

PERCHLOROETHYLENE

CAS number: 127-18-4

Synonyms: Perchlor, tetrachloroethene,
1,1,2,2-Tetrachloroethylene

Chemical formula: C₂Cl₄

Structural formula: —

Workplace exposure standard (amended)

TWA: 20 ppm (138 mg/m³)

STEL: 40 ppm (275 mg/m³)

Peak limitation: —

Notations: Carc. 2., Sk.

IDLH: 150 ppm

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

Recommendation and basis for workplace exposure standard

A TWA of 20 ppm (138 mg/m³) is recommended to protect for adverse central nervous system (CNS) effects and irritation of the eyes and upper respiratory tract in exposed workers.

A STEL of 40 ppm (275 mg/m³) is recommended to protect for acute irritation and CNS effects in exposed workers.

Discussion and conclusions

Perchloroethylene is widely used as a dry-cleaning agent and in metal degreasing. Minor uses include as a textile scouring solvent, fumigant, stain remover, paint remover and heat transfer media ingredient.

The critical effects of exposure are adverse effects on the CNS and irritation of the eyes and upper respiratory tract. Hepatotoxic and nephrotoxic (liver and kidney toxicity) effects are reported in animals. However, these kidney and liver effects are likely not relevant to humans due to biotransformation differences between humans and experimental animals (HCOTN, 2003; NICNAS, 2001).

Volunteers exposed for seven hours at 101 ppm experienced eye irritation and subjective symptoms such as headache, drowsiness and sleepiness. Exposures at 280 ppm for two hours and 600 ppm for 10 minutes is associated with loss of motor coordination. ACGIH (2018) reports a threshold for effects such as dizziness, headache, sleepiness and incoordination in the range of 100–200 ppm for five and a half to seven hours exposures. Volunteers exposed at 100 or 150 ppm experienced slightly impaired coordination with no duration of exposure provided (ACGIH, 2018). SCOEL (2009) reports no clear evidence of liver, kidney and CNS effects at exposure concentrations up to 25 ppm from studies in humans. SCOEL (2009) extrapolated a NOAEC of 20 ppm in humans for CNS effects based on summarised review of multiple human volunteer studies (SCOEL, 2009).

HCOTN (2003) recommended a health-based TWA of 20 ppm (while the administrative TWA of 35 ppm is published) to protect for effects on the CNS and eye irritation in workers. SCOEL also derived a TWA of 20 ppm and added a STEL of 40 ppm to protect for acute CNS effects. TWA by other primary sources ranged from 10 ppm to 50 ppm, with ACGIH (2018) providing a TLV-TWA of 25 ppm and a STEL of 10 ppm.

The TWA of 20 ppm (138 mg/m³) by HCOTN and SCOEL is recommended to be adopted and is supported by ACGIH evaluation. The STEL of 40 ppm (275 mg/m³) by SCOEL is also recommended to protect for acute effects on the CNS.

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.

A skin notation is recommended based on evidence of potential dermal uptake in humans contributing significantly to total body dose.

APPENDIX

Primary sources with reports

Source	Year set	Standard
SWA	1991	TWA: 50 ppm (340 mg/m³); STEL: 150 ppm (1,020 mg/m³)
ACGIH	2001	TLV-TWA: 25 ppm (170 mg/m³); TLV-STEL: 100 ppm (685 mg/m³)
<p>TLV-TWA and TLV-STEL recommended to minimise the potential for eye irritation, CNS symptoms and potential liver injury.</p> <p>TLV-STEL recommended to minimise the risk of anaesthetic-like effects.</p> <p>Summary of data:</p> <ul style="list-style-type: none"> Stated to provide a margin of safety in minimising potential discomfort and subjective complaints that may occur from prolonged exposure at 100–200 ppm. <p>Human data:</p> <ul style="list-style-type: none"> Reports cases of accidental, high-level exposure resulting in light-headedness, unconsciousness and injury to the liver and kidneys; no further details One study detailed the following effects in exposed subjects; no further information provided: <ul style="list-style-type: none"> 216 ppm: dizziness and sleepiness 280 ppm for 2 h: loss of motor coordination 600 ppm for 10 min: loss of motor coordination Subjects exposed for 7 h at 101 ppm experienced eye irritation and subjective symptoms such as headache, drowsiness and sleepiness; no further details No consistent effects on behavioural tests in volunteers exposed at 25 or 100 ppm for 5.5 h intervals; no further details Volunteers exposed at 100 or 150 ppm experienced slightly impaired coordination; results of behavioural test were normal; no further details Based on the above evidence, agency concludes a threshold for effects such as dizziness, headache, sleepiness and incoordination exists in the range of 100–200 ppm for 5.5–7 h exposures Inconclusive evidence regarding reproductive effects in several epidemiological studies; inadequacies in studies Available epidemiological studies do not confirm any increased risk of cancer in exposed humans. <p>Animal data:</p> <ul style="list-style-type: none"> 4-h LC₅₀ of 5,200 ppm for mice and 4,000 ppm for rats Rats exposed at >1,000 ppm 7 h/d for 4 d showed CNS depression, including ataxia, somnolence and anaesthesia; effects diminished after repeated exposure suggesting tolerance development Fatty degeneration of the liver in mice following a single 4 h exposure at 200, 400, 800 or 1,600 ppm Fatty liver degeneration in mice exposed at 200 ppm 4 h/d, 6 d/wk for 1, 2, 4 or 8 wk Mice exposed at 9, 37, 75 or 150 ppm continuously for 30 d developed abnormal gross pathological appearance of the liver at all concentrations 		

Source	Year set	Standard
<ul style="list-style-type: none"> Some evidence of carcinogenicity in rats and mice <i>via</i> inhalation; disagreement in interpretation of the study; not considered relevant for human exposure. <p>Insufficient evidence for a sensitiser or skin notation.</p>		
DFG	2017	MAK: 10 ppm (69 mg/m³)
<p>MAK recommended to protect for neurotoxic, hepatotoxic and nephrotoxic effects.</p> <p>Carcinogenic effects observed in animal studies.</p> <p>Summary of additional data:</p> <p>Human data:</p> <ul style="list-style-type: none"> MAK based on following: <ul style="list-style-type: none"> NOAEC of 20 ppm for neurotoxicity; 4 males, 4 females exposed at 0, 20 (males only), 100 or 150 ppm (males only) for 1, 3 or 7.5 h/d, 5 d/wk for 1 wk LOAEC of 50 ppm for slight but significant effects on visually evoked potentials; 22 males exposed at 10 or 50 ppm for 4 h/d for 4 d; 10 ppm five times lower than LOAEC for only slight effects therefore not consider genuine NOAEC no specific derivation of MAK of 10 ppm provided Skin notation based on following: <ul style="list-style-type: none"> immersion of one thumb (≈20 cm²) for 30 min, a concentration of 0.31 ppm was determined in exhaled air; extrapolated to surface area of 2,000 cm² (100 x more) results in 31 ppm exhaled; corresponding concentration in the air for absorption by inhalation only would be 60–150 ppm (no derivation provided) which is more than MAK. 		
SCOEL	2009	TWA: 20 ppm (138 mg/m³); STEL: 40 ppm (275 mg/m³)
<p>TWA recommended based on studies in humans and animals involving liver, kidney, lung and CNS effects.</p> <p>STEL is recommended to protect for CNS effects from short-term exposures.</p> <p>Summary of additional data:</p> <p>Basis for TWA</p> <ul style="list-style-type: none"> Considers the following human and animal evidence as enough to recommend a TWA of 20 ppm; no specific derivation provided No clear evidence from studies in humans for repeated dose effects (liver, kidney, CNS) at exposure concentrations up to 25 ppm; taken as NOAEC; based on following: <ul style="list-style-type: none"> study finding no effects on the frequency of subjective symptoms, psychomotor test results and markers of liver and kidney toxicity in dry cleaners with 6-y exposure at 21 ppm (mean 8-h TWA) compared with an unexposed control group No clear evidence for liver toxicity at exposure concentrations <50 ppm mean 8-h TWA no convincing evidence for kidney toxicity at mean exposure levels in the range 1.2–23 ppm no clear association between neurobehavioural/neurological deficits and repeated exposure in the workplace (dry cleaners) at ≤67 ppm for 10 yr or in volunteers at concentrations ≤150 ppm exposed for 7.5 h/d for 5 d NOAEC of 20 ppm in humans for effects on the CNS; based on summarised review of multiple human volunteer studies In rats and mice: LOAEC of 100 ppm for kidney damage; 2 y exposure 6 h/d, 5 d/wk 		

Source	Year set	Standard
		<ul style="list-style-type: none"> Congestion of the lungs in mice following 2 y exposure at ≥ 100 ppm; considered LOAEC for effects in lungs. Dermal exposure of both hands and lower arms ($2,000 \text{ cm}^2$) for 1 h expected to contribute more than 10% to the systemic dose, risk of exposure in common workplace activities basis for skin notation. <p>Basis for STEL</p> <ul style="list-style-type: none"> Short-term LOAEC of 218 ppm and NOAEC of 109 ppm based on summarised short-term studies in volunteers; cited by ACGIH (2018) as 216 ppm.
OARS/AIHA	NA	NA
No report.		
HCOTN	2003	TWA: 35 ppm (240 mg/m³)
<p>Recommends an updated health-based OEL of 20 ppm (138 mg/m^3) TWA.</p> <p>Summary of additional data:</p> <ul style="list-style-type: none"> Experimental animals (especially mice) have a specifically high sensitivity to the hepatotoxic effects following exposure; differences between humans and experimental animal regarding biotransformation in case of nephrotoxicity deem evidence in animals as inadequate; considers neurotoxicity most sensitive and relative effects to derive TWA Based on available human database concludes an LOAEC of 100 ppm for neurotoxicity; no specific explanation provided Dismisses the LOAEC of 50 ppm for slight visually evoked potentials in humans (cited by DFG, 2017) due to methodological shortcomings in the study Transient eye, nose and throat irritation at 100 ppm Derivation of recommended OEL TWA <ul style="list-style-type: none"> applies a safety factor of 5 to the human LOAEC of 100 ppm for neurotoxicity to extrapolate from LOAEL and to account for inconclusive evidence for some minor neurological effects below LOAEL; no further information. 		

Secondary source reports relied upon

Source	Year	Additional information
NICNAS	✓ 2001	<ul style="list-style-type: none"> Low acute toxicity in humans Acute exposure at $>2,000$ ppm has resulted in collapse, coma and seizures Reports of dizziness, mood changes, faintness, headache or nausea reported at concentrations >100 ppm at various exposure durations; no further details Respiratory irritation observed in humans exposed at >216 ppm Rodents not considered an appropriate model for humans because of differences in rates of metabolism.
IARC	✓	<ul style="list-style-type: none"> There is limited evidence in humans but sufficient evidence in experimental animals for the carcinogenicity.

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	Carcinogenicity – category 2
NICNAS	NA
EU Annex	Carcinogenicity – category 2
ECHA	Carc. 2
ACGIH	Carcinogenicity – A3
DFG	Carcinogenicity – 3B, H (skin)
SCOEL	Carcinogenicity – D, Skin
HCOTN	Carcinogenicity – category 1A
IARC	Carcinogenicity – Group 2A
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:

Dermal repeat-dose NOAEL ≤ 200 mg/kg:

Dermal LD₅₀/Inhalation LD₅₀ < 10:

In vivo dermal absorption rate > 10%:

Estimated dermal exposure at WES > 10%:

yes

a skin notation is warranted

IDLH

Is there a suitable IDLH value available?

Yes

Additional information

Molecular weight:

165.83

Conversion factors at 25°C and 101.3 kPa:

1 ppm = 6.79 mg/m³; 1 mg/m³ = 0.15 ppm



Molecular weight:	165.83
This chemical is used as a pesticide:	<input type="checkbox"/>
This chemical is a biological product:	<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:	✓ 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](#) on the ACGIH website.

Deutsche Forschungsgemeinschaft (DFG) (2016) Tetrachlorethen – MAK value documentation.

European Chemicals Agency (ECHA) (2019) tetrachloroethylene – REACH assessment.

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).

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2009) Recommendation from the Scientific Committee on Occupational Exposure Limits for tetrachloroethylene (perchloroethylene). SCOEL/SUM/133.

Health Council of the Netherlands (HCOTN) (2003) Tetrachloroethylene (PER). Health-based calculated occupational cancer risk values. The Hague: Health Council of the Netherlands; publication no. 2003/01OSH.

International Agency for Research on Cancer (IARC) (2014) Tetrachloroethylene (Perchloroethylene). IARC Monographs on the evaluation of the carcinogenic risk to humans.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2001 Priority Existing Chemical Report tetrachloroethylene (CAS No. 127-18-4)

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