRIS) Chemical Assessment Summary – Beryllium and compounds.

US National Institute for Occupational Safety and Health (NIOSH) (1994) Immediately dangerous to life or health concentrations – beryllium compounds.