



EUROPEAN COMMISSION  
ENVIRONMENT DIRECTORATE-GENERAL

Directorate B – Protecting the natural environment  
B.4 – Biotechnology and Pesticides

ESSENTIAL USE APPLICATION  
FORM FOR BIOCIDES

### 1. MEMBER STATE

Austria	<input type="checkbox"/>	Belgium	<input type="checkbox"/>	Cyprus	<input type="checkbox"/>	Czech Republic	<input checked="" type="checkbox"/>	Denmark	<input type="checkbox"/>
Estonia	<input type="checkbox"/>	Finland	<input type="checkbox"/>	France	<input type="checkbox"/>	Germany	<input type="checkbox"/>	Greece	<input type="checkbox"/>
Hungary	<input type="checkbox"/>	Ireland	<input type="checkbox"/>	Italy	<input type="checkbox"/>	Latvia	<input type="checkbox"/>	Lithuania	<input type="checkbox"/>
Luxemburg	<input type="checkbox"/>	Malta	<input type="checkbox"/>	The Netherlands	<input type="checkbox"/>	Poland	<input type="checkbox"/>	Portugal	<input type="checkbox"/>
Slovenia	<input type="checkbox"/>	Slovakia	<input type="checkbox"/>	Spain	<input type="checkbox"/>	Sweden	<input type="checkbox"/>	United Kingdom	<input type="checkbox"/>

### 2. ACTIVE SUBSTANCE

2.1. Common name	<p><b>Hydrogen cyanide</b> Name according to Appendix I of Directive 67/548/EHS: Kyanovodík ; Kyanovodík [] %</p> <p>Czech name: Kyanovodík IUPAC: Hydrogen cyanide CAS: Hydrocyanic-acid</p> <p>Synonyms: Prussic acid, Cyanwasserstoff, formonitrile, blauwzur, Blausäure, Uragan D, Cyclon B, zaclondiscoids, formic anammonide, evercyn, cyjanowodor, cyaanwaterstof, blausaeure, acido cianidrico, acide cyanhydrique</p>
2.2. EC and/or CAS N°	<p>CAS no.: 74-90-8 EINECS no.: 200-821-6</p>
2.3. Molecular and Structural formula (including details on isomeric composition) – molecular mass	<p>Summary formula: HCN Structural formula: H-C≡N Molecular mass: 27.03</p>
2.4. Method of manufacture (in brief terms)	<p>Hydrogen cyanide is produced by the Andrussov method – by methane (or natural gas) ammoxidation. It is a continuous process with ammonia, natural gas and air as base materials. The reaction proceeds on a PtRh 10 alloy catalyst, at 1,020-1,100°C (1,868-2,012°F), with heat generation, according to the following stoichiometric equation:</p> $\text{NH}_3 + \text{CH}_4 + 1.5 \text{O}_2 \quad \text{HCN} + 3\text{H}_2\text{O} + 481\text{kJ}$

2.5. Specification of purity in g/kg or g/l as appropriate

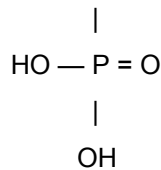
As a stabilizing additive preventing spontaneous polymerisation, a mixture of sulphur dioxide and phosphoric acid is added to liquid hydrogen cyanide.

- a) Chemical name: Sulphur dioxide  
Content: 0.9–1.1 wt. percent
- b) Chemical name: Phosphoric acid ...%)  
Molecular mass: 98.0 wt. percent

2.6. Identity of impurities and additives – including stabilisers

- a) Chemical name: Sulphur dioxide  
CAS no.: 7446-09-5  
EINECS no.: 231-195-2  
Index number: 016-011-00-9  
Molecular formula:  $\text{SO}_2$   
Structural formula:  $\text{O} = \text{S} = \text{O}$   
Molecular mass: 64,0  
Content: 0.9 – 1.1 wt. percent  
Classification: T, R23; C, R34

- b) Chemical name: Phosphoric acid ...%)  
CAS no.: 7764-38-2  
EINECS no.: 231-633-2  
Index number: 015-011-00-6  
Molecular formula:  $\text{H}_3\text{PO}_4$   
Structural formula:



- Molecular mass: 98.0  
Content: 0.08 – 0.12  
Classification: C, R34

2.7. Origin of substance (in case of a natural substance)

The substance is produced by chemical synthesis.

2.8. Physical chemical

None of the given parameters has been experimentally determined by the applicant. Hydrogen cyanide is a historic chemical substance, particularly described in reviewed research literature.

properties in accordance with Annex IIA, Point III, to Directive 98/8/EC, as appropriate

Data given below come from the official publication of U. S. Department of Health and Human Services, published in 2004. (ATSDR, 2004).

**Melting point, boiling point, relative density**

*Melting point* 13.4°C (7.90°F) From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

*Boiling point* 25.7°C (78.3°F) From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

*Relative density* 0.6884 (liquid at 20°C/68°F)  
From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

**Vapour pressure**

83992.86 Pa (at 20°C/68°F)

Henry constant: 5167.575 Pa . m<sup>3</sup> . mol<sup>-1</sup>

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

**Physical state, colour, odour**

Colourless liquid.

Colourless gas.

Bitter almond like odour.

Scent threshold 0.17ppm (wt./vol.) in water

0.58ppm (wt./vol.) in air

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

**Solubility in water**

The substance is fully miscible with water.

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

**Partition coefficient n-octanol – water, incl. pH (5-9) and temperature dependence**

K<sub>ow</sub> = 0.66

K<sub>ow</sub> = 1.07 (calculated)

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

**Flammability, incl. self-flammability and identification of combustion products**

In mixture with air, hydrogen cyanide forms explosive mixtures with the following limits:

upper explosive limit: 40 vol. %

lower explosive limit: 5.6 vol. %.

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

**Ignition point**

Ignition point: -17.8°C/-0.04°F (closed cup)

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

2.9. A summary or toxicological and ecotoxicological information for the substance

**TOXICOLOGICAL AND METABOLIC STUDIES**

**Acute toxicity – oral**

Since the substance is a gas at body temperature, the test may not be performed with HCN. For inorganic cyanides, the following toxicometric parameters are given in literature:

Rat (S-D) single 4 mg.kg<sup>-1</sup> (kill 19 out of 20, KCN)

Rat (NS) single 22 mg.kg<sup>-1</sup> LD50 (Ca(CN)<sub>2</sub>)

Rat (NS) single 8 mg.kg<sup>-1</sup> LD50 (NaCN)

Mouse (S-W) single 6 mg.kg<sup>-1</sup> (kill 19/20)

S-D – Sprague-Dawley

S-W – Swiss – Webster

From: (ATSDR, 2004, p. 141) \*Peer Reviewed\*

LD<sub>50</sub>(mouse, orl) = 8.5 mg.kg<sup>-1</sup>

From: (Verschuieren, 1983, p. 743) \*Peer Reviewed\*

### **Acute toxicity – dermal**

#### **Lethal effects:**

The lowest LD<sub>50</sub> value of dermal exposure to hydrogen cyanide given in the research study (ATSDR, 2004) was determined for female rabbits

LD<sub>50</sub>(rabbit, derm., HCN) = 6.7 mg.kg<sup>-1</sup>.

LD<sub>50</sub> values for potassium cyanide and sodium cyanide are slightly higher in the cited sources:

LD<sub>50</sub>(rabbit, derm., NaCN) = 7.7 mg.kg<sup>-1</sup>

LD<sub>50</sub>(rabbit, derm., KCN) = 8.9 mg.kg<sup>-1</sup>.

Cyanides permeate more easily through damaged or wet skin:

LD<sub>50</sub>(rabbit, derm. skarif., NaCN) = 4.1 mg.kg<sup>-1</sup>

LD<sub>50</sub>(rabbit, derm. moist, NaCN) = 6.3 mg.kg<sup>-1</sup>

#### **Non-lethal effects:**

Non-lethal systemic effects after dermal application of HCN and cyanides on female rabbits were in the research study (ATSDR, 2004) characterizes as follows

Albinotic rabbit	HCN	0.9 mg.kg <sup>-1</sup>	rapid breathing cornea opacity and inflammation
Albinotic rabbit	KCN	2.5 mg.kg <sup>-1</sup>	rapid breathing cornea opacity and inflammation
Albinotic rabbit	NaCN	2.1 mg.kg <sup>-1</sup>	rapid breathing cornea opacity and inflammation
		1.69 mg.kg <sup>-1</sup>	NOAEL

### **Acute toxicity – by inhalation**

#### **Lethal effects:**

The following determined toxicometric parameters are given in the research study (ATSDR, 2004, pp. 29-30):

Rat (Wistar)	5 min	563 mg.m <sup>-3</sup>	LC <sub>50</sub> (5 min)
Rat (NS)	60 min	160 mg.m <sup>-3</sup>	LC <sub>50</sub> (60 min)
Mouse (ICR, males)	5 min	323 mg.m <sup>-3</sup>	LC <sub>50</sub> (5 min)
Mouse (ICR, males)	3 min	448 mg.m <sup>-3</sup>	90% kill
Mouse (Swiss-Webster)	30 min	18 mg.m <sup>-3</sup>	LC <sub>50</sub> (30 min)
Rabbit (NS)	35 min	207 mg.m <sup>-3</sup>	LC <sub>50</sub> (35 min)

The database (HSDB, 2006, HCN) contains further comparable toxicometric values

LC<sub>50</sub>(dog, ihl., 3 min) = 336 mg.m<sup>-3</sup>

LC<sub>50</sub>(mouse, ihl., 30 min) = 189.3 mg.m<sup>-3</sup>

Acute inhalation toxicity of hydrogen cyanide for rats depending on the exposure time:

Exposure time	LC <sub>50</sub> (mg.m <sup>-3</sup> )
10 s	3778
1 min	1471
5 min	493
30 min	173
60 min	158

From: (WHO, 2004, p. 18)

LC<sub>50</sub>(rat, ihl.) = 157.6 mg.l<sup>-1</sup>

From: (Verschuieren, 1983, p. 743) \* Peer Reviewed\*

#### **Non-lethal effects:**

The following information on non-lethal effects of hydrogen cyanide inhalation are given in the research study (ATSDR, 2004, pp. 30, 31):

#### **Systemic failures:**

Monkey ( <i>Cynomolgus</i> )	30 min	112 mg.m <sup>-3</sup>	significant breathlessness
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			bradycardia, arrhythmia, T-wave abnormalities
Mouse (Sviss-Webster)	30 min	63 mg.m <sup>-3</sup>	50% increased respiratory speed
Neurological failures: Monkey ( <i>Cynomolgus</i> )	30 min	112 mg.m <sup>-3</sup>	unconsciousness, irregular breathing, EEG changes
Rat (Long-Evans)	3.5 h	56 mg.m <sup>-3</sup>	NOAEL

### **Skin and eye irritation**

No studies on hydrogen cyanides effects on skin and mucous membranes of laboratory animals have been published according to the conclusions of the research study (ATSDR, 2004, p. 41). The same study states (p. 79) that application of dicyanogen to skin of rabbits at concentrations 5,000ppm CN<sup>-</sup> for 8 hours did not cause dermal damage.

### **Skin sensitisation**

No data regarding sensitisation effects of hydrogen cyanide and cyanides are given in literature (WHO, 2004, p. 25).

### **Mammal metabolism study. Basic toxicokinetics including skin absorption study**

#### **Absorption**

Due to hydrogen cyanide physical-chemical properties, oral exposure is practically out of question.

Regarding absorption of hydrogen cyanide the research study (ATSDR, 2004, p. 85) states that in tests with HCN vapours performed on guinea pigs with shaved bellies, after 30-60 minutes of exposure, toxicity symptoms were observed, including rapid breathing, muscle twitching, unconsciousness and death. Similar tests with dogs, whose bodies (both shaved and unshaved excluding head and neck) were exposed to HCN vapours, did not show any toxicity symptoms after 180 minutes of exposure to HCN 5.572 mg.m<sup>-3</sup> concentration. Exposure to 15,000 mg HCN.m<sup>-3</sup> led to death after 47 minutes of dermal absorption.

#### **Distribution**

Concerning the distribution of hydrogen cyanide following inhalatory exposure, the research study (ATSDR, 2004, p. 86) states that it is rapidly distributed by blood throughout the body.

The highest concentrations of cyanides in two dogs poisoned by an unknown concentration of hydrogen cyanide were found in their lungs, blood and hearts.

In rats exposed to HCN concentrations 400 and 1,320 mg.m<sup>-3</sup>, killed after 10 and 5 minutes, were found no differences in cyanide concentrations in various body tissues which would have depended on the HCN exposure concentration. Average cyanide concentrations in tissues of rats from both groups were 4.4µg.kg<sup>-1</sup> of wet weight of the organ in lungs, 3.0µg.kg<sup>-1</sup> of wet weight in blood, 2.15µg.kg<sup>-1</sup> of wet weight in liver, 1.4µg.kg<sup>-1</sup> of wet weight in brain, and 0.68µg.kg<sup>-1</sup> of wet weight in spleen.

In rats exposed to 3,040mg HCN.m<sup>-3</sup> for 5 minutes, the following values of cyanide content in body tissues were found:

170µg.100 ml<sup>-1</sup> of blood, 48µg.100 ml<sup>-1</sup> in blood plasma, 0µg.100 g<sup>-1</sup> in liver, 6µg.100 g<sup>-1</sup> in kidneys, 50µg.100.g<sup>-1</sup> in brain, 62µg.100.g<sup>-1</sup> in heart, 54µg.100.g<sup>-1</sup> in lungs, and 6µg.100.g<sup>-1</sup> in spleen.

Concerning the distribution of cyanides in the bodies of laboratory animal after dermal exposure, the research study (ATSDR, 2004, p. 88) states:

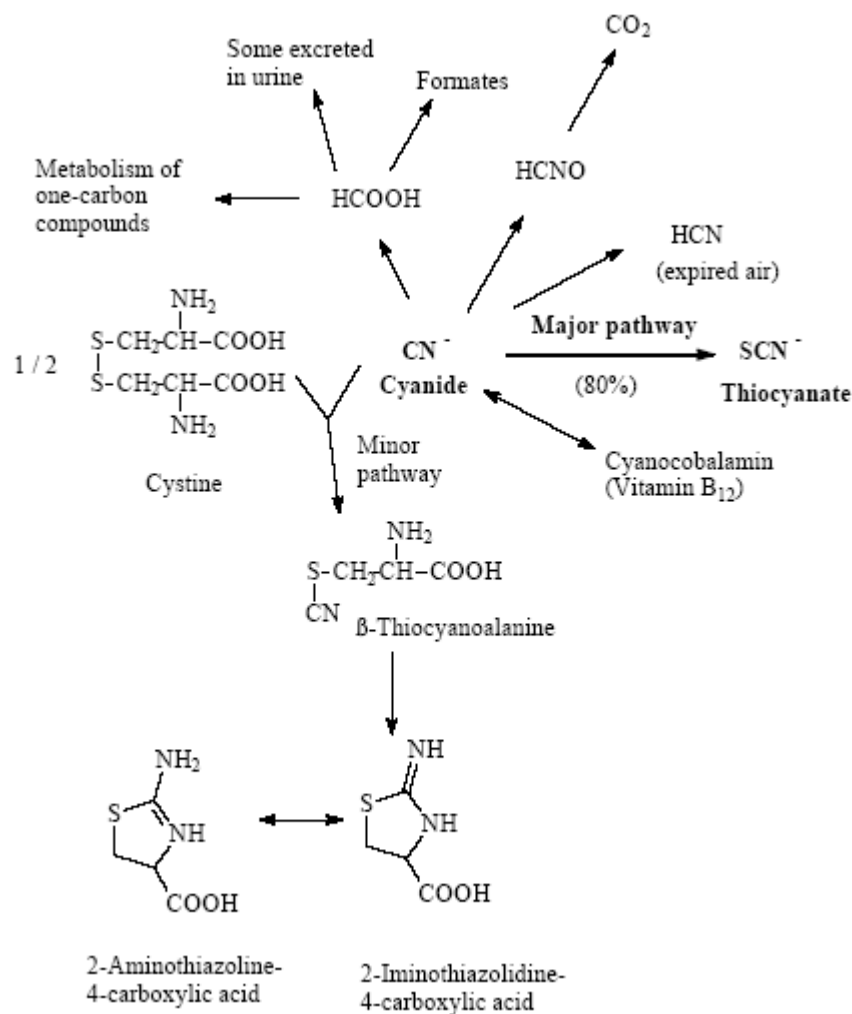
In six rabbits exposed dermally to HCN in concentration 33.75mg HCN.kg<sup>-1</sup>, the following

concentrations were found: 310 and 144 $\mu\text{g CN}^- \cdot 100 \text{ ml}^{-1}$  in blood and blood serum, and in body tissues (in  $\mu\text{g} \cdot 100 \cdot \text{g}^{-1}$ ): 26 liver, 66 kidneys, 97 brain, 110 heart, 120 lungs and 21 spleen.

### Metabolism

As the research study (WHO, 2004, pp. 15-16) states, approx. 80% of absorbed cyanides is metabolised by activity of mitochondrial enzyme rhodanese which catalyses the transfer of thiosulphate sulphur to cyanide with the generation of thiocyanate. The transfer rate is limited by the thiosulphate availability. Rhodanese is present in mitochondria of all tissues, however its occurrence in different tissue kinds varies. Generally, a higher concentration can be found in liver, kidney, brain and muscles. The thiosulphate supply is, however, limited. The rhodanese content in the nasal mucous membrane of rats is approx. 7x higher than in liver. The rhodanese activity is higher in dogs than in monkeys, rats and rabbits.

Other sulphur transferases, too, participate in metabolising cyanide. Other cyanide metabolic processes proceeding mammal organisms are clearly shown in the following picture taken from literature (WHO, 2004, p. 16):



### Toxicity upon short-time repeated dose (28 days)

The research study (ATSDR, 2004, pp. 31-32) gives the following summary of toxicometric parameters of HCN toxicity found out after repeated inhalatory exposure:

#### Lethal effects:

Dog 28 days, 30 min. $\cdot$ d $^{-1}$ , 2-day intervals 50 mg. $\cdot$ m $^{-3}$  25% kill

#### Systemic effects:

Rat 20 days, 4-day intervals, 12.5 min/d 224 mg. $\cdot$ m $^{-3}$  increased activity of creatine

Dog 28 days, 30 min.d<sup>-1</sup>, 2-day intervals 45 mg.m<sup>-3</sup> phosphokinase  
dyspnea

### **Subchronic 90–day study, two types**

No results of any chronic toxicity study of hydrogen cyanide administered to laboratory animals by means of inhalation have been published according to the conclusions of the research study (ATSDR, 2004, pp. 227-244).

### **Chronic toxicity**

No results of any chronic toxicity study of hydrogen cyanide administered to laboratory animals by means of inhalation have been published according to the conclusions of the research study (ATSDR, 2004, pp. 227-244).

No results of any chronic toxicity study of hydrogen cyanide administered orally to laboratory animals have been published according to the conclusions of the research study (ATSDR, 2004, pp. 45-74).

No results of any chronic toxicity study of hydrogen cyanide administered dermally to laboratory animals have been published according to the conclusions of the research study (ATSDR, 2004, pp. 75-80).

### **Mutagenity study**

#### ***Detection of gene mutations on micro-organisms with metabolic activation in vitro***

According to the conclusions of the research study (ATSDR, 2004, pp. 81-83), results from in-vitro tests of reverse mutations of hydrogen cyanide on bacteria *S. typhimurium* were described. In TA98 strain, no mutagenic effects of hydrogen cyanide in a system without metabolic activation, as well as with metabolic activation by S9 fraction, have been observed. In TA100 strain, a slight mutagenic effect in metabolic activation tests, and mutagenic effects in metabolic activation tests were observed.

In other tests performed with NaCN in TA97, TA98, TA100 and TA1535 strains, no positive results in systems without as well as with activation were shown.

#### ***Detection of cytogenetic (clastogenic) effects (chromosomal aberration) on mammal cells in vitro with metabolic activation***

In literature, we have found no results of in-vitro studies of cytogenetic effects of hydrogen cyanide performed by OECD 473 method

#### ***Detection of gene mutations on mammal cells in vitro with metabolic activation***

In literature, we have found no results of in-vitro studies of gene mutations of hydrogen cyanide on mammal cells performed by OECD 476 method.

Literature (ATSDR, 2004, p. 82) brings results of several tests performed with mammal cells with cyanide by methods not corresponding to OECD 476 method. Tests with HCN without metabolic activation repeatedly showed an increased number of DNA fragments connected with cytotoxicity in in-vitro tests on several lines of eucarvotic organisms (TK6 of human lymphoblasts, rat thymocytes, hamster BHK-21 cells).

No decrease of DNA synthesis in HeLa cells was observed in tests with KCN with as well as without metabolic activation.

### **Results of another *in vivo* study in tissues other than bone marrow**

The research study (ATSDR, 2004, p. 81) records results of a study, in which increased DNA fragmentation was observed in mitochondria isolated from the brain of male mice after subcutaneous administration of 2.8mg CN<sup>-</sup> (as KCN). kg<sup>-1</sup>.

### **Test of possible effects on germ cells**

In literature, we have found no results of studies of hydrogen cyanide possible effects on germ cells in compliance with OECD 478 or 483.

The research study (ATSDR, 2004, p. 81) describes an experiment, in which potassium cyanide in a single dose  $1\text{mg CN}^- \cdot \text{kg}^{-1}$  was administered to mice, but did not cause inhibition of testicular DNA synthesis.

### **Carcinogenicity study**

None of the published studies performed on laboratory animals has proved an increase risk or cancer occurrence as a result of exposure to hydrogen cyanide or inorganic cyanides (ATSDR, 2004, pp. 44, 74, 80).

### **Toxicity for reproduction**

The research study (ATSDR, 2004, pp. 72-73) states that no results of tests with HCN on laboratory animals, focused on toxicity for reproduction, were found.

The results of toxicity for reproduction and development studies given below were performed only with alkali cyanides or with organic substances and food containing a higher amount of unstably organically bonded cyanides (acetone cyanohydrin, manioc).

### **Teratogenicity tests – rabbit and one rodent species**

No developmental defects were observed in a study, in which manioc was administered to female rats (Wistar) between 1-16 day of gestation and between 1-21 day of lactation in a dose corresponding to a daily intake approx.  $1.2\text{mg CN}^- \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ , and manioc combined with KCN in a dose corresponding to a daily intake  $51\text{mg CN}^- \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ . In continuation of the tests with offspring fed by similar doses of manioc and of manioc combined with potassium cyanide, weaned offspring descended from mother exposed to a higher dose of  $\text{CN}^-$ , decrease of their growth rate, regardless the exposure level in utero, was observed (ATSDR, 2004, pp. 73, 57).

### **Fertility study**

#### ***Oral exposure:***

As the most suitable for determining control parameters have been chosen those results of the research study (ATSDR, 2004, p. 72), coming from a 90-day oral study in which sodium cyanide was administered in feed water to rats and mice.

At the daily dose of  $12.5\text{mg CN}^- \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ , weight decrease of the left epididymis, left end of epididymis and the left testicle, and decrease of the sperm number and of the size of sperm heads was observed at males.

At the daily dose of  $24.3\text{mg CN}^- \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ , significant weight decrease of the left epididymis and left end of epididymis was observed at males, but no changes in sperm motility or sperm head concentration.

At the daily doses of  $4.9$  and  $12.5\text{mg} \cdot \text{kg}^{-1} \cdot \text{d}^{-1}$ , extension of proestrus and diestrus phases of the cycle, and shortening estrus and metestrus phases of the cycle occurred at females.

#### ***Inhalatory exposure:***

Tests of acetone cyanohydrin inhalation brought according to (WHO, 2004, p. 23) the following results:

Within a male fertility study, 15 male rats were exposed by inhalation to acetone cyanohydrin  $6\text{h} \cdot \text{d}^{-1}$  5 days a week for 69 days (i.e. 48 exposure days), i.e. hydrogen cyanide concentrations 0, 11, 32 and  $64\text{mg HCN} \cdot \text{m}^{-3}$ . Then each of the males was coupled with three unexposed females.

No effects on average body weight, clinical symptoms of toxicity, or anatomical changes during an overall biopsy were observed. Further, no difference in successful coupling, in the total number of implants, and in preimplantary and postimplantary losses was observed between

the control and the exposed groups.

### **Experience from published observations of hydrogen cyanide effects on human health**

Effects of hydrogen cyanide and cyanides on human health have been observed for more than two hundred years, since hydrogen cyanide was first isolated by Scheele in 1782. However, hydrogen cyanide had been known long before then, as early as in the ancient Egypt and Greece, eliminated from stones of some drupes, used for murders, suicides and executions. The most tragic chapter in the usage of hydrogen cyanide was its employment as a warfare gas (at Vincennite, France, First World War) and for genocide (Nazi Germany).

### **Toxicity after inhalatory exposure**

#### **Lethal effects**

The research study (ATSDR, 2004, p.27) states – based on US army information – that hydrogen cyanide concentration of  $613\text{mg.m}^{-3}$  is an average concentration killing humans within 10-minute of inhalatory exposure. Records of industrial accidents show that concentration  $303\text{mg.m}^{-3}$  immediately kills humans. Concentration  $203\text{mg HCN.m}^{-3}$  causes death within 10 minutes,  $152\text{mg HCN.m}^{-3}$  within 30 minutes.

#### **Respiratory tract effects**

A group of volunteers exposed to concentration  $9\text{mg.m}^{-3}$  of cyanides in the form of dicyanogen experienced after 6-8-minute exposure irritation of nasal mucous membranes. Half-concentration did not have this effect.

People (5-15 years of age) chronically exposed to concentrations 6.4-10.4ppm of a non-specific form of cyanides released from sodium cyanide and copper[II] cyanide at electrolytic galvanizing experienced breathlessness. Similar effects were observed also in silver-extracting plants. Further symptoms included coughing, sore throat, changes in appetite, hyperemia (increased blood flow) of nasal mucous membrane, bleeding nose, hemoptysis (coughing up of blood).

#### **Cardiovascular effects**

The research study (ATSDR, 2004, p. 38) describes inhalatory effects of unspecified hydrogen cyanide concentration on cardiovascular system. Symptoms, including cardiac activity slowdown, irregular heartbeat, and audio-visual defects, appeared within 1-3 minutes of exposure. The most common effects of inhalatory poisoning by hydrogen cyanide were palpitation and decreased blood pressure. The chronically exposed humans mentioned above complained also about chest pains. Employees exposed to 15ppm of hydrogen cyanide experienced palpitation and chest pains.

#### **Gastrointestinal system effects**

Sixty-nine percent of employees exposed to 15ppm of hydrogen cyanide suffered nausea and vomiting. Similar problems were reported by employees exposed to concentrations 6.4-10.4ppm. Gastrointestinal effects are ascribed to irritation effects of central nervous system and/or gastric mucous membrane by ingested part of inhaled hydrogen cyanide.

#### **Haematological effects**

Humans exposed to hydrogen cyanide concentrations 6.4-10.4ppm showed detectable increase of haemoglobin and white blood cells, compared to a control unexposed group. Echymosis basophilia, which is an indication of toxic effects, was observed in 28 out of 36 persons. In another group of men, increase of neutrophils, increase of erythrocytes sedimentation rate and drop in haemoglobin values were observed.

#### **Musculoskeletal effects**

No musculoskeletal effects of hydrogen cyanide inhalation have been described.

### ***Hepatic effects***

Inhalation of cyanides caused increased basic phosphatase level in blood serum, but did not cause increased level of bilirubin.

Inhalation of 200ppm of hydrogen cyanide for unspecified time caused anuresis followed by polyuria.

### ***Endocrine system effects***

Increase of TSH (thyroid stimulating hormone) mean levels in humans exposed to 15ppm of hydrogen cyanide. Thyromegaly (abnormally enlarged thyroid gland) was observed in humans long-time exposed to 6.4-10.5ppm of hydrogen cyanide. Endocrine effects were ascribed to activity of thiocyanates formed by metabolising cyanides.

### ***Skin effects***

Rash was observed in 42% of humans exposed to 15ppm HCN. No skin symptoms were observed in humans long-time exposed to effects of 6.4–10.4ppm of hydrogen cyanide.

### ***Eye effects***

Concentration 8ppm of cyanides generated from dicyane caused eye irritation, but concentration 4ppm did not. Partial loss of peripheral vision was observed as a permanent effect of 13-minute exposure to 452ppm HCN. Other studies describe eye irritation caused by 15ppm HCN and lacrimation at 6.4ppm HCN.

### ***Body mass effects***

Partial loss of appetite was observed in 58% of humans exposed to 15ppm HCN, and body mass decrease at 50%.

### ***Immunologic and lymphoreticular effects***

No immunologic and lymphoreticular effects of hydrogen cyanide have been described.

### ***Neurological effects***

The primary target of cyanide toxicity is the central nervous system. Inhalation of hydrogen cyanide causes first short-time stimulation followed by depression, convulsions, unconsciousness and suppression of primary reflexes, dilatation of pupils, paralysis and even death.

Lower concentrations of hydrogen cyanide may cause funny turn, breathlessness, dizziness, languor and headache. Worsening of recent memory with convulsions were observed as distant effects a year after acute intoxication by hydrogen cyanide.

Symptoms observed after chronic exposure to 15ppm HCN after unspecified time include increased languor, dizziness, headache, sleeping disorders, ringing in ears, limb convulsions, fainting. Some neurological disorders continued even ten months after the end of exposure. Other studies describe headache, weakness, changes in taste and smell perception, nausea, concentration disorders and psychoses, loss of recent as well as remote memory, impairment of vision, psychomotoric abilities and visual recognition.

No studies have been published on inhalatory effects of cyanides and hydrogen cyanide concerning *fertility, developmental defects and increase of cancerous diseases occurrence*.

### **Toxicity after dermal exposure**

Dermal exposure to hydrogen cyanide is the second most serious route of exposure for humans.

The research study (ATSDR, 2004, p. 74) gives estimated **lethal** value LD<sub>50</sub> for humans 100mg CN/kg, calculated as HCN.

No data have been published on *haematological, musculoskeletal, hepatic and endocrine effects, or on effects on body mass, gastrointestinal system, skin, exes and immunologic and lymphoreticular system* caused by dermal exposure to cyanides.

#### **Respiratory system effects**

Problems with breathing were observed in an employee after hand exposure to HCN.

#### **Cardiovascular system effects**

Palpitation was observed in three humans, who worked 8–10 minutes in an atmosphere with 20,000ppm HCN wearing masks only.

#### **Renal system effects**

Temporary oliguria was observed in one person full-body exposed for three minutes to copper[II] cyanide solution.

#### **Neurological effects**

Nausea, asthenia and headache were observed in humans wearing masks exposed to 20,000ppm HCN for 8-10 minutes.

#### **Genotoxicity**

According to the research study (ATSDR, 2004, p. 80) conclusions, no data have been published concerning genotoxic effects of hydrogen cyanide and cyanides on humans after oral or inhalatory exposure.

## **ECOTOXICOLOGICAL INFORMATION**

#### **Acute toxicity for fish**

The research study of cyanide toxicity for aquatic organisms (US EPA, 1985, p. 5) states, that the most sensitive aquatic organism is rainbow trout for which an average value of  $LC_{50}$   $44.73\mu\text{g}\cdot\text{l}^{-1}$  has been determined from available information. Upon long-term observation of cyanide effects on reproduction of fish *Lepomis macrochirus*, concentration  $5.2\mu\text{g}\cdot\text{l}^{-1}$  was set as the NOEC value for fish.

Literature contains also evidence that spawn, larva and warm-water fish are generally more resistant to cyanide effects than adult salmonids.

Further toxicometric values come from Verschueren, 1983, p. 742:

$LC_{50}$  (96h, rainbow trout) =  $57\mu\text{g}\cdot\text{l}^{-1}$

$LC_{50}$  (96h, *Lepomis macrochirus*, fry) =  $232\text{--}365\mu\text{g}\cdot\text{l}^{-1}$

$LC_{50}$  (96h, *Lepomis macrochirus*, young fish) =  $75\text{--}125\mu\text{g}\cdot\text{l}^{-1}$

$LTC_{50}$  (96h, *Pimephales promelas*, spawn) =  $121\text{--}352\mu\text{g}\cdot\text{l}^{-1}$

$LC_{50}$  (96h, *Pimephales promelas*, fry) =  $82\text{--}122\mu\text{g}\cdot\text{l}^{-1}$

$LC_{50}$  (96h, *Pimephales promelas*, young fish) =  $82\text{--}137\mu\text{g}\cdot\text{l}^{-1}$

#### **Acute toxicity for *Daphnia magna***

$EC_{50}$  (48h, *Daphnia*) = 1.8mg/l From: (Verschueren, 1983, p. 742)

$EC_{50}$  (48h, *Daphnia magna* Straus) = 1.07mg.l<sup>-1</sup> From: (CETA VÚOS, 2002a)

#### **Growth inhibition test of algae**

$E_bC_{50}$  (0–72h, *Scenedesmus subspicatus* Brinkman) = 0.04mg.l<sup>-1</sup>

$E_rC_{50}$  (0–72h, *Scenedesmus subspicatus* Brinkman) = 0.12mg.l<sup>-1</sup>

From: (CETA VÚOS, 2002b)

#### **Inhibition of microbiological activity**

25mg.l<sup>-1</sup> HCN without obvious impact

30mg.l<sup>-1</sup> HCN inhibitory effect beginning after 6 days

50mg.l<sup>-1</sup> HCN 10% decrease of gas formation

From: (Verschueren, 1983, p.742) \*Peer reviewed\*

#### **Degradability**

##### **Biotic**

Mechanism of degradation in water:



Mechanism of degradation in soil:



From: (Verschueren, 1983, p. 742)

##### **Abiotic**

Cyanides dissolved in water oxidize in alkali medium (pH > 9.2) by chlorine to cyanates, while in acid pH the main elimination process is their volatilisation into the atmosphere.

From: (HSDB, 2006; HCN)

Reaction rate constant HCN with hydroxyl radicals produced photochemically in the steam phase was determined  $3 \cdot 10^{-14} \text{cm}^3 \cdot (\text{mol} \cdot \text{s})^{-1}$ . This corresponds to atmospheric half-life approx. 535 days at atmospheric concentration of hydroxyl radicals  $5 \cdot 10^5 \text{cm}^{-3}$ . (1)

Hydrogen cyanide is not expected to directly photolyze due to the lack of absorption in the ultraviolet part of the spectrum.

pK<sub>a</sub> value of 9.2 suggests that hydrogen cyanide is at high pH dissociated and exists in the form of an anion<sup>3</sup>).

Hydrogen cyanide may form inorganic complexes with metals present in soil.

(1) Atkinson R; J. Phys. Chem. Ref. Data Monograph 1 (1989) \*Peer reviewed\*

(2) Lyman WJ et al; Handbook of Chemical Property Estimation

Methods. Washington, DC: Amer Chem Soc pp. 7-4, 7-5 (1990) \*Peer reviewed\*

(3) USEPA; Treatability Manual Vol. 1. Treatability Data. USEPA-600/8-80- 042 (1980)

\*Peer reviewed\*

(4) Pesce LD; Kirk-Othmer Encycl Chem Technol 4th ed. Kroschwitz JI, ed.

NY, NY: John Wiley and Sons 7: 758-82 (1993) \*Peer reviewed\*

#### **Summary of ecotoxicological effects, fate and behaviour of the substance in the environment**

Hydrogen cyanide is an omnipresent substance formed in the natural environment by biological syntheses in organisms of many bacteria, fungi, algae and plants, including plants used as fodder and food. A significant quantity of hydrogen cyanide is released into the atmosphere by volcanic activity; it is generated at incineration of natural materials (coal, wood, grass, tobacco etc.), at incineration of organic substances (e.g. polymers, especially with a high content of nitrogen, waste etc.). Another source of hydrogen cyanide and cyanides released into the environment is industrial production and the usage of hydrogen cyanide and its organic as well as inorganic compounds.

Due to its low boiling point, high vapour pressure at temperatures over 10°C (50°F), and lower relative density compared to the density of air, hydrogen cyanide fate and behaviour in the environment is different from those of other cyanide compounds. The main environmental compartment, into which the biggest part of released hydrogen cyanide gets transferred, is air.

Persistence half-life of hydrogen cyanide in the atmosphere is 1-3 years. The most important mechanism of its degradation in air is a reaction with hydroxyl radicals released by air moisture. Since hydrogen cyanide is incapable of absorbing light radiation within the visible spectrum, almost no direct photolysis occurs.

Although hydrogen cyanide quite readily dissolves in water, and depending on pH dissociates ( $pK_a$  is 9.2) while cyanide anions are formed, it tends to volatilise from water environment at temperatures and water pH usual for most industrialized regions of the world. At water pH below 8 and temperature below 25°C (77°F), approximately 94% of cyanides present in water occur in a non-dissociated form of hydrogen cyanide. By micro-organism activity, hydrogen cyanide persisting in water partly transforms into less toxic substances. Due to the high toxicity of hydrogen cyanide for some species of bacteria, degradation in bacterial cultures adapted to the presence of hydrogen cyanide and cyanides proceeds more readily than in non-adapted cultures. With metals present in the water, part of dissolved cyanides may react to little toxic complex compounds. The half-life of cyanides in water is not known. Cyanides dissolved in water have only a low ability to get bound in the fish body.

The ability of hydrogen cyanide to get bound to dry soil is also low. As in water, the biggest part of hydrogen cyanide volatilises from the soil and only a small part is transferred by microbial or chemical processes into less toxic chemical compounds.

If the hydrogen cyanide concentration in any environmental compartment reaches a sufficient concentration, it affects all life organisms as highly toxic even at very low concentrations.

Fish is generally more sensitive to hydrogen cyanide effects than invertebrates, with the exception of e.g. daphnia with approximately the same sensitivity as fish. Spawn, larva and warm-water fish are generally less sensitive to hydrogen cyanide effects in water. The most sensitive species are salmonids. For rainbow trout an average value of  $LC_{50}$  44.73  $\mu\text{g CN} \cdot \text{l}^{-1}$  was determined by analysing available published information. The NOEC value for cyanides in water has been estimated at 5.2  $\mu\text{g CN} \cdot \text{l}^{-1}$  upon results of a long-term experiment on fish reproduction.

### 3. AVAILABLE INFORMATION ON THE ESSENTIAL USE

3.1. Product type and use(s) for which the derogation is required

Type 8 – Wood preservatives

Preparations used for the conservation of wood, including timber and wood products, against wood-destroying or disfiguring products.

Type 18 – Insecticides, acaricides and preparation for reduction of other arthropod

Preparations used for regulation of arthropod (e.g. insect, mites, ticks, spiders and crustaceans) populations, including preparations used for killing external parasites in spaces where animals are reared or transported, excluding situations when the animals stay in treated areas at the time, when the preparation is still active.

Preparations for treating empty storehouses or containers, bags, drums, showers etc., excluding those intended exclusively for storing plants and plant products.

3.2. Method(s) of application

#### **Description of a fumigation process with hydrogen cyanide in empty spaces**

When handling and using the preparation, all precautions and requirements of par. 22, section 5 of Act no. 157/1988 Coll., on handling highly toxic substances, must be observed. Fumigation must be reported at least 48 hours in advance to a competent health officer and to local authorities. The treated building must be marked. The treatment may be carried out only in such places where there is no risk of health hazard to humans, animals and the surroundings. Interior as well as exterior examination of the building, together with evaluation of all circumstances affecting the safety of the area and enabling technical securing of the building must be carried

out prior to the treatment itself.

First, all food intended for using (flower, bran, groats, flakes etc.), liquids, plants, tobacco products, first-aid boxes, aquariums etc. shall be removed from the premises. Thick layers of dust or crusts formed on wet spots shall be removed or broken. All machines, silos, transport routes and lids shall be open to ensure easy circulation of the gas. The whole building shall be hermetically closed by sealing all windows, doors and other openings with soda-fibre paper strips coated with a starch adhesive. Openings which may not be sealed in this way (e.g. electric wiring passages) shall be sealed with sand. Drain pipes fitted with siphons need not to be sealed.

Prior to the fumigation commencement, temperature and air humidity shall be measured, and pest infestation of the building shall be determined. Temperature inside the building may not drop below 10°C (50°F) during the whole process.

After the building is sealed, all unauthorised personnel must leave. The fumigation supervisor shall take over keys from the building (as well as spare ones) and together with a representative of the customer shall carry out a final inspection. They shall control condition of the sealing, whether all personnel have left the building and whether water, gas and electricity lines are disconnected. Since the beginning of this inspection, the entry into the building shall be guarded and warning notices shall be placed on the building.

Before the cans with gas are opened, it is necessary to clean the spots where they are to be placed. All objects from the floor, which may cause someone to trip over, and hanging objects shall be removed, slippery spots shall be wiped or covered, to eliminate any possible danger for the personnel performing the treatment in masks (limited range of vision).

After the final inspection is over, a required number of cans shall be prepared. The number shall be calculated from the cubic capacity of the building and from the quantity of gas released from one can.

Dosage: 10g/m<sup>3</sup>, i.e. 1kg per 100m<sup>3</sup> in field conditions.

Packing: Uragan D2 (stabilized liquid hydrogen cyanide) is supplied completely soaked into a porous material in a 1.5kg gas-tight can.

In multi-storeyed buildings with interconnected storeys it is necessary to use 10% more gas on the bottom floor. In buildings with separated storeys the dosage follows the cubic capacity. The cans are distributed from the top storey downwards. They shall be placed in one row, with equal distances between them. All the rows shall lead towards exits. If the ground plan is complex, ways towards the exits shall be marked with arrows. If the cans are transported by a lift, this shall be done without any personnel inside the lift. The cans shall be handled without rolling or throwing. Personnel distributing the cans must have gas masks ready to use.

Based on the building size, the supervisor shall determine a number of personnel to take part in the treatment and shall divide them into groups. The treatment must be performed by a group of at least three workers. If there are any defects discovered during the process (e.g. unsealed opening or broken windows), these shall be always fixed by a group, not by a single person.

The work group assigned to open the cans shall check openers, masks, filters (expiration date). The process of filling the building with the gas shall be performed by fresh personnel, not sweaty or out of breath.

The filling process shall start at least 5 hours before sunset, so that possible defects in the sealing (discovered after the gas has been released) could be fixed. If there are more groups at work, none of them may pass through an area already filled with gas. During the gas filling process, the groups shall check on each other and shall leave the building together. Then the building shall be locked and sealed.

One person shall open the cans for 1-2 other persons who shall empty the cans on the floor to the sides or behind them, never to the front. The content must not be placed on top of each other and must not be stepped on to prevent contamination of clothing and shoes. Empty cans shall be always placed with the open side up. They shall be prevented from being lost inside the

building. After the building is closed, it is necessary to switch off main electricity supply.

For the whole filling time, there must be personnel guarding the entrance, however the exit shall not be locked. If any member of a group is attacked by nausea, in case of a three-member group both remaining members of the group shall take this person outside; in case of bigger groups, at least one member of the group shall accompany the sick person outside.

During the whole time (i.e. from the beginning of the filling to handing over a ventilated building) the process supervisor must be available. Assigned personnel shall guard the building for the whole time of the process, as well as check the surroundings and adjacent buildings till the treated building is handed over. All accessible places must be provided with posters with skull and bones sign and label "Warning! Treated with highly dangerous gas – hydrogen cyanide! No entry!". Further the posters must contain the date and time of the filling, exposure time, ventilation time, and date and time of expected clearing; as well as the supervisor's name. The posters shall be removed only after the building has been cleared.

The treated building shall be cleared after it has been ventilated. The ventilation shall start not later than two hours before sunset, and shall be done actively using a fan or passively by air draught with windows and doors open. The building shall be ventilated from the bottom to the top storey.

The ventilation must not be carried out when it is misty, raining, smoggy, or sultry (due to limited air circulation). During the first phase the ventilation must not be carried out towards water courses, streets etc. Windows facing these directions shall be open only after the gas concentration has been diluted (air movement and wind must be taken into account). The most suitable is active ventilation provided by a fan above the roof of the ventilated building, with windows being open only after the gas concentration has been diluted. If the air temperature drops below 10°C (50°F), the ventilation shall be carried out by opening and closing the windows in intervals to prevent the inside of the building from cooling down.

The ventilation shall be carried out by at least three persons, with two of them opening the building and the third one guarding and checking gas concentrations outside the building. Personnel inside the building shall check on each other and leave the building together. The ventilation time of an empty building is usually 24-48 hours, depending on weather conditions or increased humidity.

After the ventilation, prior handing the building over, the supervisor shall check the number of cans (the number of empty cans must correspond with the number or those brought in). Fibre reels shall be collected and incinerated. Prior to the opening, it is necessary to pay special attention to wet spots, where hydrogen cyanide may be absorbed and gradually released later on, when the temperature increases. Prior to handing the building over, all machinery shall be put into operation for approximately 15 minutes, with windows open.

When there is no indication of hydrogen cyanide presence, the building may be cleared. Under Government Ordinance no. 178/2001 Coll., the average permissible concentration of hydrogen cyanide in work atmosphere is 3mg/m<sup>3</sup>, the maximal concentration then 10mg/m<sup>3</sup>.

The determination of the hydrogen cyanide presence in air shall be done using detection tubes for hydrogen cyanide type 2a. These are produced by Dräger Safety AG&Co.KgaA, Lubeck, Germany, and distributed in the Czech Republic by Dräger Safety s.r.o., Pod Sychrovem I/64, Praha 10.

Only specially trained personnel at least 18 years old may handle hydrogen cyanide. Personnel handling the substance must use approved protective equipment: gastight chemical protective clothing (ČSN EN 464), special breathing apparatus with a filter unit (ČSN EN 132 and 133), cap or hat, rubber gloves (ČSN EN 374-1) and rubber boots (ČSN EN 346).

After finishing the filling, personnel shall take off the protective clothing and keep moving in an open space for 3-5 minutes to ensure ventilation of the gas from the clothing and body. Only then they shall take off the mask or breathing apparatus. Each work group must have a sufficient reserve of filters in operating conditions or oxygen/air bottles for breathing apparatuses. If using filters, specified time must be observed. used filters shall be disposed of.

Each group must be equipped with a resuscitation apparatus and first-aid box, should any poisoning occur. Apart from standard equipment, the first-aid box must also contain:

- nitramyl, vial 20pcs.
- devenal, vial 10ml 5pcs.
- caffeine, vial (koffeinum nitrosum) 10pcs.
- natrium nitrosum, vial 10ml 5pcs.
- sterile syringe 20, 10 and 2ml, 2pcs. each 6pcs.
- sterile intravenous needles 10pcs.
- sterile hypodermic needles 5pcs.
- closed vessel with potable water (4 litres) 1pc

The first-aid box as well as resuscitation apparatus shall be made ready to use prior to the gas filling commencement.

Medical treatment may be consulted with the Toxicology centre in Prague: Klinika nemocí z povolání, Na Bojišti 1, Praha 2, 24-hour tel.: 224 919 293, 224 915 402.

If only a part of the building is fumigated, remaining parts (offices, control rooms, dwelling parts, workrooms etc.) may not be entered.

During the whole treatment, any manipulation with open flame is prohibited (smoking, heating). All sources of sparks (telephones, refrigerators, automatic switches etc.) must be switched off for the whole time. In case of fire snow-type fire extinguishers shall be used.

After the treatment has finished, empty cans and reels (free of hydrogen cyanide) shall be collected and disposed of. The cans shall be sent to a dumping site, the reels incinerated.

### 3.3. Number and timing of applications

**Treatment is one-time** and effective with short exposure and ventilation times. Uragan D2 (HCN) does not have any persistent effect.

Number of applications in a building: 1

Exposure time: 24 hours at temperature above 18°C (54.5°F), 48 hours at below 18°C.

Ventilation time of an empty building: usually 24-48 hours.

Temperature inside the treated building must not drop below 10°C (50°F) during the whole process. The exposure and ventilation times may be influenced by weather conditions or increased humidity of the area.

### 3.4. Classification & Labelling

#### **Classification**

Hydrogen cyanide is listed in Appendix I of Directive 67/548/EHS under the following entries:

#### **Hydrogen cyanide**

CAS no. 74-90-8; EINECS no. 200-821-6; Index no: 006-006-00-X

F+, R12

T+, R26

N, R50, R53

#### **Hydrogen cyanide [] %; Hydrocyanic-acid [] %**

CAS no. 74-90-8; EINECS no. 200-821-6; Index no: 006-006-01-7

F+, R12

T+, R26

N, R50, R53

Specific concentration limits hydrogen cyanide [] %:

Concentration	Classification
C ≥ 25%	T+, N; R26/27/28-50-53
7% ≤ C < 25%	T+, N; R26/27/28-51-53
2.5% ≤ C < 7%	T, N; R23/24/25-51-53
1% ≤ C < 2.5%	T, N; R23/24/25-52-53
0.25% ≤ C < 1%	Xn; R20/21/22-52-53
0.1% ≤ C < 0.25%	Xn; R20/21/22

#### Packaging label text

Hydrogen cyanide Index no.: 006-006-00-X

Symbols:

- F+ – Extremely flammable
- T+ – Highly toxic
- N – Dangerous for the environment

#### R-phrases:

- R12 Extremely flammable.
- R26 Very toxic by inhalation.
- R50/53 Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment

#### S-phrases:

- (S /2) Keep locked up and out of reach of children.
- S7/9 Keep container tightly closed and in a well-ventilated place.
- S16 Keep away from sources of ignition – No smoking.
- S 36/37 Wear suitable protective clothing and gloves.
- S38 In case of insufficient ventilation, wear suitable respiratory equipment.
- S45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
- S60 This material and its container must be disposed of as hazardous waste.
- S61 Avoid release to the environment. Refer to special instructions/Safety data sheets.

3.5. Available data on effects on human or animal health and the environment (including exposure and risk assessment and proposals for risk mitigation) from the use

#### Human exposure at using Uragan D2 for fumigation:

Application concentration of hydrogen cyanide: 10g HCN.m<sup>-3</sup>.  
 Personnel handling Uragan D2 for fumigation must use personal protective equipment (gastight chemical clothing, breathing apparatus, gloves and rubber boots, see above), which ensure observing applicable valid limits for HCN content in work atmosphere during fumigation in an environment with an increased concentration of HCN in air. The limits in the Czech Republic are laid down by Government Ordinance no. 178/2001 Coll., as amended, setting out conditions for the protections of employees at work:

$$\text{NPK} = 10\text{ppm HCN.m}^{-3} \approx 11.2\text{mg HCN.m}^{-3}$$

$$\text{PEL} = 3\text{ppm HCN.m}^{-3} \approx 3.36\text{mg HCN.m}^{-3}$$

After the treatment with hydrogen cyanide is finished, treated buildings are cleared for further use only when residual concentration of hydrogen cyanide is lower than PEL value, i.e. 3mg HCN.m<sup>-3</sup>.

#### Environmental exposure for Uragan D2 used for fumigation:

Hydrogen cyanide may be used as a fumigant only in hermetically sealed spaces. It is released

into the environment only during the ventilation phase, when practically all of the substance used for the treatment is released into the atmosphere. The ventilation rate depends on a number of factors, the most important being air exchange intensity inside the ventilated building, and air temperature and humidity. Fumigation may be performed only at temperatures above 10°C (50°F) and at weather conditions excluding rain, fog and inversion.

Hydrogen cyanide ventilated either by air draught or by using fans and blowers is released directly to the atmosphere. Due to lower relative mass of its vapours compared to relative mass of air, released hydrogen cyanide rises directly upwards into higher layers of the atmosphere, gradually gets diluted and at the same time in contact with air moisture hydrolysed to ammonium formate and eventually to ammonia.

Under local applicable regulations, treated buildings may be ventilated by using forced ventilation, while residual hydrogen cyanide is captured by chemical absorption or incinerated.

In the Czech Republic, hydrogen cyanide may be ventilated into the atmosphere without being captured or disposed of in any other way.

3.6. Information on efficacy

**Impact**

Insecticide

**Target organisms:**  
All development stages of any storehouse pests (e.g. cockroach, cricket, mites, woodlouse, larder beetle, wheat beetle, powder-post beetle, auger beetle, woodworm, spider beetle, mealworm, sawyer beetle, snout beetle, gelechid moth, meal moth) and human health pests (louse, bug, bed bug, scabies, fleas).

**Protected buildings:**  
Empty structures (buildings), e.g. storehouses, museums, temples, railway carriages, ships and river boats, airplanes, containers, packaging, depositories, wooden historical monuments, libraries, etc.

**Effects on target organism and adequate concentration**  
Functions as a respiratory poison, destroying metabolism of pests. Reliably kills all development stages of any storehouse pests and human health pests, except for hypopial mites and adult grain weevils at lower concentrations or short exposure time.

Efficiency to target organisms: up to 99%

The usage of hydrogen cyanide does not lead to resistance. Level of indicated resistance is not higher than factor 3, which stands for a very low resistance level, practically non-relevant.

**Impact method and recommended concentration**  
The impact efficiency is immediate after reaching a lethal concentration of hydrogen cyanide in air inhaled by target organisms. Exposure time shall be set depending on the pest species, level of attack, conditions of hydrogen cyanide spreading within the treated building and weather conditions. Air temperature inside the treated building must be higher than 10°C (50°F) for the whole time of the process.

Dosage: 10g/m<sup>3</sup>, i.e. 1kg per 100m<sup>3</sup> in field conditions.

Exposure time: 24 hours at temperature above 18°C (54.5°F)  
48 hours at temperature below 18°C (54.5°F)

Ventilation time: min. 24 hours for active ventilation  
min. 48 hours for passive ventilation

The ventilation time may be significantly influenced by weather conditions.

## 4 - JUSTIFICATION OF THE ESSENTIAL USE

### 4.1. Significance of the harmful organism

All development stages of target organisms - storehouse pests (e.g. cockroach, cricket, mites, woodlouse, larder beetle, wheat beetle, powder-post beetle, auger beetle, woodworm, spider beetle, meal-worm, sawyer beetle, snout beetle, gelechid moth, meal moth) damage stored goods; depositories, museums, temples, transport vehicles - railway carriages, ships and river boats, airplanes; containers and packaging, antiquities (wooden historical monuments), libraries, etc.

They make these places strongly unpleasant for people to stay in.

They also present risk to electrical wiring.

Other target organisms - human health pests (louse, bug, bed bug, scabies, fleas), may transmit infectious diseases, and their occurrence in all the above mentioned spaces is highly undesirable.

### 4.2. Importance of the intended use and estimated scale of use - maximum quantity of active substance per year

Uragan D2 (active substance hydrogen cyanide) is in selected areas of usage a fully effective substitute for harmful methyl bromide which is one of the most harmful substances for the ozone layer damaging it 60times faster than CFCs.

Uragan D2 (active substance hydrogen cyanide) is ozone layer friendly; functions as a respiratory poison, destroying metabolism of pests. Reliably kills all development stages of any storehouse pests and human health pests. Treatment is one-time, Uragan D does not have any persistent effect.

Hydrogen cyanide as the active substance meets required criteria of efficiency and availability in the Czech Republic and is classified as a substance without carcinogenic effects on humans.

It is completely harmless for the ozone layer as well as for the environment, while highly efficient with a short exposure time of fumigation, and fast to ventilate, which is an important fact regarding continuity of production.

Recommended dosage of URAGAN D2: 10g/m<sup>3</sup> fumigated space, i.e. 1% concentration.

Target organism efficiency: up to 99%, its usage does not lead to resistance.

The main although not the only usage is disinsection of empty storage spaces and similar buildings, for example transport containers, railway carriages, cargo-holds.

The preparation is also useful for the protection of museums, churches and historical structures, and as protection of archival documents, historical collections and depositories against damage and deterioration by wood-destroying and other insect.

**Maximal quantity of the active substance per year: 8 t**

4.3. If the essential use is not permitted, what would be the consequences for health, safety, protection of cultural heritage or the functioning of society (including cultural and intellectual aspects)?

In terms of its originality – efficiency, capacity and rate of the application process, Uragan D2 with hydrogen cyanide as the active substance has no comparable and acceptable alternative regarding the health protection (EPA classification of HCN is grade D, i.e. a substance without carcinogenic effects on humans), environmental protection and social-economical aspects.

Uragan D2 (active substance hydrogen cyanide) is in selected areas of usage a fully effective substitute for harmful methyl bromide. HCN is completely harmless to the ozone layer as well as to the environment, and is a very important strategic material for the Czech Republic.

The Czech Republic has been actively participating in meeting requirements of the Montreal Protocol and follow-up negotiations on restriction of substances damaging the ozone layer, and has joined the search for an alternative to methyl bromide. Import and usage of methyl bromide is banned in the Czech Republic. The obligation to completely stop using methyl bromide was fulfilled already by 1 January 2003 thanks to the preparation Uragan D2 (HCN).

Uragan D2 (active substance hydrogen cyanide) is the only fully effective substitute for methyl bromide in the above mentioned usages.

In terms of public health and cultural heritage protection, and the overall functioning of society in the Czech Republic, while meeting conclusions of the Montreal Protocol and follow-up negotiations, extending valid permit for hydrogen cyanide to be put on the market in the Czech Republic as an active substance seems critical and necessary.

**Consequences of non-granting the extension:**

The Czech Republic undertook to meet requirements of the Montreal Protocol and takes concern in the protection of the ozone layer, as well as of the environment as a whole.

Not granting the extension of the permit for hydrogen cyanide would certainly mean deterioration of the public health and would have vast economical consequences for the whole country, since hydrogen cyanide is in certain fields of

usage the only fully effective substitute for methyl bromide.  
Risk to public health together with other consequences would involve not only the Czech Republic, but subsequently also other countries due to spreading infectious diseases, etc.

Should such a undesirable situation be prevented from occurring, the Czech Republic may be in the risk of violating pa. 2H, sec. 5 of the Montreal Protocol, which could consequently affect the position of the whole European Union at meetings of the protocol parties.

Since all possible measures must be taken to prevent using methyl bromide, it is necessary to extend the give period for putting existing HCN substances on the Czech market.

4.4. Need for the biocidal product / active substance in resistance or other pest management programmes (for example integrated pest management)

Uragan D2 (active substance – HCN) is not a pesticide.

## 5 - WHY THE USE OF THIS ACTIVE SUBSTANCE IS ESSENTIAL

5.1. Active substances currently used [elsewhere in the EU/worldwide) to control the problem described in 4.1. and their approval/authorisation status

No alternative permitted active substance exists.

The only alternative in use is methyl bromide, which is not acceptable for the environment an its usage is banned (see the Montreal Protocol and follow-up negotiations).

5.2. Evidence that there are no available technically and economically feasible alternatives or substitutes that could be acceptable from the standpoint of environment and health

As a result of two research projects, held by the Ministry of the Environment of the Czech Republic in 2004 and 2005, it was found out that in the Czech Republic HCN is still the only acceptable alternative available for the above listed usage.

The research proved that phosphine is not suitable for usage due to lower efficiency, significantly longer exposure time, and its corrosive effects which make it unsuitable for certain usages (e.g. in storehouses).  
Conclusion of the research is such that phosphine is not acceptable as an substitute for hydrogen cyanide due to its corrosive effects.

Methyl bromide is another substance with similar effects as hydrogen cyanide. However, it is one of the most harmful substances for the ozone layer damaging it 60times faster than CFCs, and whose usage in the Czech Republic is banned in compliance with international obligations concerning the ozone layer protection.

From the above mentioned it is obvious that no employable alternatives exist and that HCN as an active substance (Uragan D2) is the only acceptable alternative for the Czech Republic.

## 6 - PROPOSED PLAN FOR A MORE PERMANENT SOLUTION

6.1. Evidence of a plan to submit a dossier for the evaluation and inclusion of the active substance in one of the annexes to Directive 98/8/EC

In cooperation with VUOS Pardubice (*Research Institute for Organic Syntheses*), complete documentation was elaborated on the inclusion of hydrogen cyanide (as an active substance of the biocidal preparation Uragan D2) in the list I or IA (list of active substances and active substances with low risk) of Directive 98/8/EC acting in accordance with the Regulation (EC) No. 1048/2005, Article 4b (ES) (Extension of the period for introduction on the market).

This documentation was submitted to the Ministry of the Environment of the Czech Republic, Registry of chemical substances, on 28 February 2006.

(Note: See Appendices.)

6.2. Any outline of work carried out to develop an alternative or substitute to the active substance

In 2004 and 2005 the Ministry of the Environment of the Czech Republic held two research projects on searching for alternative substitutes for methyl bromide.

As a result of two research projects it was found out that in the Czech Republic HCN is still the only acceptable alternative available, and its importance for meeting international obligations concerning the ozone layer protection, while ensuring the protection of public health in the country, is critical.

## 7- OTHER INFORMATION

- E.g.:
- Steps that are being taken to minimise the proposed uses
  - Steps to minimise the emissions and human exposure associated with the proposed uses and waste management related to the biocidal product
  - Acceptability of the active substance in light of the criteria in Annex VI of Directive 98/8/EC

The Uragan D2 preparation (with HCN as an active substance) is applied in situations where no other active substance may be used. The application must be carried out in compliance with provisions and requirements of par. 61, sections 4 and 5 of Act no. 258/2000, on handling highly toxic substances. Fumigation must be reported at least 48 hours in advance to a competent health officer and to local authorities. The treated building must be marked. The treatment may be carried out only in such places where there is no risk of health hazard to humans, animals and the surroundings. Interior as well as exterior examination of the building, together with evaluation of all circumstances affecting the safety of the area and enabling technical securing of the building must be carried out prior to the treatment itself.

For detailed information concerning human exposure and environmental protection see section 3.5 of this

Application.

Uragan D2 is not a pesticide.

The substance is currently being evaluated according to Appendix VI of Directive 98/8/EC. Current knowledge shows that hydrogen cyanide is a substance with well-described properties and well-known and long-term successfully applied measures concerning the protection of human health and the environment against its dangerous effects.

EPA classification of HCN - grade D, i.e. a substance without carcinogenic effects on humans.

Both active substance HCN and Uragan D2 (with HCN as an active substance) are harmless to the ozone layer.