

## ZINC OXIDE (DUST & FUME)

**CAS number:** 1314-13-2

**Synonyms:** Zincite, zinc white

**Chemical formula:** ZnO

### Workplace exposure standard (amended)

**TWA:** 2 mg/m<sup>3</sup> (fume and dust)

**STEL:** 10 mg/m<sup>3</sup>

**Peak limitation:** —

**Notations:** —

**IDLH:** 500 mg/m<sup>3</sup>

**Sampling and analysis:** The recommended value is quantifiable through available sampling and analysis techniques.

### Recommendation and basis for workplace exposure standard

A TWA of 2 mg/m<sup>3</sup> for both fume and dust is recommended to protect for metal fume fever in exposed workers.

A STEL of 10 mg/m<sup>3</sup> is recommended to protect for adverse pulmonary response in exposed workers

### Discussion and conclusions

Zinc oxide is widely used in pigments, rubber, cosmetics and ointments and electronic devices. Occupational exposure to zinc oxide may occur during its manufacture (dust) or through its formation as a fume as a result of subjecting zinc or zinc containing alloys to elevated temperatures such as welding.

The critical effect of exposure is metal fume fever with symptoms including cough, dyspnoea, fever, chills, sub-sternal chest pain, nausea and vomiting. Complete recovery generally occurs without intervention within 24 to 48 hours.

There is no evidence to distinguish between the effects caused by fume and dust exposures. Volunteers inhaling zinc oxide at 0.5 mg/m<sup>3</sup> for two hours did not have noticeable effects or increases in inflammation markers (DFG, 2010). The DFG (2010) considered this concentration to be a NOAEC (DFG, 2010). Metal fume fever occurs in test subjects after a single two-hour exposure at 2.5 mg/m<sup>3</sup> of freshly formed zinc oxide (ACGIH, 2018). Symptoms of metal fume fever develop in volunteers exposed at 5 mg/m<sup>3</sup> (fume) for two hours per day over three consecutive days (ACGIH, 2018; DFG, 2010). A significant pulmonary response observed in volunteers after a brief exposure at concentrations greater than 10 mg/m<sup>3</sup> (ACGIH, 2018). Rats and guinea pigs developed inflammation of the lung after a single three-hour exposure at 2.5 mg/m<sup>3</sup>. There is evidence of tolerance development in humans and animals (ACGIH, 2018).

The evidence suggests the critical effect occurs in both humans and animals at 2.5 mg/m<sup>3</sup>. Noting the lack of long-term data, a TWA of 2 mg/m<sup>3</sup> for both fume and dusts of zinc oxide (inhalable fraction) is recommended to protect for metal fume fever in workers. The data indicate pulmonary response in

humans briefly exposed at greater than 10 mg/m<sup>3</sup> and therefore a STEL of 10 mg/m<sup>3</sup> is also recommended.

### **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.

There are insufficient data to recommend a skin notation.

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## APPENDIX

### Primary sources with reports

Source	Year set	Standard
<b>SWA</b>	<b>1991</b>	<b>TWA: 10 mg/m<sup>3</sup> (dust)</b> <b>TWA: 5 mg/m<sup>3</sup>; STEL 10 mg/m<sup>3</sup> (fume)</b>
<b>ACGIH</b>	<b>2003</b>	<b>TLV-TWA: 2 mg/m<sup>3</sup>; TLV-STEL: 10 mg/m<sup>3</sup></b>
<p>TLVs recommended to reduce incidence of metal fume fever. These TLV are expressed as respirable particulate mass because the fume particles produced in high temperature operations such as welding are in the fine and ultrafine size fractions.</p> <p>Summary of data:</p> <ul style="list-style-type: none"> <li>Biochemical, cellular, and molecular changes in the mammalian lung reported in rats and mice studies at exposure at of 1 or 2.5 mg/m<sup>3</sup> for 3 h</li> <li>Pulmonary response to fumes in mice is strain dependent, suggesting a genetic component in interindividual variability in response.</li> </ul> <p>Human data:</p> <ul style="list-style-type: none"> <li>Metal fume fever symptoms include cough, dyspnoea, fever, chills, sub-sternal chest pain, nausea, and vomiting: <ul style="list-style-type: none"> <li>complete recovery generally occurs without intervention within 24–48 h</li> </ul> </li> <li>Pulmonary function changes absent after a 2 h exposure to freshly formed ZnO at 5 mg/m<sup>3</sup> (no further details)</li> <li>Volunteers exposed to 600 mg/m<sup>3</sup> (fumes) for 10 min experienced persistent rales, decreased vital capacity, developed coughing and complained of URT irritation and substernal chest pain</li> <li>Inhalation studies at up to 430 mg/m<sup>3</sup> for 5 h produced chest pain (no further information)</li> <li>The following reported in male workers who used oxy-acetylene torches to cut zinc-bound linings of stone crushers exposed for 1–3 h at 320 and 580 mg/m<sup>3</sup>: <ul style="list-style-type: none"> <li>experienced nausea on the job, chills and dyspnoea</li> <li>severe chest pain developing 2–12 h later</li> <li>average period of disablement was 4 d with some patients later developing pneumonia</li> </ul> </li> <li>Metal fume fever not reported in workers engaged in pouring molten zinc and exposed at 8–12 mg/m<sup>3</sup> (fume) (no further information)</li> <li>A significant pulmonary response occurs after a brief exposure at &gt;10 mg/m<sup>3</sup> in controlled exposure studies</li> <li>Tolerance reported in sheet metal workers exposed once for 2 h/3 d (consecutive) at 5 mg/m<sup>3</sup> with symptoms of fever. Based on evaluation of interleukin-6 (IL-6) in bronchoalveolar lavage fluid which was significantly less compared to response of naive volunteers exposed to a single dose of 2.5 mg/m<sup>3</sup> for 2 h</li> <li>Repeated industrial exposure where the skin was coated with the dust caused papular-pustular skin eruptions in the axilla, inner thigh, inner arm, scrotum, and pubic area.</li> </ul> <p>Animal data:</p> <ul style="list-style-type: none"> <li>Biochemical, cellular and molecular changes in the mammalian lung reported in rats and mice studies following exposure at 1 or 2.5 mg/m<sup>3</sup> for 3 h</li> </ul>		

Source	Year set	Standard
		<ul style="list-style-type: none"> <li>Rats and guinea pigs developed inflammation in the lung following a single 3 h exposure at 2.5 mg/m<sup>3</sup> (no further information)</li> <li>Initial hypothermia of 0.5–2°C, followed by a rise in body temperature (up to 1°C above normal) 6–18 h later in guinea pigs exposed at 1,000–2,600 mg/m<sup>3</sup> for 1 h: <ul style="list-style-type: none"> <li>Guinea pigs died during or immediately after cessation of exposure, when exposed at ≤2,500 mg/m<sup>3</sup> for 3–4 h</li> </ul> </li> <li>Exposures in guinea pigs at 5–8 mg/m<sup>3</sup> (fume) 3 h/d for 5 or 6 d (consecutive) caused adverse effects in pulmonary function manifesting as gradual reduction in total lung capacity, vital capacity and decreased CO diffusion and either small or no alterations in tidal volume, respiratory frequency, airway resistance or compliance</li> <li>Repeated exposure at 5 mg/m<sup>3</sup> caused signs of oedema and increased cellular proliferation in the lungs of guinea pigs (no further information)</li> <li>Tolerance to the symptoms of metal fume fever produced by ZnO has been reported in animal exposure studies.</li> </ul> <p>Insufficient data to recommend skin, sensitiser or carcinogenicity notations.</p>
<b>DFG</b>	<b>2009</b>	<b>MAK: 2 mg/m<sup>3</sup> (inhalable fraction)</b> <b>MAK: 0.1 mg/m<sup>3</sup> (respirable fraction)</b>
		<p>Summary of data:</p> <ul style="list-style-type: none"> <li>At a concentration of 0.5 mg/m<sup>3</sup> each, ultrafine (median particle diameter 0.04 µm) and fine particles (median particle diameter 0.29 µm) caused no noticeable effects in 12 healthy adult volunteers at rest after inhalation through a mouthpiece for 2 h: <ul style="list-style-type: none"> <li>0.5 mg/m<sup>3</sup> considered NOAEC and used to justify MAK of 0.1 mg/m<sup>3</sup> respirable fraction (no derivation provided)</li> </ul> </li> <li>Lung function disorders nor asthmatic symptoms found in 234 zinc ore smelting workers with an average 5.5 yr of exposure (total dust 2.5–4.5 mg/m<sup>3</sup>): <ul style="list-style-type: none"> <li>basis for MAK value of 2 mg/m<sup>3</sup> for the inhalable fraction</li> </ul> </li> <li>Volunteers exposed once for 2 h at 2.5 mg/m<sup>3</sup> (fume) (LOEL), body temperature and the plasma IL-6 level increased significantly cf sheet metal workers exposed to concentrations of 5 mg/m<sup>3</sup> (fume) 3 h/d for 5 or 6 d (consecutive) and symptoms of metal fume fever developed (cited by ACGIH, 2018)</li> <li>Studies of employees of a zinc factory indicated occupational exposure at levels not exceeding 5 mg/m<sup>3</sup> for several years causes neither chronic bronchitis nor impairment of lung function.</li> </ul>
<b>SCOEL</b>	<b>NA</b>	<b>NA</b>
		No report.
<b>OARS/AIHA</b>	<b>NA</b>	<b>NA</b>
		No report.
<b>HCOTN</b>	<b>NA</b>	<b>NA</b>
		No report.

## Secondary source reports relied upon

Source	Year	Additional information
NICNAS	* ND	• Human health tier 1 assessment

## 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	NA
EU Annex	NA
ECHA	—
ACGIH	—
DFG	—
SCOEL	NA
HCOTN	NA
IARC	NA
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

Insufficient data to assign a skin notation.

## IDLH

Is there a suitable IDLH value available? Yes

## Additional information

Molecular weight:	81.38
Conversion factors at 25°C and 101.3 kPa:	1 ppm = 3.33 mg/m <sup>3</sup> ; 1 mg/m <sup>3</sup> = 0.3 ppm
This chemical is used as a pesticide:	<input type="checkbox"/>
This chemical is a biological product:	<input type="checkbox"/>



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This chemical is used as a pesticide:	<input type="checkbox"/>
This chemical is a by-product of a process:	<input type="checkbox"/>
A biological exposure index has been recommended by these agencies:	<input type="checkbox"/> ACGIH <input type="checkbox"/> DFG <input type="checkbox"/> SCOEL

## Workplace exposure standard history

Year	Standard
<a href="#">Click here to enter year</a>	

## References

American Conference of Industrial Hygienists (ACGIH®) (2018) TLVs® and BEIs® with 7<sup>th</sup> Edition Documentation, CD-ROM, Single User Version. Copyright 2018. Reprinted with permission. See the [TLVs® and BEIs® Guidelines section](#) on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2009) Zinc and its inorganic compounds – MAK value documentation.

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