# Pentane (all isomers)

| CAS number: | 109-66-0 (n-pentane)  463-82-1 (neo-pentane)  78-78-4 (isopentane) |
| --- | --- |
| Synonyms: | Amyl hydride (n-pentane),  2,2-dimethylpropane (neo-pentane),  2-methylbutane (isopentane) |
| Chemical formula: | C5H12 |
| Structural formula: | — |

Workplace exposure standard (amended)

| TWA: | **1,000 ppm (3,000 mg/m3)** |
| --- | --- |
| STEL: | **—** |
| Peak limitation: | **—** |
| Notations: | **—** |
| IDLH: | **1,500 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 1,000 ppm (3,000 mg/m3) is recommended to protect for irritation and narcosis in exposed workers.

## Discussion and conclusions

n-Pentane and isopentane are liquids and neo-pentane is a gas under standard conditions. They are used as aerosol and foam propellants, solvents and in petrol production. Their vapours are denser than air.

All three pentane isomers are metabolised analogously and share comparable toxic endpoints. They are often used as isomeric mixtures, which supports their grouping for this evaluation (ACGIH, 2018; DFG, 2007, OECD, 2008; SCOEL, 1997).

Critical effects of exposure are respiratory tract irritation and narcosis as demonstrated in animals.

Acute exposures at 5,000 ppm had no effects in volunteers. NOAEC between 3,000 and 6,800 ppm are reported in sub‑chronic rat inhalation studies; the relevance of a slight change in blood serum composition at 3,000 ppm in one study is unclear (ACGIH, 2018; DFG, 2007). Respiratory tract irritation is demonstrated at 32,000 ppm in mice; narcosis follows exposures above 90,000 ppm.

All available primary sources (ACGIH, 2018; DFG, 2007, SCOEL, 1997), other than SWA, published a TWA of 1,000 ppm based on the NOAEC in sub‑chronic studies in rats. This TWA is recommended to be adopted as it is expected to be protective of the critical effects observed in animals and is below 10% of the lower explosive limit of n-pentane (NIOSH, 1994).

There is insufficient evidence to warrant the recommendation of a STEL and the recommended TWA is considered adequately protective for acute effects (ACGIH, 2018; DFG, 2007, SCOEL, 1997).

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

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1991 TWA: 600 ppm (1,770 mg/m3); STEL: 750 ppm (2,210 mg/m3) | |
|  |
| ACGIH 2014 TLV-TWA: 1,000 ppm (2,950 mg/m3) |
| TLV-TWA intended to protect for irritation and narcosis.  Summary of data:  Grouped assessment of 3 pentane isomers: *n*-, neo- and isopentane. All pentane vapours are denser than air and can accumulate in low-lying areas below the breathing zone. TLV-TWA is based on weight of health-based evidence in humans and animals and safety precautions due to explosive risk. Considered sufficiently low to provide substantial safety margin for irritant and narcotic effects. TLV-STEL of 750 ppm withdrawn in 1998.  Human data:   * Odour threshold: 400 ppm * No mucous membrane irritation or other symptoms observed in volunteers at 5,000 ppm (10 min) * Blisters and itching following topical application (duration not specified), blisters formed after 5 h * Peripheral nerve damage in 5 exposed belt manufactory workers; solvent used by workers comprised 80% pentane, 14% heptane, 5% *n*-hexane; effects were likely due to n-hexane component of the mixture, symptoms included anorexia, fatigue, weakness, muscular incoordination/failure in legs.   Animal data:   * Narcosis at 90,000–120,000 ppm (mice, 5–60 min), lethal at 130,000 ppm (mice, 30 min):   + LC50: 100,000–300,000 ppm (mice, <2 h); survivors recovered in 8 min   + no effects at 16,000 ppm (mice, 5 min) or 6,800 ppm (rats, 8 h/d, 3 d); signs of respiratory irritation at 32,000 and 64,000 ppm (mice, 5 min) * Slight reversible increase in calcium and phosphorus serum concentrations at 3,000 and 10,000 ppm n-pentane (rats, 6 h/d, 5 d/wk, 2 wk), effect not observed in related sub‑chronic exposures studies * LD50: >2,000 mg/kg (species unspecified, oral) * *n*-Pentane non-irritating to skin (rabbits) and non-sensitising in maximisation test (guinea pigs, no further details provided) * Several sub‑chronic inhalation studies report NOAELs in the range of 3,000–6,800 ppm for haematological, ophthalmic, histopathologic and neurological changes (rats, 6–12 h/d,  5–7 d/wk, 13–30 wk); NOAEL are generally at the highest tested doses:   + mixed exposure to *n*-butane and *n*-pentane (1:1) at 1,000 or 4,500 ppm caused transient lethargy, eye encrustation, tremors and reversible body weight reduction, but no nephrotoxicity (90 d) * No effects on development or maternal toxicity between 1,000–10,000 ppm n-pentane (rats, 6 h/d, GD 6–15) * Non-mutagenic *in vitro* or *in vivo* * All isomers are metabolically oxidised to corresponding pentyl alcohols and ketones, none are considered neurotoxic by the agency:   + elimination half-life: 0.13 h; below 100 ppm (modelled metabolic saturation).   Insufficient data to recommend a TLV-STEL or notations for carcinogenicity, skin absorption or sensitisation. |
| DFG 2007 MAK: 1,000 ppm (3,000 mg/m3) |
| Summary of additional information:  Assessment grouped with 3 other pentane isomers based primarily on toxicological data for *n*- pentane and evidence that other branched pentane isomers are less toxic. Critical effects are irritation and narcosis at higher concentrations. No studies available that determine a threshold for these effects in humans. Based on weight of toxicological evidence of other alkanes and NOAEL of 6,660 ppm from 13-wk inhalation study with rats (also cited in ACGIH, 2014); MAK considered sufficiently low to protect for the critical effects.  Skin notation not assigned due to low modelled dermal penetration rate relative to inhalational exposure at the MAK.  Sensitiser notation not assigned due to negative results in maximisation test with guinea pigs.  Human data:   * Non-irritating to skin in volunteer study with high purity *n*-pentane (n=15, occlusive patch, 24 h); contradicts results of second dermal application study that used unspecified isomeric mixture of unknown purity (also cited in ACGIH, 2014) * Modelled dermal absorption rates from 2 studies: 0.337 and 0.007 mg/cm2/h.   Animal data:   * Mechanism of toxicity likely due to non-specific membrane binding as with other alkanes and alcohols based on analysis of LC50 values (unspecified species) * Absorption in lungs following 50–70 min exposure: 19% (*n*-pentane), 9% (isopentane),  5% (neo-pentane), lower toxicity of branched isomers associated with their lower absorption rates (rats) * Skin penetration rate *in vitro*: 73.4 ng/cm2/min (rats) * No significant effects to kidneys up to 4,500 ppm in 90-d inhalation study with isobutane and isopentane 1:1 mixture; slight signs of nephropathy in males at 28 d (rats, 90 d, also cited by ACGIH, unclear which isomers were used in study) * No adverse effects in repeat gavage developmental study up to 1,000 mg/kg/d *n*-pentane (rats, GD 6–15) * Negative mutagenicity results *in vivo* in micronucleus assay with n-pentane (rats); negative *in vitro* results for branched isomers in *S. typhimurium*; equivocal results for chromosomal aberrations with n-pentane in Chinese hamster ovarian cells.   Insufficient data to recommend notations for carcinogenicity. |
| SCOEL 1997 TWA: 1,000 ppm (3,000 mg/m3) |
| Summary of additional information:  Grouped assessment. Critical effects are irritation and narcosis at very high concentrations. Based on weak toxicological database, evidence suggests pentane isomers have low toxicity in humans and animals. Recommended TWA based on sub-chronic inhalation studies that reported NOAEL of 3,000 ppm for pentane and 4,437 ppm for mixed exposures with other alkanes, which suggest a TWA of 1,000 ppm is sufficiently protective given the uncertainties in the available dataset.  All isomers have lower explosive limits in the range of 1.32–1.42% in air.  Animal data:   * No adverse effects up to 4,437 ppm of 1:1:1:1 mixture of *n*-butane, *n*-pentane, isobutane and isopentane in sub-chronic inhalation study with rats (also cited in ACGIH, 2018 and DFG, 2004) * No mutagenicity data presented.   Insufficient data to recommend a STEL. |
| OARS/AIHA NA NA |
| No report. |
| HCOTN NA NA |
| No report. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| NICNAS |  | 2018 | * Tier I assessment for n-pentane (no further details) * No entry for other isomers. |
| OECD |  | 2008 | * Grouped assessment of *n*-pentane, isopentane and cyclopentane due to similar toxicokinetic profiles * Slight haematological changes reported at 1,793 ppm cyclopentane in males only in sub-chronic inhalation study (rats, 2 wk); effect not observed in subsequent 13-wk study and therefore dismissed for assessment. * CNS depression only occurs at levels near or above the lower explosive limit (14,000 ppm) * 2 industrial studies (n=203) of pentane exposure during solvent use reported average exposure of 11 ppm (range:  0–200 ppm) * LD50: 3,000 mg/kg (rabbits, dermal). |
| US NIOSH |  | 1994 | * IDLH based on 10% of the lower explosive limit of *n*-pentane. |

### 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 | *All* *isomers*: — |
| HCIS | *All* *isomers*: — |
| NICNAS | NA |
| EU Annex | *All* *isomers*: — |
| ECHA | *All isomers:* — |
| ACGIH | *All* *isomers*: — |
| DFG | *All* *isomers*: — |
| SCOEL | *All* *isomers*: — |
| 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

| Calculation |
| --- |
| |  |  |  |  | | --- | --- | --- | --- | | Adverse effects in human case study: | no |  |  | | Dermal LD50 ≤1000 mg/kg: | no |  |  | | Dermal repeat-dose NOAEL ≤200 mg/kg: |  |  |  | | Dermal LD50/Inhalation LD50 <10: |  |  |  | | *In vivo* dermal absorption rate >10%: |  |  |  | | Estimated dermal exposure at WES >10%: | no | -2.00 |  | |  |  | -2 | **a skin notation is not warranted** | |

### IDLH

| Is there a suitable IDLH value available? | Yes, based on LEL |
| --- | --- |

## Additional information

| Molecular weight: | 72.15 |
| --- | --- |
| Conversion factors at 25°C and 101.3 kPa: | 1 ppm = 2.95 mg/m3; 1 mg/m3 = 0.34 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) Pentane (all isomers) – MAK value documentation.

Deutsche Forschungsgemeinschaft (DFG) (2004) Pentane (all isomers) – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (1997) Recommendation from the Scientific Committee on Occupational Exposure Limits for pentane, isopentane and neopentane. SCOEL/SUM/79.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2018) n-Pentane: Human health tier I assessment – IMAP report.

Organisation for Economic Cooperation and Development (OECD) (2008) SIDS initial assessment profile – C5 Aliphatic Hydrocarbon Solvents Category.

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