# mineral SpiritS

| CAS number: | 8052-41-3, 64742-82-1, 64742-95-6 |
| --- | --- |
| Synonyms: | Mineral turpentine, Stoddard solvent, white spirits, paint thinners, solvent naphtha (petroleum light), hydrocarbon solvents, turps |
| Chemical formula: | — |
| Structural formula: | — |

 Workplace exposure standard (amended)

| TWA: | **50 ppm (296 mg/m3)** |
| --- | --- |
| STEL: | **100 ppm (593 mg/m3)** |
| Peak limitation: | **—** |
|  Notations: | **Carc. 1B** |
| IDLH: | **20,000 mg/m3** |
| **Sampling and analysis**: The recommended value is quantifiable through available sampling and analysis techniques.  |

## Recommendation and basis for workplace exposure standard

A TWA of 50 ppm (296 mg/m3) is recommended to protect for irritation, central nervous system (CNS) impairment and brain damage in exposed workers.

A STEL of 100 ppm (593 mg/m3) is recommended to protect for acute irritation, nausea and CNS depression in exposed workers.

## Discussion and conclusions

Mineral spirits include mineral turpentines, thinners and white spirits that are petroleum-derived solvents. They are complex hydrocarbon mixtures distinguished by their level of refinement, which primarily determines their aromatic hydrocarbon content in the C6–C12 range. In Australia, mineral turpentine typically contains 40 per cent aromatics, white spirit type 1 contains up to 25 per cent and white spirit type 3 contains less than 1 per cent. Depending on their composition, these products are used as paint thinners, fuel, dry cleaning agents or degreasers. Individual constituents should also be considered when in majority concentration or when the mixture contains more than 0.1% w/w benzene.

Critical effects of exposure are eye and skin irritation, CNS depression, nausea and chronic brain damage (ACGIH, 2018; SCOEL, 2007).

No specific toxicity data for mineral turpentine or other petroleum solvents with high aromatic contents is reported in the available source material. However, the database for white spirits generally shows no significant differences in the adverse effect profile with respect to aromatic content (SCOEL, 2007). Based on this information, mineral turpentine and solvent naphtha are provisionally assessed in combination with white spirits.

A NOAEC of 100 ppm for irritation and CNS impairment is established from several acute volunteer inhalation studies ranging in duration from 0.25 to seven hours (DFG, 2010). Difficulties in modelling chronic occupational exposure and confounding co-exposures complicate interpretation of the available epidemiological data (DFG, 2010). However, this level of potency is consistent with a NOAEC of 90 ppm for neurophysiological changes estimated in a cohort study of exposed workers (SCOEL, 2007). Other epidemiological data suggest a NOAEC for neurophysiological endpoints near 40 ppm, but their predictive strength is limited by confounding exposures (DFG, 2010; SCOEL, 2007).

Based on the evidence of human exposure data provided by sources, the TWA of 50 ppm by DFG (2010) is recommended. The recommended TWA is expected to be sufficiently low to protect for irritation and chronic CNS impairment observed at 100 ppm in acutely exposed volunteers and 90 ppm in chronically exposed workers, respectively.

In view of the acute NOAEC and reports of nausea at 440 ppm (ACGIH, 2018), a STEL of 100 ppm is expected to be protective of these effects. This recommendation is supported by the evaluation presented by DFG (2010), which is informed by the SCOEL (2007) assessment.

## Recommendation for notations

Classified as a category 1B 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 not recommended based on the available evidence.

# Appendix

### Primary sources with reports

| Source Year set Standard  |
| --- |
| SWA 1991 TWA: 480 mg/m3 (mineral turpentine); 790 mg/m3 (white spirits)  |
|  |
| ACGIH 2001 TLV-TWA: 100 ppm (525 mg/m3) |
| TLV-TWA intended to protect for eye and skin irritation, nausea, narcosis and potential kidney damage. Potential adverse kidney effects are observed in rats at 330 ppm; margin of safety provided by the TLV-TWA for this endpoint is not discussed. The term Stoddard solvent is used interchangeably with white spirits and mineral spirits and assumes an aromatic content of 14%.Summary of information:TLV-TWA based on combined toxicity data of various constituents of white spirits, which agree with results of acute volunteer inhalation studies (derivation/calculation not presented). Renal damage is reported in rats at 330 ppm. Therefore, occupational exposures should be controlled to <100 ppm.Human data:* Odour threshold 1–120 ppm
* Eye irritation at 150 ppm in 1/6 volunteers in acute inhalation study with mineral spirits (15 min):
* eye irritation in 6/6 volunteers at 470 ppm
* No significant effects at 400 ppm in acute inhalation study with mineral spirits (3-5 min):
* cited article concludes that 400 ppm is maximum tolerable limit for 8 h workplace exposure
* Regarding these volunteer exposure data, cited review article concludes irritation threshold is 370 ppm
* Nausea and vertigo reported at 440–875 ppm in volunteer inhalation study with “white spirits” (83% aliphatics, 17% aromatics) (n=15, males, at rest and during exercise, 30 min):
	+ linear relationship of alveolar and arterial concentrations of solvent components absorption of aliphatics calculated at 46–59%, aromatics at 58–70%
	+ total systemic absorption increased during exercise; proportion of aliphatics to aromatics decreased during exercise (no further details provided)
* Nausea and vomiting in workers exposed to white spirits (83% aliphatic, 17% aromatic) over 4 mo (no details on exposure or further characterisation of solvent); one worker developed aplastic anaemia and died several months later from septicaemia:
	+ death attributed to exposure to myelotoxic compounds, e.g. benzene, in solvent mixture
* Follicular dermatitis of hands and forearms reported from repeat exposure (no further details)
* Exposures that produce nausea (not specified) associated with hepatic toxicity and jaundice (no further details).

Animal data:* Toxicological data for decane considered due to high proportion (65%) of C10 hydrocarbons in mineral spirits, acute toxicity data for other alkanes are also provided:
	+ LC50: 540 ppm (decane) (mice, 3.75 h); 3,200 (nonane), 13,500 (octane), 16,000 ppm (heptane) (mice, 4 h)
* Mortality in 1/18 animals at 1,400 ppm (rats, 8 h); eye irritation, bloody exudate from nostrils, slight ataxia observed
* Mortality at ≈1,400 ppm (dogs, cats, 2.5–7.5 h); tremors and convulsions observed
* No significant effects at 84, 190, and 330 ppm mineral spirits (dogs, 6 h/d, 5 d/wk, 13 wk)
* Renal damage and elevated blood-urea-nitrogen at 300 ppm (rats, 13 wk, dose frequency not specified)
* Minor pulmonary oedema at 290 ppm (guinea pigs only) reported in 2 parallel subchronic inhalation studies (guinea pigs, rats, rabbits, dogs, monkeys, 8 h/d, 5 d/wk, 30 d, and 24 h/d, 7 d/wk, 90 d):
	+ no renal damage in rats as observed in former study, possibly due to different strain
	+ no signs of histopathology observed in the other species at 290 ppm
* Mutagenicity and ADME data not reported.

Insufficient data to recommend a TLV-STEL or notations for carcinogenicity, skin absorption, or sensitisation. |
| DFG 2010 MAK (heavy hydrotreated petroleum naphtha): 50 ppm (300 mg/m3) |
| Summary of additional information:Data relevant to the evaluation presented as heavy hydrotreated petroleum naphtha and relies primarily on SCOEL (2007) evaluation of “white spirit”. Human toxicokinetics of aromatic-containing and non-aromatic-containing mixtures of “white spirits” is not significantly different. Assumes molecular weight of 145 g/mol.Occupational data obtained for heavy hydrotreated petroleum naphtha considered inadequate for the derivation of a MAK due to potentially confounding mixed exposures.MAK for heavy hydrotreated petroleum naphtha based on NOAEC of 100 ppm for local irritation and objective CNS impairment in acute volunteer inhalation study; NOAEC is halved to account for increased respiratory volume under workplace conditions to derive a MAK of 50 ppm. Peak excursion factor of 2 applied due to systemic effects.Heavy hydrotreated petroleum naphtha not classifiable as human carcinogen due to inadequacy of available epidemiological data and inconclusive animal studies.Skin notation not warranted based on low dermal absorption rate in rats relative to exposure at the MAK.Human data:* 8 acute volunteer inhalation studies (n=6–25) used to estimate NOAEC of 100 ppm for irritation and CNS impairment:
	+ doses ranged from 10–680 ppm and included mixtures of various aromatic/aliphatic contents, exposures ranged from 0.25–6 h
	+ NOAEC: 200 ppm for irritation and self-reported CNS effects (n=12, 6 h); 3 solvent mixtures tested with 0–18% aromatics
	+ NOAEC: 100 ppm for irritation and objective CNS effects (n=12, 4 h); 21% aromatics
	+ NOAEC: 50 ppm for irritation (n=12, 4 h); 0% aromatics
* Several occupational studies are presented but not considered in evaluation due to insufficient documentation or confounding co-exposures to other solvents:
	+ local irritation and impaired reaction times and performance in memory tests in painters exposed at 40 ppm over an estimated 22 yr (also cited by SCOEL, 2007)
* Increased risk of liver cancer in painters exposed to various thinning solvents, turpentine, and white spirits (no further details).

Animal data:* Increased incidence of regenerative tubular epithelia (males/females) and proteinaceous casts on dilated tubules (males only) at 300 ppm in subchronic inhalation study with non-aromatic “white spirits” (rats, 6 h/d, 5 d/wk, 13 wk, not cited by ACGIH, 2018); significant reduction in body weight gain (males/females) and relative kidney weight increased at 900 ppm (males only):
	+ NOAEC: 300 ppm for non-aromatic white spirits; agency concludes nephropathy observed at 300 ppm in males is sex- and species-specific
* Transient lachrymation, haemorrhagic nasal discharge and narcosis at 400 ppm of “white spirits” in chronic inhalation study (rats, 5 d/wk, 6 h/d, 6 mo); changes in electrophysiological parameters (not specified) and decreased dark-phase motor activity observed at 800 ppm; no histopathological changes observed at 400 or 800 ppm
* Increased pheochromocytomas (adrenal gland tumours) at ≈100 and 200 ppm (550 and 1,100 mg/m3) in chronic inhalation study with non-aromatic white spirits (rats, 6 h/d, 5 d/wk, 2 yr):
	+ not considered relevant to humans due to sex- and species-specific metabolism
* Concentration-dependent increased incidence of hepatocellular adenomas only in females at ≈100, 200, and 400 ppm (550, 1,100, and 2,200 mg/m3) in chronic inhalation study with non-aromatic white spirits (mice, 6 h/d, 5 d/wk, 2 yr):
	+ increased tumour incidence statistically significant at 400 ppm
	+ cited article evaluated increased tumorigenicity as possibly substance-related
	+ increased tumour incidence considered irrelevant to assessment due to sex-specificity and absence of carcinomas
* Non-aromatic white spirits non-mutagenic *in vitro* in bacteria, mammalian, and human cell lines, and *in vivo* in mice; no information for aromatic white spirits presented.

Insufficient data to recommend a sensitiser notation. |
| SCOEL 2007 TWA: 20 ppm (116 mg/m3); STEL: 50 ppm (290 mg/m3) |
| Summary of additional information:Assessment based primarily on toxicological data for white spirit type 1 (aromatic content of 13–30%), and white spirit type 3 (aromatic content <1%). OEL considered to apply to all complex hydrocarbon mixtures with primary constituents in C6–C12 range. NOAEC range of 40–90 ppm for brain damage and chronic CNS disturbances from several human exposure studies used as POD to recommend TWA of 20 ppm. STEL of 50 ppm recommended based on NOAEC of acute volunteer inhalation studies, which report NOAEC for self-reported symptoms and eye irritation between 50 and 100 ppm.Skin notation recommended due to increased body burden from dermal uptake relative to exposure at the OEL.Human data:* Agency considers NOAEC for irritation and CNS effects to be near 100 ppm based on controlled inhalation studies, lower irritation thresholds reported in occupational studies possibly due to confounding subjective irritation from odour and mixed exposures
* Based on comparison of pharmacokinetically modelled data between rats and humans, CNS concentrations of solvent constituents similar in both species and predicted a NOAEC of 100 ppm for CNS depression in humans
* No significant change in lower airway symptoms of workers following substitution of type 1 for type 3 white spirits; average exposure was 37 ppm with peaks of 120 ppm (n=148, >4 h) in group exposed only to white spirits:
	+ increased prevalence of nose and throat symptoms (not specified) in exposed groups compared to controls
* Eye irritation, headache and tiredness significantly increased at 400 ppm (17% aromatics) chamber study with student volunteers exposed at 0, 34, 100, 200, 400 ppm (n=9, age: 23, 7 h); eye irritation at 100 ppm in painters exposed in same study at 0, 50, and 100 ppm (n=9, age: 49, 7 h)
* Increased odds ratio for abnormal coordination and signs of brain damage by computer tomography in cross-sectional study of painters (n=85, exposed) and brick layers (n=85, control), white spirits assumed to contain 15–20% aromatics:
	+ no significant difference between exposure groups and controls at a TWA of 100 ppm for 6 yr
	+ NOAEC of 40 ppm for 13 yr exposure
	+ high level of uncertainty for this NOAEC due to difficulty in modelling these data with respect to chronic exposure and mixed exposures
* No change in neurophysiological parameters and psychiatric evaluations in painters (n=135) and carpenters (n=71) exposed at ≈90 ppm over 10 yr (120 exposure-months) reported in cohort study; exposures equivalent to 130–250 exposure-months associated with increased risk of chronic encephalopathy; NOAEC ≈90 ppm
* Several epidemiological studies of occupationally exposed painters associated impaired mental performance with exposure, but not considered in the evaluation due to inadequacies in the experimental design, low statistical power, or confounding mixed exposures
* Available epidemiological studies and a case-referent study insufficient to demonstrate causal association between increased cancer risk and occupational exposure to white spirits in painters, metal workers, construction workers and dry cleaners
* No quantitative skin permeability data available; however, dermal penetration rate: 0.02 mg/cm2/h estimated from *in vivo* human skin penetration for a variety of hydrocarbon constituents of white spirits

Animal data:* No significant differences in skin absorption between different types of white spirits
* Kidney lesions (males only) in subchronic inhalation study at 345, 690, and 1,292 ppm (rats, 6 h/d, 5 d/wk, 13 wk); no clinical signs of toxicity at any exposure, slight lethargy at 1,292 ppm
* Transient increase in reaction times at 400 and 800 ppm of white spirits (18% aromatics) in repeat inhalation study (rats, 8 h/d, 3 d); after 2nd exposure, reaction time effects not significant:
	+ NOAEC 100 ppm
* Aromatic white spirits not considered teratogenic based on equivocal results from reproductive/developmental inhalation studies with rats
* No maternal toxicity at 0, 100, and 400 ppm of white spirits (24% aromatics) in developmental study (rats, 6 h/d, GD 6–15); no effect on litter size or average foetal weight; skeletal variations at 100 and 400 ppm considered due to growth retardation, not malformation
* Equivocal evidence for carcinogenicity in chronic inhalation study with non-aromatic white spirits (mice, 6 h/d, 5 d/wk, 2 yr, also cited by DFG, 2010); combined count of adenomas and carcinomas and carcinomas alone in both males and females non-significant
* Overall, white spirits considered non-mutagenic:
	+ negative results for studies using non-aromatic white spirits *in vitro* in bacteria, and *in vivo* in mammalian assays, including micronucleus assay following inhalational exposure (mice, 3 mo, no further exposure details provided)
	+ positive mutagenicity reported for aromatic white spirits in *in vitro* assay with mammalian cells with or without metabolic activation at cytotoxic concentrations.
 |
| OARS/AIHA NA NA |
| No report. |
| HCOTN NA NA |
| No report. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| NICNAS |  | 2015 | * Grouped assessment of white spirits type 1–3, chemicals in this groups are unknown or variable compositions, complex reaction products and biological materials (UVCB) containing aliphatic and aromatic hydrocarbons
* Up to 25% aromatic content when refined for cosmetic/domestic uses with expected benzene content <1%:
	+ in petroleum naphtha refinery streams, benzene content is 1%
* Classified as category 1 carcinogen and mutagen based on benzene content; however, if shown that the benzene content <0.1% w/w, this classification is not applicable:
	+ benzene content of refined forms is typically below threshold for mutagenicity and carcinogenicity classification
	+ benzene content of unrefined forms is above this threshold
* LOAEL: 500 mg/kg/d for haematological changes with white spirit type 2 (composition not specified) in repeat dermal application study (rats, 28 d)
* LOAEL: 200 mg/kg/d for decreased growth rate for unrefined substance (composition not specified) in repeat dermal application study (rabbits, 28–90 d):
* increased mortality at 1,000 mg/kg/d.
 |
| IARC |  | 1989 | * Grouped assessment as petroleum solvents. Available epidemiological data and chronic animal studies provide inadequate evidence for carcinogenicity in humans due to mixed exposures, small study sizes and, in the case of animals, short study durations:
	+ classified as Group 3.
 |
| US NIOSH |  | 1994 | * *Stoddard solvent*: IDLH based on acute inhalation toxicity data in humans.
 |

### 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 | Carc. 1B |
| HCIS | Carcinogenicity – category 1B |
| NICNAS | Carc. Cat 2 |
| EU Annex | Carcinogenicity – category 1B |
| ECHA | Carc. 1B |
| ACGIH | — |
| DFG | NA |
| SCOEL | Skin |
| 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: |   |   |   |
| Dermal LD50 ≤1000 mg/kg: | no |   |   |
| Dermal repeat-dose NOAEL ≤200 mg/kg: | yes | 3.00 |   |
| Dermal LD50/Inhalation LD50 <10: |   |   |   |
| *In vivo* dermal absorption rate >10%: |   |   |   |
| Estimated dermal exposure at WES >10%: | no | -2.00 |   |
|   |   | 0.5 | **a skin notation is not warranted** |

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### IDLH

| Is there a suitable IDLH value available? | Yes |
| --- | --- |

## Additional information

| Molecular weight: | 145 |
| --- | --- |
| Conversion factors at 25°C and 101.3 kPa:  | 1 ppm = 5.73 mg/m3; 1 mg/m3 = 0.175 ppm |
| This chemical is used as a pesticide: |[ ]
| This chemical is a biological product: |[ ]
| This chemical is a by-product of a process: |[x]
| 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) (2010) Naphtha (petroleum), hydrotreated heavy – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2007) Recommendation from the Scientific Committee on Occupational Exposure Limits for “White Spirit”. SCOEL/SUM/87.

European Chemicals Agency (ECHA) (2019) White spirits – REACH assessment.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2015) Hydrocarbon solvents commonly used in their refined forms: Human health tier II assessment – IMAP report.

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

International Agency for Research on Cancer (IARC) (1989) Some Petroleum Solvents. IARC Monographs – Volume 47.

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).