# Aluminium – DUSTS (METAL, PYRO, OXIDE) & COMPOUNDS (soluble, ALKYLS)

| CAS numbers: | 7429-90-5 (Aluminium and compounds)  1344-28-1 (Aluminium oxide) |
| --- | --- |
| Synonyms: | Aluminum, aluminium oxides, alkyl and organoaluminium |
| Chemical formula: | Al (elemental) |
| Structural formula: | — |

Workplace exposure standard (interim)

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

## Recommendation and basis for workplace exposure standard

An interim TWA of 1 mg/m3 is recommended to protect for adverse effects in the lungs and central nervous system (CNS) in exposed workers.

It is recommended that a review of additional data sources be undertaken at the next scheduled review for soluble aluminium compounds due to insufficient data on identified dose-response relationships.

## Discussion and conclusions

Aluminium is naturally abundant and used in metal alloys and manufacturing. In air, it is usually associated with particulate matter with exposure impacting the lungs and CNS. Less soluble forms of aluminium (e.g. aluminium metal and aluminium oxide) demonstrate markedly less bioavailability than the more soluble forms (e.g. alkyl aluminium compounds; ACGIH, 2018; DFG 2007; HCTON, 2013).

A LOAEL was reported at 4.6 to11.5 mg/m3 for psychomotor and cognitive impairment in a group of 87 aluminium factory workers occupationally exposed for eight hours over 12 years (US EPA, 2006). Increased prevalence of neurological effects was reported at a body burden equivalent to breathing 1.6 mg/m3 for 40 years (insoluble form). However, these dose-response relationships are not considered to be robust and further investigation is recommended.

A LOAEL of 0.25 mg/m3 for granulomatous change in the peribronchial lymph node in rats is reported following aluminium chlorohydrate exposure. However, there is insufficient information on the factors affecting aluminium toxicity in the lungs to derive a health-based level for insoluble and poorly soluble forms of aluminium from the aluminium chlorohydrate exposure data (HCOTN, 2013).

A NOAEL for aluminosis of 2.45 mg/m3 (as aluminium oxide) isreported in rats. Minor respiratory effects in rats are reported at 2.5 mg/m3 for insoluble forms of aluminium (HCTON, 2013).

Noting the uncertainties and on a weight of evidence, the interim TWA is considered sufficient to protect for adverse effects in the lungs and CNS in exposed workers. However, further investigation of additional sources is recommended.

## Recommendation for notations

Not classified as a carcinogen according to the Globally Harmonized System of Classification and Labelling of Chemicals.

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

A skin notation is not recommended based on the available evidence.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1991 TWA: 5 mg/m3 (Aluminium metal, aluminium pyro powder); TWA: 10 mg/m3 (Aluminium welding fumes, aluminium oxide); TWA: 2 mg/m3 (Aluminium soluble salts, aluminium alkyls) | |
|  |
| ACGIH 2008 TLV-TWA: 1 mg/m3 |
| TLV-TWA recommended for insoluble forms (including aluminium metal, aluminium oxide, bauxite ore dust and emery dust) and considered sufficiently low to protect against pneumoconiosis, lower respiratory tract irritation and neurotoxicity.  Summary of data:  Human data:   * Several studies of workers reported respiratory effects; effects possibly associated with co-exposure to fluorides * A study of male Al product workers (n=1,142) concluded a slight reduction in pulmonary function likely related to cumulative exposures of >100 mg/m3.yr (as total dust) * 6 new cases of asthma reported in Al refinery workers (no number subjects provided) exposed to 2.6–5.5 mg/m3 following an AlF3 leak (no duration specified); sharp decline in number of new asthma cases when concentrations were reduced to 0.4–1.0 mg/m3 * A study of employees of 3 Al2O3 refineries exposed to 0.98–2.18 mg/m3 Al2O3 (4 h weighted average) reported no associated significant adverse respiratory effects * changes in pulmonary function (not clinically significant) a likely result of exposure to irritants * Case report of death of 2 workers, 1 exposed to concentrations up to 615–685 mg/m3 (total dust; 51 mg/m3 respirable dust) powdered metallic Al (81% metal and 17% oxide); 1 worker showed signs of pulmonary interstitial fibrosis after 2 yr; 4 others showed signs of nodular interstitial fibrosis (no further information) * Case report of worker death exposed to metal flake powder following pulmonary fibrosis, encephalopathy, seizures and neurological symptoms (no further information) * Increased prevalence of neurological effects reported at a body burden equivalent to breathing 1.6 mg/m3 for 40 yr (insoluble form); corresponds to a urinary aluminium level of 100 µg/L and represents a threshold for neurological effects * Al not considered to be a causal factor in Alzheimer’s disease.   Animal data:   * NOAEL: 2.45 mg/m3 Al2O3 (rats, fibrosis/aluminosis) * Minor respiratory effects in rats at 2.5 mg/m3 (insoluble forms) * Evidence suggests high oral doses of soluble Al compounds may be associated with maternal and foetal toxicity.   Insoluble forms poorly absorbed and readily cleared from the lungs by mucociliary and bronchoalveolar activity.  Toxicological data for the soluble compounds, alkyl compounds, and for metal flakes and powder coated with oxidation inhibited oils were considered inadequate.  TLV-TWA of 1 mg/m3 is recommended based on the neurological effects from the inhalational of 1.6 mg/m3 for 40 yr, considering all available animal and human data. |
| DFG 2007 MAK: 1.5 mg/m3 (respirable); 4 mg/m3 (inhalable) |
| MAK recommended for dusts containing Al metal, oxide or hydroxide and is considered protective of effects in the lungs and CNS (excludes ultrafine particles, which can occur during Al welding).  Summary of additional data:   * Soluble salts have a markedly higher bioavailability than insoluble forms * NOAEL data in humans inadequate * High Al concentrations in workplace air caused lung fibrosis and aluminosis. (no further information); Al concentration in urine in such situations reported >200 µg/L (BAT value) * Concentrations in urine >200 µg/L associated with a significant increase in aluminosis * Not found to be mutagenic in bacterial and in mammalian cell tests. |
| SCOEL NA NA |
| No report |
| OARS/AIHA NA NA |
| No report |
| HCOTN 2013 NA |
| No health-based OEL recommended for metal or other compounds.  Summary of additional data:   * Considers available human data insufficient to derive health based OEL for metal and compounds; animal data available for Al2Cl(OH)5: * high incidences of changes in peribronchial lymph node at 2.5 mg/m3 Al2Cl(OH)5 (rat, 6 mo); minimal changes at 0.25 mg/m3 Al2Cl(OH)5 (LOAEL) * based on LOAEL in rats of 0.25 mg/m3, recommends health based OEL for Al2Cl(OH)5 of 0.05 mg/m3, as inhalable dust * Suggests insoluble or poorly soluble forms of Al may act similarly in the lungs but the is insufficient information on the factors effecting Al toxicity in the lungs applying the health-based OEL derived from Al2Cl(OH)5 for insoluble and poorly soluble forms of Al is not acceptable * Lists OELs for soluble salts from other international bodies as 1–2 mg/m3. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| ECHA |  | 2002 | * LC50: >2.3 mg/L (oxide) (rat, inhalation) as Al(OH)3 * NOAEC: 70 mg/m³ (inhalable oxide); (rat, subchronic) as Al(OH)3. |
| US EPA |  | 2006 | * LOAEL: 4.6–11.5 mg/m3 (human; 8 h occupational); psychomotor and cognitive impairment (as Al). |

### 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 | — |
| HCIS | — |
| NICNAS | — |
| EU Annex | — |
| ECHA | — |
| ACGIH | Carcinogenicity – A4 (7429-90-5) |
| DFG | — |
| SCOEL | NA |
| HCOTN | — |
| IARC | — |
| 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 |
| --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | Adverse effects in human case study: |  |  |  |  | | Dermal LD50 ≤1000 mg/kg: |  |  |  |  | | Dermal repeat-dose NOAEL ≤200 mg/kg: | no | -3.00 |  |  | | Dermal LD50/Inhalation LD50 <10: |  |  |  |  | | *In vivo* dermal absorption rate >10%: |  |  |  |  | | Estimated dermal exposure at WES >10%: |  |  |  |  | |  |  | -3 | **a skin notation is not warranted** | | |

### IDLH

| Is there a suitable IDLH value available? | No |
| --- | --- |

## Additional information

| Molecular weight: | 26.98 (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) (2007) Aluminium Dusts containing aluminium as metal aluminium oxide and aluminium hydroxide – MAK value documentation.

Health Council of the Netherlands (HCOTN) (2010) Aluminium and aluminium compounds. Health-based calculated occupational cancer risk values. The Hague: Health Council of the Netherlands; publication no. 2012/32.

European Chemicals Agency (ECHA) (2002) Aluminium hydroxide – REACH assessment.

US Environmental Protection Agency (US EPA) (2006) Provisional Peer Reviewed Toxicity Values for Aluminum.