# chromium (VI) (as Cr)

| CAS number: | — |
| --- | --- |
| Synonyms: | Chrome; chromate; dichromate; hexavalent chromium |
| Chemical formula: | Cr(VI) |
| Structural formula: | — |

Workplace exposure standard (amended)

| TWA: | **0.007 µg/m3** |
| --- | --- |
| STEL: | **—** |
| Peak limitation: | **—** |
| Notations: | **Carc 1B, Sk., DSEN** |
| IDLH: | **—** |
| Sampling and analysis: |  |

## Recommendation and basis for workplace exposure standard

A TWA of 0.007 µg/m3 is recommended to reduce the risk of cancer in exposed workers.

## Discussion and conclusions

Hexavalent chromium (Cr[VI]) compounds have been used in pigments in a range of products and applications.

Water-soluble Cr(VI) compounds are highly irritating to the skin and mucous membranes and may cause sensitisation of the skin and respiratory tract. Based on evidence in animals and humans, Cr(VI) is characterised a non-threshold based genotoxic carcinogen (ACGIH, 2018; DFG, 2016; US EPA, 1998). Its carcinogenicity is demonstrated to act *via* a mutagenic mode of action.

The recommended TWA of 0.007 µg/m³ has been calculated at a minimal cancer risk level applying an inhalation unit risk value. This value is based on data from a study reporting an increased risk of lung cancer in exposed workers (US EPA, 1998).

## Recommendation for notations

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

Classified as a skin sensitiser but not a respiratory sensitiser according to the GHS.

A skin notation is recommended based on evidence of dermal absorption in animals.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA Year TWA: 0.05 mg/m3 | |
|  |
| ACGIH 2018 TLV-TWA: 0.0002 mg/m3, as Cr(VI), Inhalable particulate matter TLV-STEL, 0.0005 mg/m3, as Cr(VI), Inhalable particulate matter |
| TLV-TWA and TLV-STEL recommended to protect for severe irritation of the upper and lower respiratory tract and from decreases in lung function in exposed workers. TLV-TWA and TLV-STEL also expected to minimise respiratory sensitisation and reduce the likelihood of asthmatic responses in sensitised individuals.  Summary of data:  Water-soluble Cr(VI) compounds are highly irritating to the skin and mucous membranes and may cause sensitisation of the skin and respiratory tract.  Human data:   * Retrospective cohort study identified corrosive nasal and ear effects occurring within 1 mo following the onset of exposure to median exposures of 0.010–0.015 mg/m3 * Significant excess rates for nasal irritation, mucosal atrophy and ulceration and decreased lung function in workers exposed to mean 8-h TWA of 0.002–0.020 mg/m3 * nasal irritation and signs of mucosal atrophy at levels <0.002 mg/m3 (8-h TWA) * NOAEL of 0.0002–0.0012 mg/m3 for respiratory effects * Water soluble Cr(VI) is readily absorbed *via* skin and detected by increased Cr excretion in urine * Acknowledged that Cr(VI) compounds cause lung and sinonasal cancers in humans * Reported an excess risk of lung cancer death estimated at 1/1,000 workers exposed to 0.0002 mg/m3 * Reported a risk of lung cancer deaths of 2/1,000 workers exposed to 0.001 mg/m3 for a working lifetime.   Animal data:   * LOAEL of 0.096 mg/m3 Cr(VI) for persistent inflammatory changes in the lungs in rats exposed for 30 and 90 d; adjusted to 8 h/d, 5 d/wk equivalent: * a human equivalent LOAEL of 0.002 mg/m3 derived using species-specific dosimetry modelling * further adjusted to obtain a NOAEL of 0.0002 mg/m3 * Dermal LD50 of 336–763 mg/kg for female and male rabbits.   Genotoxicity data:   * Chromium species resulting from metabolic processing of Cr(VI) are capable of interaction with DNA to produce genotoxic and mutagenic effects * Intracellular reduction of Cr(VI) produce DNA adducts, DNA-strand breaks, DNA-protein crosslinks, oxidized bases, abasic sites (apurinic/apyrimidinic site) and DNA inter- and intra-strand crosslinks and can lead to dysfunctional DNA replication and repair mechanisms. |
| DFG 2016 Not assigned |
| No recommended MAK due to confirmed carcinogenic properties.  Summary of additional data:   * Increased relative risk of mortality from lung cancer in chromate and chrome-plating plants * Confirmed carcinogenic effects in animals * Genotoxic in numerous studies with bacteria and mammalian cells * Chromium-DNA adducts can reduce the accuracy of base pairing in DNA replication and cause gene mutation; increased mutation frequency and genomic instability due to the formation of DNA double strand breaks can be attributed to an incorrect mismatch repair of chromium-DNA adduct. |
| SCOEL 2017 Not assigned |
| No TWA recommended due to carcinogenicity.  Based on the available evidence, concluded Cr(VI) compounds are carcinogens with no threshold.  Derived limit values of 0.025, 0.05 or 0.1 mg/m3 based on excess cancer risk. |
| OARS/AIHA NA NA |
| No report. |
| HCOTN 2016 TWA: 10 µg/m3; STEL: 20 µg/m3 (soluble Cr[VI] compounds) TWA: 50 µg/m3 (poorly soluble Cr[VI] compounds) |
| Concludes all hexavalent chromium compounds are carcinogenic substances with no threshold and genotoxic mechanisms. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| US EPA |  | 1998 | * Rapidly taken up by cells through the sulphate transport system where it is quickly reduced to trivalent forms; trivalent forms do not readily cross cell membranes * Carcinogenesis likely to result from the formation of mutagenic DNA lesions following intracellular reduction to the Cr(III) * IUR derived from mortality study (1951) and follow up (1975) on a cohort of chromate workers investigating lung cancer association with the work environment * An additional follow up (1997) reported that lung cancer rates clearly increased by gradient level of exposure to total chromium * The relationship between gradient level of exposure and lung cancer rates is less clear for Cr(III) and Cr(VI). |

### Carcinogenicity — non-threshold based genotoxic carcinogens

| Is the chemical mutagenic? | Yes |
| --- | --- |
| Is the chemical carcinogenic with a mutagenic mechanism of action? | Yes |
| **The chemical is a non-threshold based genotoxic carcinogen.** |  |
| Is a cancer slope factor or inhalation unit risk value available? | Yes |
| Inhalation unit risk value (1/(µg/m³)) | 0.012 |
| Calculated TWA value (µg/m3) | 0.007 |

## Notations

| Source | Notations |
| --- | --- |
| SWA | NA |
| HCIS | Carcinogenicity – category 1B; Skin sensitisation – category 1. |
| NICNAS | NA |
| EU Annex | Carcinogenicity – category 1B, Skin sensitisation – category 1. |
| ECHA | Carcinogenicity – category 1B. |
| ACGIH | Carcinogenicity – A1, Skin (water-soluble compounds only), RSEN, DSEN. |
| DFG | Carcinogenicity – 1, H (skin), Sh (dermal sensitiser). |
| SCOEL | Carcinogenicity – A, Sensitisation (respiratory), Sensitisation (dermal). |
| HCOTN | — |
| IARC | Carcinogenicity – Group 1. |
| US NIOSH | NA |

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 |
| --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | Adverse effects in human case study: | yes |  |  |  | | Dermal LD50 ≤1000 mg/kg: | yes | 3.00 |  |  | | Dermal repeat-dose NOAEL ≤200 mg/kg: |  |  |  |  | | Dermal LD50/Inhalation LD50 <10: |  |  |  |  | | *In vivo* dermal absorption rate >10%: |  |  |  |  | | Estimated dermal exposure at WES >10%: |  |  |  |  | |  |  | 3 | **consider assigning a skin notation** | | |

### IDLH

| Is there a suitable IDLH value available? | No, the chemical is a genotoxic carcinogen |
| --- | --- |

## Additional information

| Molecular weight: | N/A |
| --- | --- |
| 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) (2016) Chromium(VI) compounds (inhalable fraction) – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2017) Recommendation from the Scientific Committee on Occupational Exposure Limits for chromium VI compounds. SCOEL/REC/386.

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).

Health Council of the Netherlands (HCOTN) (2016) Hexavalent chromium compounds. Health-based recommendation on occupational exposure limits. The Hague: Health Council of the Netherlands; publication no. 2016/13E.

International Agency for Research on Cancer (IARC) (2012) Arsenic, Metals, Fibres and Dust. IARC Monographs on the evaluation of the carcinogenic risk to humans.

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 – Hexavalent Chromium.