# Cadmium and compounds (as Cd)

| CAS number: | 7440-43-9 |
| --- | --- |
| Synonyms: | — |
| Chemical formula: | Cd |
| Structural formula: |  |

Workplace exposure standard (amended)

| TWA: | **1 µg/m3** |
| --- | --- |
| STEL: | **—** |
| Peak limitation: | **—** |
| Notations: | **Carc. 2** |
| IDLH: | **9 mg/m3** |
| Sampling and analysis: | The recommended value is quantifiable through available sampling and analysis techniques. |

## Recommendation and basis for workplace exposure standard

A TWA of 1 µg/m3 is recommended to protect for effects on the kidneys in exposed workers.

## Discussion and conclusions

Cadmium is a naturally occurring element that is primarily used as a coating for other metals and can be found in a range of consumer products. It is also recovered as a by-product during the refining of zinc, lead and copper.

The critical health effects include systemic long-term effects on the kidneys and lung cancer. Carcinogenic effects were reported in rats after multiple routes of exposure. An epidemiological study found no excess cancer incidence in workers exposed to an estimated cumulative exposure of cadmium corresponding to a 40-year TWA of 21 to 40 mg/m3. Cadmium oxide is acutely toxic in rats with a reported inhalation LC50 of 25 mg/m3. Acute, high exposures *via* inhalation are reported to be intensely irritating and to result in severe respiratory effects in humans including metal fume fever (ACGIH, 2018; DFG, 2006).

A study reviewing published data has presented a cumulative life-time lowest-effect exposure of 0.1 to 0.4 mg/m3 per year for kidney effects in workers (SCOEL, 2017). This value equates to an LOAEC of 0.0025 mg/m3. Applying an uncertainty factor of 2 to account for lack of NOAEC derives a TWA of 1 µg/m3. This TWA is considered sufficiently low to protect for adverse effects in kidneys and reduce the risk of cancer in exposed workers (SCOEL, 2017; HCTON, 2013).

## Recommendation for notations

Classified as a category 2 carcinogen according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Not classified as a skin sensitiser or respiratory sensitiser according to the GHS.

There are insufficient data to recommend a skin notation.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1995 TWA: 0.01 mg/m3 | |
| There is sufficient evidence that human exposure to cadmium and compounds may result in the development of lung cancer, based on animal studies and limited epidemiological evidence. The Working Group recommends that these compounds be classified as Carcinogen Category 2 (Probable Human Carcinogen). |
| ACGIH 2001 TLV-TWA: 0.01 mg/m3 (as Cd, total particulate) TLV-TWA: 0.002 mg/m3 (as Cd, respirable particulate) |
| The TLV-TWA for total particulate fraction is recommended to minimise the potential for development of preclinical kidney dysfunction. The respirable particulate TLV-TWA is recommended to minimise the potential for lower respiratory tract accumulation of a cadmium burden that could induce lung cancer.  Both TLV-TWAs should also significantly reduce the potential for metal fume fever in exposed workers.  Summary of data:  Human data:   * Acute inhalation overexposure reported to be intensely irritating and result in severe tracheobronchitis, pneumonitis and pulmonary oedema * Fatal cases reported after exposure to an estimated 40 mg/m3 and 50 mg/m3 for 1 h and 9 mg/m3 for 5 h * Non-fatal pneumonitis reported after exposure to estimated 0.5 and 2.5 mg/m3 * Kidney considered the primary target related to chronic exposure * Exposure to concentrations of 0.5 mg/m3 respirable sized dust for 6–12 yr resulted in urinary concentrations of β 2-microglobulin of >290 µg/L in 19% of the population study compared with 3.4% in the control group * an increase in β 2-microglobulin is an early indicator of renal dysfunction * No excess cancer found in workers exposed to an estimated cumulative exposure corresponding to a 40 yr TWA of 21–40 mg/m3.   Animal data:   * Inhalation study; rats exposed to cadmium chloride (CdCl2) 23 h/d for 18 mo; exposure/primary lung carcinoma frequency: * 12.5 µg/m3 =15.4%, 25 µg/m3 =52.6%, 50 µg/m3 =71.4%; no primary lung carcinomas in control group * A follow up study exposed rats to CdCl2, CdO (dust and fume), cadmium sulfate (CdSO4) and cadmium sulfide (CdS); effects reported: * 30 µg/m3 CdCl2 for 6 mo resulted in lung nodules in 1/20 males, not in females * 30 µg/m3 CdOfor 18 mo resulted in lung nodules in 2/20 males (no further information) * 90 µg/m3 CdSfor 18 mo resulted in lung nodules in 17/20 females (no further information). |
| DFG 2006 NA |
| No MAK recommended due to carcinogenic properties.  Summary of additional data:   * Estimated an 8 h exposure to 1 mg/m3 is hazardous to life and 5 mg/m3 is lethal * Epidemiological investigations in workers suggest exposure to cadmium and its inorganic compounds correlates with occurrence of lung cancer in humans * Based on the epidemiological evidence, an increased relative risk of renal cancer is likely * Carcinogenic effects found in rats after inhalation and oral, intratracheal, intraperitoneal, subcutaneous and intramuscular exposure * LC50: 30 mg/m3 (rats, CdO, 15 min); 25 mg/m3 (rats, CdO, 30 min) * LC50: ≈940 mg/m3 (monkeys, CdO, 14 min) * NOAEC of 0.025 mg/m3 CdO in rats for lung effects (13 wk study) * NOAEC of 0.01 mg/m3 CdO in hamsters for lung effects (16 mo study) * In general, did not induce mutations in bacterial assays * Mutations induced in yeast assays * Formation of DNA strand breaks, gene mutations and chromosome aberrations observed in mammalian cells; inhibited of damage in DNA caused by other compounds * Cd ion possibly more genotoxic than historically assumed. |
| SCOEL 2010 TWA: 0.004 mg/m3 (respirable fraction) |
| TWA recommended to protect for systemic nephrotoxicity (effects in kidney).  Summary of additional data:   * Reported a cancer risk estimate of 1 excess in 100,000 for exposure to a lifetime exposure of 0.02 µg/m3 based on epidemiological data * Reported a cumulative life-time lowest-effect exposure of 0.1–0.4 mg/m3 yr for kidney effects in workers; ≡LOAEC of 0.0025–0.01 mg/m3 * TWA based on kidney effect LOAEC * TWA relates to both fumes and dust and to inhalable fraction as all inhaled cadmium can contribute to the critical effect * Skin notation not warranted * Not considered to be sensitiser or reproductive toxicant. |
| OARS/AIHA NA NA |
| No report. |
| HCOTN 2019 TWA: 4 µg/m3 (respirable fraction) in combination with a BLV |
| TWA recommended to protect for effects in the kidneys and carcinogenic effects in exposed workers.  Summary of additional data:   * Reported an equivalent LOAEL of 12.5 µg/m3 based on cumulative exposure of 500 µg/m3 yr (CdO) leading to changes in residual lung volume * Applying an UF of 3 to the LOAEL derives the recommended TWA of 4 μg/m3 * Recommended a health-based BLV in urine of 2 μg/g creatinine (as cadmium) to protect workers against systemic toxicity, used in combination with a health-based TWA * Accounts for non-occupational exposures as it accumulates in the body. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| NICNAS |  | 2016 | * LOAEC of 0.0031 mg/L, based on lung effects (increased residual levels of the chemical), derived from study on workers exposed to CdO fumes <0.5 mg/m³ over several yr * Reproductive LOAEL of 1 mg/m³ reported based on 13 wk inhalation study in rats; with decreased spermatid counts and increased oestrous cycle lengths. |
| IARC |  | 1993 | * Based on sufficient evidence in humans and animals for lung cancer; classified as carcinogenic to humans (Group 1). |

### Carcinogenicity — non-threshold based genotoxic carcinogens

| Is the chemical mutagenic? | No |
| --- | --- |
| **The chemical is not a non-threshold based genotoxic carcinogen.** |  |

## Notations

| Source | Notations |
| --- | --- |
| SWA | Carc. 2 |
| HCIS | Carcinogenicity – category 1B |
| NICNAS | Carc. Cat. 2 |
| EU Annex | Carcinogenicity – category 1B |
| ECHA | Carcinogenicity – category 1B |
| ACGIH | Carcinogenicity – A2 |
| DFG | Carcinogenicity – 1, H (skin) |
| SCOEL | Carcinogenicity – C |
| 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 |
| --- |
| Insufficient data to assign a skin notation. |

### IDLH

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

## Additional information

| Molecular weight: | 112.41 (element) |
| --- | --- |
| 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) (2006) Cadmium and its inorganic compounds – MAK value documentation.

European Chemicals Agency Regulation (ECHA) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2010) Recommendation from the Scientific Committee on Occupational Exposure Limits for cadmium and its inorganic compounds. SCOEL/SUM/136.

Health Council of the Netherlands (HCOTN) (2000) Cadmium and its compound. Evaluation of the effects on reproduction, recommendation for classification. The Hague: Health Council of the Netherlands; publication no. 2000/04OSH.

Health Council of the Netherlands (HCOTN) (2019) Cadmium and inorganic cadmium compounds. Health-based recommendation on occupational exposure limits. The Hague: Health Council of the Netherlands; publication no. 2019/03.

International Agency for Research on Cancer (IARC) Cadmium and cadmium compounds. IARC Monographs – 100C.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2016) Cadmium: Human health tier II assessment – IMAP report.

Tenth Adaptation to Technical Progress Commission Regulation (EU Annex) 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 National Institute for Occupational Safety and Health (NIOSH) (1994) Immediately dangerous to life and health concentrations – Cadmium compounds (as Cd).