# Cyanides (as CN, Inorganic salts)

| CAS number: | 151-50-8 |
| --- | --- |
| Synonyms: | Cyanide salts, potassium cyanide, sodium cyanide, calcium cyanide, ammonium cyanide; silver cyanide, barium cyanide, gold cyanide |
| Chemical formula: | CN- |
| Structural formula: | — |

Workplace exposure standard (amended)

| TWA: | **1 mg/m3** |
| --- | --- |
| STEL: | — |
| Peak limitation: | **5 mg/m3** |
| Notations: | **Sk.** |
| IDLH: | **25 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 1 mg/m3 is recommended to protect for chronic neurological symptoms and thyroid enlargement in exposed workers.

A peak limitation of 5 mg/m3 is recommended to protect for acute exposure resulting in immediate and severe health effects (death, coma, respiratory failure) in exposed workers.

## Discussion and conclusions

This report presents the evaluation of inorganic cyanide salts including calcium cyanide, sodium cyanide and potassium cyanide. Due to its presence in gaseous form, hydrogen cyanide (HCN) has been evaluated separately. The alkali cyanide salts act *via* the same mechanism as HCN which is by the release of cyanide ion (ACGIH, 2018).

In humans, long-term exposure to cyanide at concentrations of 4.7 to 13.9 mg/m3 causes headaches, weakness, dizziness, throat irritation, dyspnoea, thyroid enlargement and an increase in thiocyanate excretion in the urine. Concentrations of 20 to 40 mg/m3 are reported to be associated with slight acute effects in workers; while a concentration of greater than 135 mg/m3 is fatal, indicating a steep dose-response (ACGIH, 2018; DFG, 2012; SCOEL, 2010; HCOTN, 2002).

Using the LOAEL in humans of 4.7 mg/m3 as a starting point and applying a factor of five for the lack of a NOAEL, HCOTN (2012) and SCOEL (2010) derive a TWA of 1 mg/m3. Additionally, starting at the LOAEL of 20 mg/m3 for acute effects and applying a factor of two for slight effects at the LOAEL, HCOTN (2012) derives a peak limitation of 5 mg/m3. These concentrations are considered protective for the identified critical effects in exposed workers.

## 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 recommended based on evidence in animals.

# Appendix

### Primary sources with reports

| Source Year set Standard |
| --- |
| SWA 1991 TWA: 5 mg/m3 |
|  |
| ACGIH 2001 TLV-Ceiling: 5 mg/m3 |
| TLV-Ceiling recommended for Ca(CN)2, NaCN and KCN to minimise the potential for headache, nausea, nasal, throat and pulmonary irritation, and enlargement of the thyroid gland, which can result from prolonged, low concentration exposure.  HCN is evaluated separately.  Summary of data:  These alkali cyanide salts act *via* the same mechanism as HCN – by release of the cyanide ion.  NaCN, KCN and Ca(CN)2 will liberate HCN gas upon hydrolysis or in the presence of acids.  Human data:   * No adverse effects in workers exposed at concentrations on the order of 10 ppm (no further information) * Workers exposed at ≤5 ppm (5.1 mg/m3) reported nasal irritation and ulceration of the septum (no further information) * A study in workers exposed at 4.2–12.4 ppm in the breathing zone (7 yr) reported increased incidence of headache and weakness * LOAEL of 6.4 ppm NaCN (5–15 yr) reported for dyspnoea, precordial pain, vomiting, increased haemoglobin and lymphocytes, lacrimation, thyroid enlargement, confusion, headache, dizziness and weakness.   Animal data:   * LD50 NaCN and KCN range 5–10 mg/kg; ≡CN >100 ppm HCN in air * Similar acute toxicity between KCN and HCN * 30 min LOAEL 60 ppm (HCN) in mice; 50% decrease in average respiratory rate.   Insufficient data to recommend sensitiser or carcinogenicity notations. |
| DFG 2003 MAK: 2 mg/m3 (inhalable fraction as cyanide) |
| Summary of additional data:   * In humans, long-term exposure at 4.7–13.9 mg/m3 may lead to symptoms such as headaches, weakness, dizziness, throat irritation, dyspnoea, thyroid enlargement and an increase in thiocyanate excretion in the urine * LOAEL 4.7 mg/m3 * in humans, CN detoxification of 0.1 mg/kg/h equates to detoxification of 56 mg per 8 h (70 kg worker inhaling 10m3) * exposure to MAK of 2 mg/m3 equates to 20 mg over 8 h or 0.28 mg/kg (70 kg worker inhaling 10m3) * NOAEL for CN of 4.6 mg/kg in male rats; 1.6 mg/kg female rats; reproductive effects * Dermal LD50 14.63 mg/kg NaCN and 22.33 mg/kg KCN in rabbits * NaCN and KCN negative in *Salmonella typhimurium* and *Escherichia coli*. |
| SCOEL 2010 TWA: 1 mg/m3 (expressed as cyanide); STEL: 5 mg/m3 |
| Summary of additional data:   * Uses LOAEL of 4.7 mg/m3 cyanide (DFG, 2003) with UF of 5 to account for LOAEL to NOAEL to derive a TWA of 1 mg/m3 * Steep dose-response relationship and severe acute effects in humans (death); STEL of 5 mg/m3 recommended; no further information * No evidence for carcinogenicity or effects on reproduction. |
| OARS/AIHA NA NA |
| No report. |
| HCOTN 2002/2012 TWA: 1 mg/m3 (as cyanide); Ceiling: 10 mg/m3 (as cyanide) |
| Summary of additional data:   * Concentration range of 20–40 mg/m3 associated with slight acute effects within hours; concentration >135 mg/m3 fatal * steep dose-response curve warrants ceiling value * Uses LOAEL of 20 mg/m3 and applies factor of 2 to extrapolate to NOAEL to derive ceiling of 10 mg/m3 * Uses LOAEL of 4.2 ppm (4.7 mg/m3) (DFG, 2003; SCOEL, 2010) as starting point; applies factor of 5 to extrapolate to NOAEL to arrive at 1 mg/m3 as TWA. |

### Secondary source reports relied upon

| Source |  | Year | Additional information |
| --- | --- | --- | --- |
| US EPA |  | 2010 | * Reported that exposing workers to low concentrations can cause thyroid effects and CNS symptoms * Chronic or subchronic inhalation studies in experimental animals were not found * LOAEL: 6.4 ppm (7.07 mg/m3); long-term occupational study; observed thyroid effects; 36 male workers exposed; 20 males control. LOAEL was adjusted for continuous exposure to 2.5 mg/m3 and used as the POD for derivation of RfC  (8 x 10‑4 mg/m3) * A total UF of 3,000 was applied to the POD: * 10 for extrapolation of a LOAEL to a NOAEL * 3 for extrapolation from a subchronic to chronic exposure duration * 10 for human intraspecies variability * 10 to account for database deficiencies. |

### 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 | NA |
| HCIS | NA |
| NICNAS | NA |
| EU Annex | NA |
| ECHA | NA |
| ACGIH | Skin |
| DFG | H (skin) |
| SCOEL | Skin |
| 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: |  |  |  |  | | Dermal LD50 ≤1000 mg/kg: | yes |  |  |  | | Dermal repeat-dose NOAEL ≤200 mg/kg: |  | 3.00 |  |  | | Dermal LD50/Inhalation LD50 <10: |  |  |  |  | | *In vivo* dermal absorption rate >10%: |  |  |  |  | | Estimated dermal exposure at WES >10%: |  |  |  |  | |  |  | 3 | **consider assigning a skin notation** | | |

### IDLH

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

## Additional information

| Molecular weight: | 65.11 |
| --- | --- |
| 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) (2012) Hydrogen cyanide, potassium cyanide and sodium cyanide – MAK value documentation.

EU Scientific Committee on Occupational Exposure Limits (SCOEL) (2010) Recommendation from the Scientific Committee on Occupational Exposure Limits for cyanide (HCN, KCN, NaCN). SCOEL/SUM/115.

Health Council of the Netherlands (HCOTN) (2002) Hydrogen cyanide, sodium cyanide, and potassium cyanide. Health-based recommended occupational cancer risk values. The Hague: Health Council of the Netherlands; publication no. 2012/32.

Health Council of the Netherlands (HCOTN) (2012) Potassium cyanide. Evaluation of the carcinogenicity and genotoxicity. The Hague: Health Council of the Netherlands; publication no. 2012/03.

US Environmental Protection Agency (US EPA) (2010) Toxicological Review of Hydrogen Cyanide and Cyanide Salts. EPA/635/R-08/016F.

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