# mercury and compOUNDs (excluding alKYLS) (as hg)

| CAS number: | 7439-97-6 (elemental) |
| --- | --- |
| Synonyms: | — |
| Chemical formula: | Hg |
| Structural formula: | — |

Workplace exposure standard (interim)

| TWA: | **0.025 mg/m3 (elemental and inorganic)**  **0.1 mg/m3 (aryl compounds)** |
| --- | --- |
| STEL: | **—** |
| Peak limitation: | **—** |
| Notations: | **Sk.** |
| IDLH: | **10 mg/m3 (except alkyls), (as Hg)** |
| **Sampling and analysis:** The recommended value is quantifiable through available sampling and analysis techniques. | |

## Recommendation and basis for workplace exposure standard

A TWA of 0.025 mg/m3 (elemental and inorganic forms) and 0.1 mg/m3 (aryl compounds) is recommended to protect for central nervous system (CNS) and kidney effects in exposed workers and to reduce the risk of developmental effects in the progeny of exposed workers.

Given the limited data available from the primary sources, it is recommended that a review of additional sources be conducted at the next scheduled review.

## Discussion and conclusions

Mercury (Hg) is extensively used in thermometers, barometers, gauges and valves and is heavily used in dry cell batteries, lamps, wiring and switching devices and electronic equipment. Mercury is produced as by-product of gold and bauxite mining.

The critical effects of exposure include systemic short- and long-term effects including reproductive and developmental toxicity, hepatotoxicity, neurotoxicity and cumulative effects. No abnormalities in perceptual, motor, memory or learning abilities is reported in workers exposed at a long-term average concentration of 25 µg/m3 (ACGIH, 2018). Hand tremors in 26 workers exposed to an average of 26 µg/m3 differed significantly from controls and is considered an effect of duration of exposure (DFG, 2011). The World Health Organization (WHO) recommends a maximum exposure of 25 µg/m3 which is considered protective for the general population including sensitive subgroups (ACGIH, 2018). No histological changes are reported in the brain, kidneys, liver or lungs of rats, rabbits and dogs exposed at 0.1 mg/m3 (mercury vapour) for up to 83 weeks.

A developmental study in rats reports a NOAEC for offspring of 4 mg/m3 (mercury vapour) in relation to mercury levels in brain, liver and kidney (DFG, 2011). One study in multiple animal species reports a NOAEC of 0.1 mg/m3 (mercury vapour) in relation to kidney and CNS effects (SCOEL, 2007).

ACGIH (2018) recommend a TWA of 0.025 mg/m3 for elemental and inorganic forms and 0.1 mg/m3 for aryl compounds. No explanation is provided about the derivation of the TWA concentrations.

The available evidence does not provide clear separation of the toxicological data for the various mercury containing compounds. Given the limited data, a TWA of 0.025 mg/m3 (as Hg) is recommended for elemental mercury, inorganic forms of mercury compounds and a TWA of 0.1 mg/m3 is recommended for aryl mercurial compounds to limit the symptoms associated with the critical effects.

A priority review is recommended to identify any differences between the health effects, dose-response data and exposure to the different mercury containing compounds.

## Recommendation for notations

Not classified as a 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. A review of the classification for skin sensitisation is recommended as there is evidence of dermal sensitisation reported in the primary sources.

A skin notation is recommended based on evidence of dermal uptake in humans, systemic effects and the severity of potential health outcomes.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 2001 TWA: 0.025 mg/m3 as Hg (Elemental and inorganic forms) 1991 TWA: 0.1 mg/m3 as Hg (Aryl Compounds) | |
|  |
| ACGIH 2001 TLV-TWA: 0.025 mg/m3 as Hg (Elemental and inorganic forms) 2018 TLV-TWA: 0.1 mg/m3 as Hg (Aryl Compounds) |
| TLV-TWA recommended to minimise the potential for preclinical CNS changes and kidney effects, and to reduce the risk of reproductive and development effects of exposed workers.  Summary of data:  Human data:   * Numerous cases of individual poisonings of adults and children in literature; including exposure from clothing contaminated with Hg brought home from work * Symptoms of toxicity may include tremors, emotional instability and irritability, peripheral neuropathy, gingivitis, stomatitis, ocular and vision changes, hearing loss and renal impairment * effects observed in persons exposed to metallic Hg, inorganic Hg compounds and organic Hg compounds, including aryl compounds * Skin absorption is a recognised route of exposure * Study of 40 exposed workers 80% <5 yr exposure, 42% exposed <10 µg/m3, 80% exposed <40 µg/m3: * elevated mean urine and blood levels * increased plasma galactosidase and catalase activity * Workers exposed at 0.06 to 0.3 mg/m3 (no duration or frequency provided): * increased plasma enzymes correlated with exposure * marked glomerular proteinuria in 15 cases * previous neuropathy in 5 cases * hypertension and glomerular proteinuria in 4 cases * Correlation between increased glomerular dysfunction and exposure, elevated excretion of high molecular weight protein, higher prevalence of β2u-globulin in plasma without concomitant change in urinary β2u-globulin concentration; stronger correlation in workers with Hg urine levels >50 μg/g creatinine (study on 63 workers) * Study of tremors in 21 workers; finger tremors correlated with urinary Hg concentrations and exposure; 20 µmol/mol creatinine (~36 µg/L) ≡ ~17 µg/m3 exposure * Study of 26 workers exposed to average 26 µg/m3; exposed workers differed significantly from controls in the spectrum of hand tremor; duration of exposure important indicator; no further information * Study of 231 workers for signs of overt related symptoms; exposed to 0.05–0.10 mg/m3; no evident cases of intoxication identified * Study of cardiovascular reflexes in male workers; long-term exposure at 30 µg/m3 did not cause adverse effects on the autonomic nervous system * No abnormalities in perceptual, motor, memory, or learning abilities in workers exposed at a long-term average concentration of 25 µg/m3 * WHO recommend an exposure maximum of 25 µg/m3; protective for public including sensitive sub-groups. * Urine levels of 500–850 µg/L considered good predictor of polyneuropathy * In studies of attempted or successful suicides, urine Hg was not found to be a reliable indicator of the absorbed dose * Limited human data on reproductive effects, not possible to clearly establish an exposure level for absolute protection of reproduction function in male or female workers.   Animal data:   * Extensive toxicological literature on animals; clear evidence elemental and inorganic mercury compounds in several animal species producing effects parallel to those observed in humans * exposed animals display neurophysiological, kidney, behavioural, morphological, electrophysical, reproductive and biochemical effects * Rats injected IP developed spindle-shaped sarcomas containing fine droplets of Hg after 2 yr; no evidence of carcinogenic potential in humans * Inorganic Hg affected the endocrine and gonadal function with a considerable reduction in fertility in both male and female rodents * Placental transfer of elemental Hg more rapid following inhalation than by other routes * Refers to ATSDR (1989) and WHO (1991); no further information presented. * Mercuric chloride negative in *Salmonella* assay.   No explanation as to how different TLV-TWA concentrations for elemental, inorganic mercury compounds and aryl mercury compounds were derived. |
| DFG 2011 MAK: 0.02 mg/m3 as Hg (Elemental and inorganic forms) 2001 Not assigned as Hg (Aryl Compounds) |
| MAK recommended to protect for effects on the kidneys and the nervous system in exposed workers.  Elemental and inorganic Hg compounds.  No evidence provided regarding aryl compounds  Summary of additional data:   * Studies with volunteers indicates absorbed through the skin from vapour phase * Exposure of rats, rabbits and dogs at 0.1 mg/m3 (Hg vapour) (7 h/d, 5 d/wk for up to 83 wk); no histological changes in brain, kidneys, liver or lungs * NOEL 5 mg/kg in female mice, 2.5 mg/kg in male mice; mercury(II) chloride; kidney damage; sub-chronic or chronic oral study (no further information) * Pregnant rats exposed for 2 h/d GD 6–15: * maternal NOAEC 2 mg/m3 (Hg vapour) * offspring NOAEC 4 mg/m3 (brain, liver, kidney effects) * number of resorptions was increased at 8 mg/m3 on GD 15, litter size and weight at birth of the offspring were decreased * Embryotoxicity or foetal toxicity of Hg vapour increases with exposure duration * Human case studies on skin sensitisation indicate positive responses: * mercuric amidochloride (concentration not reported); 3% of patients (n=8,743) * mercuric amidochloride solution (1%); 2.5% (n=35,082) * Hg in petroleum (0.5%); 8.9% (n=2,766) * MAK based on correlation to Biological Tolerance Value and inner burden; 25 µg/g creatinine in humans; no nephrotoxic or clinically relevant neurotoxic effect is to be expected * Clastogenic *in vitro*; confirmed in one animal study; genotoxic dose level obtained in animal studies >2 mg/kg. |
| SCOEL 2007 TWA: 0.02 mg/m3 |
| TWA recommended to protect for systemic and developmental effects in exposed workers.  Summary of additional information   * TWA for elemental Hg and its inorganic divalent compounds; does not include inorganic monovalent compounds or organic mercury compounds * Common OEL derived for elemental and divalent inorganic Hg, based on the interchangeability of individual chemical forms * A critical level of 30 µg/g creatinine can be recommended to avoid possible neurobehavioural effects; * 35 µg/g creatinine predicted as ≡25 µg/m3; using mean value for extrapolating from urinary mercury of 0.7 µg/m3 * Repeated inhalation exposure of animals to elemental Hg vapour; kidney and CNS toxicity; rabbits at 0.86 mg/m3; rats at 3 mg/m3; 1 study reported NOAEC in several species at 0.1 mg/m3 * No TWA or report for inorganic monovalent compounds or organic Hg compounds. |
| OARS/AIHA NA NA |
| No report. |
| HCOTN 2000 Not assigned |
| Not assigned. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| ECHA |  | 2006 | * Evidence of a carcinogenic activity in male mice; occurrence of two renal tubule adenomas and one renal tubule adenocarcinomas; no evidence of a carcinogenic activity in female mice * The carcinogenic potential of Hg is related to metal induced oxidative stress and thus, if a potential is present in humans, a threshold effect is possible. |
| NICNAS |  | 2015 | * Accidental industrial exposure of 6 male workers to 44 mg/m3 4–8 h; chest pains, dyspnoea, cough with blood or bloody sputum, and pneumonitis; chronic effects last for several years after single accidental exposure * LC50: <27 mg/m3 (rats). |
| US EPA |  | 1995 | * LOAEC of 9 µg/m3 based on hand tremors, memory disturbance and autonomic dysfunction in human occupational inhalation studies * RfC 0.3 µg/m3 Hg exposure for public; includes sensitive subgroups. |

### 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 | NA |
| HCIS | NA |
| NICNAS | NA |
| EU Annex | NA |
| ECHA | NA |
| ACGIH | A4, Skin |
| DFG | Carcinogenicity – 3B, H (skin), Sh (dermal sensitiser) |
| SCOEL | NA |
| HCOTN | NA |
| IARC | Carcinogenicity – Group 3 |
| 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 | 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: | 200.59 (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) (2016) Mercury and inorganic mercury 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) (2007) Recommendation from the Scientific Committee on Occupational Exposure Limits for elemental mercury and inorganic divalent mercury compounds. SCOEL/SUM/84.

Health Council of the Netherlands (HCOTN) (2000) Mercury and its compounds. Evaluation of the effects on reproduction, recommendation for classification. The Hague: Health Council of the Netherlands; publication no. 2000/05OSH.

International Agency for Research on Cancer (IARC) (1993) Volume 58, Beryllium, Cadmium, Mercury, and Exposures in the Glass Manufacturing Industry. IARC Monographs on the evaluation of the carcinogenic risk to humans.

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US Environmental Protection Authority (US EPA) (1995) Integrated Risk Information System (IRIS) Chemical Assessment Summary – mercury, elemental.