

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.1.1.2.1 Ready biodegradation	Page 1 of 4
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Section A7.1.1.2.1 Annex Point IIA VII.7.6.1.1	Ready biodegradability	
References:	<p>Summaries and evaluations in this section are based mostly on exhaustive and reliably peer reviewed documents: ATSDR (2004, Toxicological profile of cyanide) (DOC IV_1) and IPCS (2004, WHO, CICAD 61: Hydrogen cyanide and cyanides: human health aspects). (DOC IV_5) and Hazardous Substance Data Bank (HSDB), National Library of Medicine's TOXNET system (state in February 2006): Hydrogen cyanide *Peer reviewed* (DOC IV_2).</p> <p>Supplement literature (from ATSDR, 2004):</p> <ol style="list-style-type: none"> 1. EPA. 1979. Cyanides. In: Water-related environmental fate of 129 priority pollutants. Vol. 1. Washington, DC: U.S. Environmental Protection Agency, Office of Water Planning and Standards, Office of Water and Waste Management. EPA440479029a. PB80204373. 12-1-12-12. 2. Malaney GW, Sheets WD, Quillin R. 1959. Toxic effects of metallic ions on sewage microorganisms. Sewage Ind Wastes 31:1909-1915. 3. Raef SF, Characklis WG, Kessick MA, et al. 1977a. Fate of cyanide and related compounds in aerobic microbial systems--II. Microbial degradation. Water Res 11:485-492. 4. US EPA, 1978c: Reviews of the environmental effects of pollutants. V. Cyanide. Cincinnati, OH: U.S. Environmental Protection Agency Health Effects Research Laboratory, Office of Research and Development. PB289920. 5. EPA. 1979. Cyanides. In: Water-related environmental fate of 129 priority pollutants. Vol. 1. Washington, DC: U.S. Environmental Protection Agency, Office of Water Planning and Standards, Office of Water and Waste Management. EPA440479029a. PB80204373. 12-1-12-12. 6. EPA. 1992f. U.S. Environmental Protection Agency. Fed Regist 57:26248. 7. Gaudy AF, Gaudy ET, Feng YJ, et al. 1982. Treatment of cyanide waste by the extended aeration process. J Water Pollut Control Fed 54:153-164. 8. Pettet, A.E.J, Mills, E.V. 1954. Biological treatment of cyanides with and without sewage. J Appl Chem 4:434-444. 9. Richards, D.J., Shieh, W.K. 1989. Anoxic-oxic activated-sludge treatment of cyanides and phenols. Biotechnol Bioeng 33:32-38. 10. Shivaraman, N., Kumaran, P., Pandey, R.A., et al. 1985. Microbial degradation of thiocyanate, phenol and cyanide in a completely mixed aeration system. Environ Pollut Ser A 39:141-150. 11. Ludzack, F.J., Moore, W.A., Krieger, H.L., et al. 1951. Effect of cyanide on biochemical oxidation in sewage and polluted water. Sewage Ind Wastes 23:1298-1307. 12. Akcil, A., Mudder, T., 2003. Microbial destruction of cyanide wastes in gold mining: Process review. Biotechnol Lett 25:445-450. 13. EPA. 1994c. Technical Report: Treatment of cyanide heap leaches and tailings. Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste. EPA530R94037. PB94201837. 14. Raybuck, S.A., 1992. Microbes and microbial enzymes for cyanide degradation. Biodegradation 3(1):3- 18. 15. Oudjehani K, Zagury GJ, Deschênes L. 2002. Natural attenuation potential of cyanide via microbial activity in mine tailings. Appl Microbiol Biotechnol 58:409-415. 	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.1.1.2.1 Ready biodegradation	Page 2 of 4
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	<p>16. Zagury GJ, Oudjehani K, Deschenes L. 2004. Characterization and availability of cyanide in solid mine tailings from gold extraction plants. <i>Sci Total Environ</i> 320:211-224.</p> <p>17. Basheer S, Kut O, Prenosil J, et al. 1992. Kinetics of enzymatic degradation of cyanide. <i>Biotech Bioeng</i> 39:629-634.</p> <p>18. Meyers, P.R., Rawlings, D.E., Woods, D.R., et al. 1993. Isolation and characterization of a cyanide dihydratase from <i>Bacillus pumilus</i> C1. <i>J Bacteriol</i> 175(19):6105-6112.</p> <p>19. Chapatwala, K.D., Babu, G.R.V., Wolfram, J.H., 1993. Screening of encapsulated microbial cells for the degradation of inorganic cyanides. <i>J Ind Microbiol</i> 11(2):69-72.</p> <p>20. Kunz, D.A, Nagappan, O., Silva-Avalos, J., et al. 1992. Utilization of cyanide as a nitrogenous substrate by <i>Pseudomonas fluorescens</i> NCIMB 11764: Evidence for multiple pathways of metabolic conversion. <i>Appl Environ Microbiol</i> 58(6):2022-2029.</p> <p>21. White, J.M., Jones, D.D., Huang, D., et al. 1988. Conversion of cyanide to formate and ammonia by a pseudomonad obtained from industrial wastewater. <i>J Indust Microbiol</i> 3:263-272.</p> <p>22. Silva-Avalos, J., Richmond, M.G., Nagappan, O., et al. 1990. Degradation of the metal-cyano complex tetracyanonickelate (II) by cyanide-utilizing bacterial isolates. <i>Microbiol</i> 56:3664-3670.</p> <p><i>For these references the applicant supplied primary source, the conclusions of which are further supported by ATSDR, ICPS, HSDB:</i></p> <p>23. Klecka GM, Landi LP, Bodner KM. 1985. Evaluation of the OECD activated sludge, respiration inhibition test. <i>Chemosphere</i> 14:1239-1251. (DOC IV_68)</p>	
Detailed justification:	<p>Biodegradation is an important transformation process for cyanide in natural surface waters, and is dependent on such factors as cyanide concentrations, pH, temperature, availability of nutrients, and acclimation of microbes. However, additional data are needed to assess the relative significance of this process in determining the fate of aquatic cyanides (1). Although the cyanide ion is toxic to microorganisms at concentrations as low as 5–10 mg/L (23, 2), acclimation increases tolerance to this compound (3). A number of pure cultures of microorganisms degrade low concentrations of cyanide under both aerobic and anaerobic conditions (4, 5, 6).</p> <p>Biodegradation data derived from use of a pure culture are not strictly relevant to natural waters that contain mixed cultures. Mixed microorganisms in sewage sludge or activated sludge acclimated to cyanide also significantly biodegrade concentrations 100 mg/L of most simple and complex cyanides (7, 8, 9, 10). In a study to evaluate the effect of the cyanide ion on biochemical oxidation conducted in sealed vessels, a 50% loss of cyanide at concentrations 6 mg/L in two natural river waters occurred at times estimated to range from <10 to 24 days (11). The rate of loss appeared to be linear within this time frame. These data may represent a biodegradation half-life; however, the possibility of loss by chemical reaction was not addressed in this study.</p> <p>Most of the available information on the mechanisms of biodegradation of cyanides in water comes from studies on the evaluation and use of this process as a means of detoxifying cyanide-containing wastes (12, 13, 14). It is known that there is a natural attenuation of the cyanide ion and thiocyanide concentrations in waste waters, for example those obtained gold mill tails, that is due the acclimation of indigenous microflora in the tailings (12, 15, 16). A number of microorganisms have been identified that are capable of uptake, conversion, sorption, and/or precipitation of the cyanide ion, cyanate, and thiocyanate, including species of the genera, <i>Actinomyces</i>, <i>Alcaligenes</i>, <i>Arthrobacter</i>, <i>Bacillus</i>, <i>Micrococcus</i>, <i>Neisseria</i>, <i>Paracoccus</i>, <i>Pseudomonas</i>,</p>	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.1.1.2.1 Ready biodegradation	Page 3 of 4
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	<p>and <i>Thiobacillus</i> (12). Some of these species, for example <i>Pseudomonas</i>, are capable of using the cyanide ion and thiocyanate as the sole source of carbon and nitrogen and therefore, are particularly effective at cyanide degradation. In fact, <i>Pseudomonas</i> is the basis of commercial applications for degrading the cyanide ion to ammonia and carbonate in waste waters generated in mining operations that use the cyanide ion to leach gold and other precious metals for low-grade ores (12).</p> <p>Recently reviewed the role of microbes in cyanide degradation (14) has categorized the microbial enzymes that use the cyanide ion as a substrate according to the following types of reactions: substitution/addition, hydrolysis, oxidation, and reduction. Sulfur transferases such as rhodanese are involved in substitution reactions that result in the conversion of the cyanide ion to the less toxic thiocyanate, whereas pyridoxal phosphate enzymes are involved in substitution/addition reactions that result in production of nitrile derivatives of amino acids. These organic nitriles may then be ultimately degraded via enzyme catalyzed hydrolysis to either the corresponding amino acid and ammonia (without formation of the free amide) or the carboxylic acid and ammonia (via formation of the free amide). The cyanide hydratase and cyanidase enzymes catalyze the hydrolysis of the cyanide ion to formamide or formic acid and ammonia, respectively. A strain of <i>Alcaligenes xylooxidans subsp. denitrificans</i> has been found to effectively hydrolyze the cyanide ion concentrations up to 300 mg.l⁻¹ down to very low levels (0.01–0.02 mg.l⁻¹) and to be resistant to inactivation by chloride, sulfate, iodide, Fe⁺², Zn⁺², or Ni⁺² at concentrations of 70 mg.l⁻¹ (17). Thus, these hydrolytic systems are some of the most promising for detoxification of cyanide-containing waste waters (14). A number of microbial systems have been identified that are capable of direct oxidation or reduction of the cyanide ion. <i>Bacillus pumilus</i>, <i>Pseudomonas fluorescens</i>, and <i>Pseudomonas paucimobili</i> have all been found to oxidize the cyanide ion to ammonia and carbon dioxide (18). In an aerobic batch bioreactor experiment, <i>Pseudomonas putida</i> was found to significantly degrade 4 mM sodium cyanide (cyanide concentration approximately 100 mg/L) to ammonia and carbon dioxide (19). Other evidence indicates that formamide and formate are additional transformation products in microbial oxidation of the cyanide ion by this species, inferring that there may be more than one pathway of cyanide biotransformation involved (20, 21). Several bacterial species have been identified that are capable of oxidative degradation of metalocyanides (22). The cyanide oxygenase system involved in this process offers a new technology for the treatment of metal cyanide wastes (14).</p>	
Conclusions:	<p>Conditions of degradation: pH = 7.5 – 8.2 Temperature: 10 – 20 °C</p> <p>Biodegradation is an important transformation process for cyanide in natural surface waters, and is dependent on such factors as cyanide concentrations, pH, temperature, availability of nutrients, and acclimation of microbes. Although the cyanide ion is toxic to microorganisms at concentrations as low as 5–10 mg/L, acclimation increases tolerance to this compound. A number of pure cultures of microorganisms degrade low concentrations of cyanide under both aerobic and anaerobic conditions. Mixed microorganisms in sewage sludge or activated sludge acclimated to cyanide also significantly biodegrade concentrations of 100 mg/L of most simple and complex cyanides. A number of microorganisms have been identified that are capable of utilizing the cyanide ion, cyanate, and thiocyanate, including species of the genera, <i>Actinomyces</i>, <i>Alcaligenes</i>, <i>Arthrobacter</i>, <i>Bacillus</i>, <i>Micrococcus</i>, <i>Neisseria</i>, <i>Paracoccus</i>, <i>Pseudomonas</i>, and <i>Thiobacillus</i>. Some of these species, e. g.</p>	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.1.1.2.1 Ready biodegradation	Page 4 of 4
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	<p><i>Pseudomonas</i>, are capable of using the cyanide and thiocyanate as the sole source of carbon and nitrogen and therefore are particularly effective at cyanide degradation.</p> <p>Sulfur transferases, such as rhodanese, convert cyanide ion to the less toxic thiocyanate, whereas pyridoxal phosphate enzymes are involved in reactions that result in production of nitrile derivatives of amino acids.</p> <p>A strain of <i>Alcaligenes xylooxidans subsp. denitrificans</i> has been found to effectively hydrolyze the cyanide ion concentrations up to 300 mg.l⁻¹ down to very low levels (0.01–0.02 mg.l⁻¹) and to be resistant to inactivation by chloride, sulphate, iodide, Fe⁺², Zn⁺², or Ni⁺² at concentrations of 70 mg.l⁻¹.</p> <p><i>Bacillus pumilus</i>, <i>Pseudomonas fluorescens</i>, and <i>Pseudomonas paucimobili</i> have all been found to oxidize the cyanide ion to ammonia and carbon dioxide. In an aerobic batch bioreactor experiment, <i>Pseudomonas putida</i> was found to significantly degrade 4 mM sodium cyanide (cyanide concentration approximately 100 mg/L) to ammonia and carbon dioxide.</p>	
Undertaking of intended data submission	No studies are planned.	

	Evaluation by Competent Authorities	
Date		
Evaluation of applicant's justification		
Conclusion		
Remarks		

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.1.3 Adsorption/ Desorption Screening test	Page 1 of 1
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Section A7.1.3 Annex Point IIA VII.7.7	ADSORPTION/ DESORPTION SCREENING TEST		
	JUSTIFICATION FOR NON-SUBMISSION OF DATA		Official use only
Other existing data []	Technically not feasible []	Scientifically unjustified []	
Limited exposure [x]	Other justification []		
References:	<ol style="list-style-type: none"> JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals Volume I (DOC IV_3) JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals, Volume II (DOC IV_4) 		
Detailed justification:	<p>The biocidal product URAGAN D2 is the same as the technical grade active substance. HCN is produced as liquid which is sorbed on surface of inert material. Boiling temperature of HCN in liquid state is 25.7 °C (78.3 °F). Due to the large surface of sorbed inert material, the evaporation is very fast. Therefore the active substance is gas only.</p> <p>No studies have been conducted to investigate adsorption and desorption to water/sediment systems of hydrogen cyanide. Hydrogen cyanide is not expected to be present in water/sediment environments because of its physical properties and use patterns (fumigant in enclosed spaces).</p> <p>Hydrogen cyanide is expected to have high mobility in soils. It is not expected to be adsorbed to suspended solids and sediment in water. It is not strongly partitioned into the sediments or suspended adsorbents, primarily due to its high solubility in water.</p>		
Undertaking of intended data submission []	No studies are planned.		

	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.1.4.1 Field study on accumulation in the sediment	Page 1 of 1
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Section A7.1.4.1 Annex Point IIIA XII.2.1	Field study in accumulation in the sediment	
	JUSTIFICATION FOR NON-SUBMISSION OF DATA	Official use only
Other existing data []	Technically not feasible [] Scientifically unjustified [x]	
Limited exposure []	Other justification []	
Reference:	<ol style="list-style-type: none"> JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals Volume I (DOC IV_3) JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals, Volume II (DOC IV_4) ATSDR (2004, Toxicological profile of cyanide) (DOC IV_1) 	
Detailed justification:	<p>Based on its physic-chemical properties log Kow = 0.66 (at 0 °C) (3), log Kow = -0.25 (at 20 °C) (1), solubility in water, HCN is not expected to bioaccumulate in aquatic organisms.</p> <p>Hydrogen cyanide is not expected to be present in water/sediment environments because of its physical properties and use patterns (fumigant in enclosed spaces). Hydrogen cyanide is a gas under all environmental conditions.</p> <p>Since hydrogen cyanide will not reside in the sediment, a field study is not applicable and consequently has not been performed.</p>	
Undertaking of intended data submission	No studies are planned	

	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Section A7.2 Annex Point IIIA XII.1	Fate and Behaviour in Soil	
	JUSTIFICATION FOR NON-SUBMISSION OF DATA	Official use only
Other existing data []	Technically not feasible [] Scientifically unjustified []	
Limited exposure [x]	Other justification []	
Reference:	<ol style="list-style-type: none"> JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals Volume I (DOC IV_3) JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals, Volume II (DOC IV_4) 	
Detailed justification:	<p>Analogous to the fate of cyanides in water, it is predicted that the fate of cyanides in soil would be dependent on cyanide concentrations, pH, temperature, metal content, concentration of microorganisms, availability of nutrients, and acclimation of microbes. Cyanide may occur as hydrogen cyanide, alkali metal salts, or as immobile metalocyanide complexes. In soil, cyanide present at low concentrations would biodegrade under aerobic conditions with the initial formation of ammonia, which would be converted to nitrite and nitrate in the presence of nitrifying bacteria.</p> <p>With respect to the intended use, the substance is not expected to come into contact with soil.</p>	
Undertaking of intended data submission	No studies are planned.	

	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Section A7.3.1 Annex Point IIIA VII.5	Phototransformation in Air	
<p>References:</p>	<p>Summaries and evaluations in this section are based mostly on exhaustive and reliably peer reviewed documents: ATSDR (2004, Toxicological profile of cyanide) (DOC IV_1) and IPCS (2004, WHO, CICAD 61: Hydrogen cyanide and cyanides: human health aspects). (DOC IV_5) and Hazardous Substance Data Bank (HSDB), National Library of Medicine's TOXNET system (state in February 2006): Hydrogen cyanide *Peer reviewed*(DOC IV_2).</p> <ol style="list-style-type: none"> JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals Volume I (DOC IV_3) JACC No 53, Cyanides of Hydrogen, Sodium and Potassium, and acetone Cyanohydrin (CAS No. 74-90-8, 143-33-9, 151-50-8 and 75-86-5), ECETOC JACC REPORT No. 53 European Centre for Ecotoxicology and Toxicology of Chemicals, Volume II (DOC IV_4) <p>Supplement literature from ATDRS,2004:</p> <ol style="list-style-type: none"> EPA. 1984a. Health effects assessment for cyanide. Washington, DC: U.S. Environmental Protection Agency. EPA540186011. EPA. 1979. Cyanides. In: Water-related environmental fate of 129 priority pollutants. Vol. 1. Washington, DC: U.S. Environmental Protection Agency, Office of Water Planning and Standards, Office of Water and Waste Management. EPA440479029a. PB80204373. 12-1-12-12. Cicerone, R.J., Zellner R. 1983. The atmospheric chemistry of hydrogen cyanide (HCN). J Geophys Res 88:10689-10696. Fritz B, Lorenz K, Steinert W, et al. 1982. Laboratory kinetic investigation of the tropospheric oxidation of selected industrial emissions. EUR 7624:192-202 Lyman, W. 1982. Atmospheric residence time. In: Lyman, WJ, Reehl, WF, Rosenblatt DH, eds. Handbook of chemical property estimation methods: Environmental behavior of organic compounds. New York, NY: McGraw Hill Book Company, 10-2-10-33. Frank SN, Bard AJ. 1977. Heterogeneous photocatalyst oxidation of cyanide ion in aqueous solutions at titanium dioxide powder. J Amer Chem Soc 99(1):303-304. 	
<p>Detailed justification:</p>	<p>Most cyanide in the atmosphere exists almost entirely as hydrogen cyanide gas, although small amounts of metal cyanides may be present as particulate matter in the air (3). Hydrogen cyanide is very resistant to photolysis at wavelengths of normal sunlight (4). The most important reaction of hydrogen cyanide in air is the reaction with photochemically generated hydroxyl radicals and subsequent rapid oxidation to carbon monoxide (CO) and nitric oxide (NO); photolysis and reaction with ozone are not important transformation processes, and reaction with singlet oxygen (O 1D) is not a significant transformation process except at stratospheric altitudes where singlet oxygen is present in significant concentrations (5). The rate of hydroxyl radical reaction with hydrogen cyanide in the atmosphere depends on the altitude, and the rate of the reaction is at least an order of magnitude faster at lower tropospheric altitudes (0–8 km) than at upper tropospheric altitudes (10–12 km) (5).</p>	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.3.1 Phototransformation in air	Page 2 of 2
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	<p>Based on a reaction rate constant of $3 \times 10^{-14} \text{ cm}^3 \cdot (\text{molecule} \cdot \text{sec})^{-1}$ at 25 °C (6) and assuming an average hydroxyl radical concentration of $5 \times 10^5 \text{ molecules} \cdot \text{cm}^{-3}$, the residence time for the reaction of hydrogen cyanide vapour with hydroxyl radicals in the atmosphere is 2 years. This value compares well with the atmospheric residence time derived by (5) of approximately 2.5 years, with a range of 1.3–5.0 years, depending on the hydroxyl radical concentrations assumed. Using the equation $t_{1/2} = 0.693 \cdot t$ for converting residence time to half-life ($t_{1/2}$) (7) and an estimated atmospheric residence time for hydrogen cyanide of 2–3 years, and assuming first-order kinetics for the reaction of hydrogen cyanide with hydroxyl radicals, an atmospheric half-life of 1.4–2.9 years can be calculated for hydrogen cyanide.</p> <p>The relatively slow rate of degradation of hydrogen cyanide suggests that this compound has the potential to be transported over long distances before being removed by physical or chemical processes. Since hydrogen cyanide is miscible in water, it appears that wet deposition may be an important fate process.</p> <p>In the presence of titanium dioxide powder, photo catalytic oxidation of cyanide proceeds at significant rates in both high intensity artificial sunlight and unfocused sunlight. With titanium dioxide powder present, more than 99% of a 1 mM (26 mg/l) solution of cyanide ion was oxidized by exposure to sunlight for two days. In the absence of titanium dioxide powder, little or no oxidation occurred (8).</p> <p>Conclusion:</p> <p>The most important reaction of hydrogen cyanide in air is the reaction with photochemically generated hydroxyl radicals and subsequent rapid oxidation to carbon monoxide (CO) and nitric oxide (NO); photolysis and reaction with ozone are not important transformation processes, and reaction with singlet oxygen (O 1D) is not a significant transformation process except at stratospheric altitudes where singlet oxygen is present in significant concentrations.</p> <p>Assuming an average hydroxyl radical concentration of $5 \times 10^5 \text{ molecules} \cdot \text{cm}^{-3}$, the residence time for the reaction of hydrogen cyanide vapour with hydroxyl radicals in the atmosphere is 2 years.</p> <p>This compound has the potential to be transported over long distances before being removed by physical or chemical processes.</p>	
Undertaking of intended data submission	No studies are planned.	

	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1_1 Acute Toxicity to Fish	Page 1 of 2
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Section A7.4.1.1 Annex Point IIA VII.7.1	ACUTE TOXICITY TO FISH		
	1	REFERENCE	Official use only
1.1 Reference	Ambient Water Quality Criteria for Cyanides; US EPA (1980). 440/5-80-037 (published). (DOC IV_69)		
1.2 Data protection	No		
1.2.1 Data owner	Unrestricted data		
1.2.2 Companies with letter of access	No companies with letter of access		
1.2.3 Criteria for data protection	Data submitted to the CA MS after 13 may 2000 for the purpose of entry existing active substance into Annex I/IA		
	2	GUIDELINES AND QUALITY ASSURANCE	
2.1 Guideline study	No presented		
2.2 GLP	No		
2.3 Deviations	Not available		
	3	MATERIALS AND METHODS	
3.1 Test material	Hydrogen cyanide		
3.1.1 Lot/Batch number	Not relevant.		
3.1.2 Purity			
3.1.3 Further relevant properties	Water solubility, vapour pressure, chemical stability, dissociation constant, and biodegradability: see: Physical and chemical properties		
3.1.4 Method of analysis	Various methods		
3.2 Preparation of TS solution			
3.3 Ref.substance	No		
3.4 Testing procedure			
3.4.1 Test organisms	Goldfish, <i>Carassius auratus</i> Fathead minnow, <i>Pimephales promelas</i> Largemouth bass, <i>Micropterus salmonides</i> Black crapple, <i>Pomoxis nigromaculatus</i> Bluegill, <i>Lepomios macrochirus</i> Yellow perch, <i>Perca flavescens</i> Brook trout, <i>Salvelinus fontinalis</i> Oncorhynchus mykiss, <i>Salmo gairdner</i> Atlantic salmon, <i>Salmo salar</i>		
3.4.2 Test system			
3.4.3 Test conditions			
3.4.4 Duration of the test	96 hours		
3.4.5 Test parameter	Mortality		
3.4.6 Statistics			

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1_1 Acute Toxicity to Fish	Page 2 of 2
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	4 RESULTS	
4.1 Results test substance		
4.1.1 Effect data	See 5.2.1	
4.1.2 Other effects	No	
4.2 Results of controls		
4.2.1 Number / % of animals showing adverse effects		
4.3 Test with ref. substance	Not performed	
	5 APPLICANT'S SUMMARY AND CONCLUSION	
5.1 Materials and methods		
5.2 Results and discussion	Free cyanide concentrations from about 0.050 to 0.200 mg/L eventually were fatal to juveniles of most of the more sensitive fish species, with concentrations much above 0.200 mg/L being rapidly fatal to most juvenile fish. Thus, there is a relatively narrow range of species sensitivity for fish. Certain life stages and species of fish appear to be more sensitive to cyanide than others. Embryos, sac fry, and warm water species tended to be the most resistant.	
5.2.1 LC ₅₀	Goldfish, <i>Carassius auratus</i> 0.318 mg/l Fathead minnow, <i>Pimephales promelas</i> 0.1251 mg/l Largemouth bass, <i>Micropterus salmonides</i> 0.102 mg/l Black crapple, <i>Pomoxis nigromaculatus</i> 0.102 mg/l Bluegill, <i>Lepomios macrochirus</i> 0.0993 mg/l Yellow perch, <i>Perca flavescens</i> 0.0926 mg/l Brook trout, <i>Salvelinus fontinalis</i> 0.0858 mg/l Oncorhynchus mykiss, <i>Salmo gairdner</i> 0.0447 mg/l Atlantic salmon, <i>Salmo salar</i> 0.090 mg/l	
5.3 Conclusion	The toxicity of cyanide increases with reduction in dissolved oxygen below the saturation and the resistance of fishes to cyanide solutions that are rapidly lethal decreases with increase in temperature.	
5.3.1 Reliability	3	
5.3.2 Deficiencies	None	

	EVALUATION BY RAPPORTEUR MEMBER STATE
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1_2 Acute Toxicity to Fish	Page 1 of 5
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Section A7.4.1.1 Annex Point IIA VII.7.1	ACUTE TOXICITY TO FISH		
	1	REFERENCE	Official use only
1.1 Reference	Kovacs T. G., and G. Leduc. 1982. Acute toxicity of cyanide to rainbow trout (<i>Salmo gairdneri</i>) acclimated at different temperatures. <i>Can. J. Fish. Aquat. Sci.</i> 39: 1426-1429. (DOC IV_70)		
1.2 Data protection	No		
1.2.1 Data owner	Unrestricted data		
1.2.2 Companies with letter of access	n/a		
1.2.3 Criteria for data protection	/		
	2	GUIDELINES AND QUALITY ASSURANCE	
2.1 Guideline study	No presented		
2.2 GLP	Not reported, but performed (1971) by the prestigious US leading public associations using standardized methods.		
2.3 Deviations	Not available		
	3	MATERIALS AND METHODS	
3.1 Test material	Hydrogen cyanide		
3.1.1 Lot/Batch number	Not relevant.		
3.1.2 Purity			
3.1.3 Further relevant properties	Water solubility, vapour pressure, chemical stability, dissociation constant, and biodegradability: see Physical and chemical properties		
3.1.4 Method of analysis	Temperature effects on cyanide toxicity.		
3.2 Preparation of TS solution			
3.3 Reference substance	No		
3.4 Testing procedure	<p>Rainbow trout purchased from La Pisciculture, Mt. Sutton, Sutton (Qué.), were held in 200-L fiberglass oval-shaped tanks at a temperature of $12 \pm 1^\circ\text{C}$. Chemical characteristics of the dechlorinated Montreal city water used during the experiments were as follows; alkalinity 87 mg.L^{-1} as CaCO_3; hardness 127 mg.L^{-1} as CaCO_3; CO_2 0.47 mg.L^{-1}. See Table A7.4.1.1-1 for oxygen and pH levels.</p> <p>After at least 2-week acclimation in the 200-L holding tanks at 12°C, the fish to be tested at 6 and 18°C were segregated and acclimated to the desired water temperatures by gradual adjustments of about 1°C.d^{-1}. The fish were then held for 7 d at these temperatures, prior to transfer into the white polyethylene (68 x 57.5 x 42 cm) test tanks, where they were held for further 2 week at the test temperatures (i.e. acclimated for 3 week at test temperatures). The tanks were connected to a flow-through system provided with thermally controlled water, at a flow of 1 L.min^{-1} in each tank, giving 99% replacement in 6 h. The entire 24-tank assembly was illuminated evenly by fluorescent light, controlled by a time switch to</p>		

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1_2 Acute Toxicity to Fish	Page 2 of 5
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		provide a 12 h photoperiod (8:30-20:30). During this period the fish were fed daily but no food was given for 48 h before the tests.	
3.4.1	Dilution water	Dechlorinated Montreal city water	
3.4.2	Test organisms	<i>Oncorhynchus mykiss</i> , <i>Salmo gairdner</i>	
3.4.3	Test system	Flow-through	
3.4.4	Test conditions	<p>The acute toxicity of HCN to rainbow trout at 6, 12, and 18°C. At hour zero a calculated amount of cyanide stock solution was mixed into each tank to produce immediately the predicted concentrations which were then maintained by Mariotte bottles. Cyanide was monitored in the test tanks twice daily. The measured concentrations never differed by more than 1% of the predicted values.</p> <p>The concentrations tested (mg HCN.L⁻¹) ranged from 0.018 to 0.056 at 6°C, 0.032 to 0.087 at 12°C, and 0.042 to 0.087 at 18°C. These ranges were selected from preliminary tests and included concentrations causing zero and 100% mortality. Control groups were maintained at each temperature under identical conditions.</p>	
3.4.5	Duration of the test	96 hours	
3.4.6	Test parameter	Mortality	
3.4.7	Monitoring of TS concentration	Yes 2/day	
3.4.8	Statistics		
		4 RESULTS	
4.1	Results test substance		
4.1.1	Effect data	See Table 1	
4.1.2	Other effects	No	
4.2	Results of controls		
4.2.1	Number/percentage of animals showing adverse effects		
4.3	Test with reference substance	Not performed	
		5 APPLICANT'S SUMMARY AND CONCLUSION	
5.1	Materials and methods	<p>The acute toxicity tests were carried out to determine the 96 hr LC₅₀ of HCN to rainbow trout at three temperatures, 6, 12 and 18 °C.</p> <p>The bioassays were carried out following standard methods. The fish weighed 9-18 g with a mean weight of 12 g, they were randomly chosen, acclimated as described above, and segregated for each test concentration and control group.</p> <p>On the day the bioassays began, the tanks were cleaned and a calculated amount of cyanide stock solution was mixed into each tank to immediately produce the predicted concentration. This was considered to be zero hour, and the desired concentrations were then maintained by metering cyanide stock solutions from Mariotte bottles.</p>	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1_2 Acute Toxicity to Fish	Page 3 of 5
	<p>Cyanide was monitored in the test tanks twice daily and the cyanide flows were adjusted when necessary. The desired concentrations never varied by more than one percent of the predicted values.</p> <p>The concentrations tested (mg HCN.L⁻¹) ranged from 0.018 to 0.056 at 6 °C, 0.032 to 0.087 at 12 °C, and 0.042 to 0.087 at 18 °C. These ranges were selected empirically such that the approximate 96 hr LC₅₀ values, determined by preliminary screening bioassays would be close to the median of the eight concentrations tested and included concentrations causing zero and 100% mortality.</p> <p>Control groups were maintained at each temperature under identical conditions.</p> <p>Observations on mortality were taken from 1 hour on up to 96 hours, at logarithmically spaced intervals. However, additional incidental observations were made after 48 hours to obtain additional information on mortality. The criterion of death was absence of respiratory movements and lack of response to probing with a glass rod upon which the fish were removed, weighed and their fork length measured.</p>			
5.2 Results and discussion	<p>The resistance of juvenile rainbow trout to cyanide was markedly affected by temperature (Table 1) and each 96-h LC₅₀ value differed significantly from those obtained at other temperatures. The cyanide level required to kill 50 % of the trout in 96 h was 2.4 times lower at 6 than at 18°C.</p> <p>The median survival times (MST) for each test concentration was estimated. Eye-fitted toxicity curves were constructed over cyanide concentrations ranging from 0.028 to 1.0 mg.L⁻¹, using data from this study and comparable data from the literature. At concentrations below 0.10 mg HCN.L⁻¹, the MST decreased at a lower temperature (Fig. 1). The lethal threshold was reached in 96 h at 18 °C but not at 12 and 6 °C. As the concentrations tested increased, the difference in the MST at each temperature became smaller (Fig.1). The curves intersect near 0.1 mg HCN.L⁻¹ above which the temperature effect on the lethal action of cyanide to trout is reversed. Thus at more rapidly lethal concentrations cyanide becomes more toxic at 18 °C than at 12 and 6 °C.</p>			
5.2.1 LC ₅₀	<p><i>Oncorhynchus mykiss</i>, <i>Salmo gairdner</i></p> <p>LC50 = 0.028 ± 0.004 mg.l⁻¹ at 6 °C</p> <p>LC50 = 0.042 ± 0.004 mg.l⁻¹ at 12 °C</p> <p>LC50 = 0.068 ± 0.004 mg.l⁻¹ at 18 °C</p>			
5.3 Conclusion	<p>Temperature and HCN concentration effect on acute toxicity is documented. LC50 values from the study conclusions:</p> <p>LC50 = 0.028 ± 0.004 mg.l⁻¹ at 6 °C</p> <p>LC50 = 0.042 ± 0.004 mg.l⁻¹ at 12 °C</p> <p>LC50 = 0.068 ± 0.004 mg.l⁻¹ at 18 °C</p> <p>Warm acclimated rainbow trout survived longer in lethal concentrations of cyanide. Toxicity curves clearly showed the temperature effect on the acute toxicity of cyanide is concentration dependent. At slowly lethal concentrations, cyanide is more toxic at lower temperatures, whereas at rapidly lethal levels the reverse occurs; the reversal takes place at 0.10 mg HCN.L⁻¹.</p>			
5.3.1 Reliability	2			
5.3.2 Deficiencies	None			

Table 1: Acute toxicity of hydrogen cyanide to rainbow trout acclimated and tested at different temperatures in flow-through system for 96 h

	6 °C	12 °C	18 °C
96-h LC50 mg.L ⁻¹ HCN (95% confidence interval)	0.028 (0.024-0.035)	0.042 (0.038-0.046)	0.068 (0.064-0.072)
Slope function	1.30	1.30	1.12
Highest cyanide conc. with no mortality in 96 h. mg HCN.L ⁻¹	0.018	0.032	0.060
Lowest cyanide conc. with 100% mortality in 96 h. mg HCN.L ⁻¹	0.037	0.053	0.087
Average weight of fish (range). g.	11.79 (9.05-15.98)	12.41 (8.29-16.02)	13.19 (9.63-17.21)
Average fork length of fish (range). mm	102 (95-110)	102 (90-111)	106 (95-119)
Mean pH (range)	8.06 (7.9-8.1)	8.10 (8.06-8.11)	7.82 (7.78-7.90)
Mean oxygen saturation (range) %	89.2 (88.2-90.1)	97.1 (95.2-98.5)	86.8 (85.7-88.3)

Fig. 1: Toxicity of HCN to rainbow trout at three temperatures

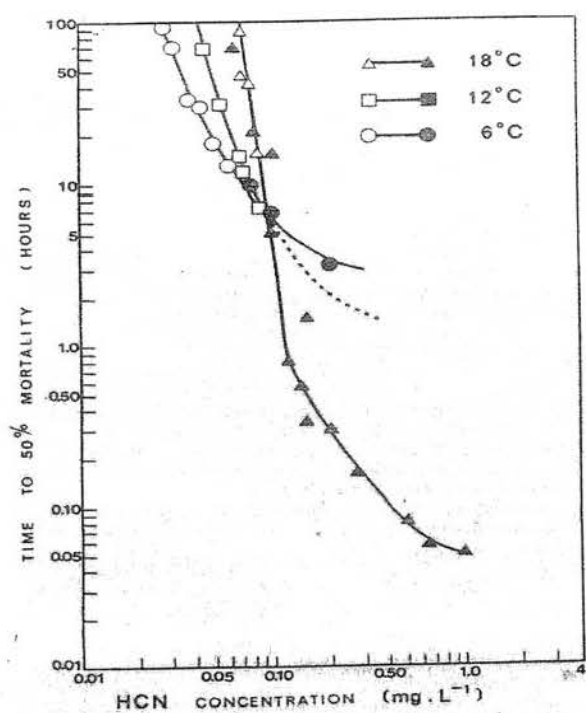


FIG. 1. Toxicity of hydrogen cyanide to rainbow trout at three temperatures: this study (open symbols); Herbert and Merkens (1952) (closed triangles); Ministry of Technology (1968) (closed circles).

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1_2 Acute Toxicity to Fish	Page 5 of 5
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	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 1 of 8
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Section A7.4.1.1		ACUTE TOXICITY TO FISH		
Annex Point IIA VII.7.1				
	1	REFERENCE		Official use only
1.1	Reference	Smith L.L, Broderius S.J., Osied D.M., Kimbal G.L., Koenst W.M., Acute Toxicity of Hydrogen Cyanide to Freshwater Fishes, Paper No. 9954, under Grant No. R802914 (DOC IV_71)		
1.2	Data protection	No		
1.2.1	Data owner	Unrestricted data		
1.2.2	Companies with letter of access	No companies with letter of access		
1.2.3	Criteria for data protection	Data submitted to the CAMS after 13 may 2000 for the purpose of entry existing active substance into Annex I/IA		
	2	GUIDELINES AND QUALITY ASSURANCE		
2.1	Guideline study	No. Sprague, J.B.: Measurement of pollutant toxicity to fish. 1. Bioassay method for acute toxicity,		
2.2	GLP	Not reported, but performed (1971) by the prestigious US leading public associations using standardized methods.		
2.3	Deviations	Not available		
	3	MATERIALS AND METHODS		
3.1	Test material	Hydrogen cyanide		
3.1.1	Lot/Batch number	Not relevant. Instead of initial identity of tested material parallel analyses during tests.		
3.1.2	Purity			
3.1.3	Further relevant properties	Water solubility, vapour pressure, chemical stability, dissociation constant, and biodegradability: see: Physical and chemical properties		
3.1.4	Method of analysis	Free cyanide concentration in each chamber was determined daily by the spectrophotometric method according to Epstein with calculated HCN concentrations based on corresponding pH and temperature measurements and using dissociation constants of molecular HCN. This method has been used as standard method for examination of water by the renowned US leading public associations.		
3.2	Preparation of TS solution	Sodium cyanide stock solutions were adjusted to pH 11 with NaOH. Test water adjusted to appropriate temperature and oxygen was conveyed by gravity from elevated head tanks to the diluter apparatus. The test substance was delivered to test chambers from intermitten – flow diluters modified.		
3.3	Reference substance	No		
3.4	Testing procedure			
3.4.1	Dilution water	Water from a deep well - see Table 1		
3.4.2	Test organisms	See Table 2 Fathead minnow, <i>Pimephales promelas</i> (Rafinesque) Bluegill, <i>Lepomis macrochirus</i> (Rafinesque)		

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 2 of 8
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		Oncorhynchus mykiss, <i>Salmo gairdneri</i> (Richardson).	
3.4.3	Test system	Flow-through - see Table 3	
3.4.4	Test conditions	See Table 4	
3.4.5	Duration of the test	96 hours	
3.4.6	Test parameter	Mortality	
3.4.7	Monitoring of TS concentration	All reported concentrations of test substance were based on analyses made on water from the test chamber.	
3.4.8	Statistics	The concentration – percent mortality data were analysed with a logarithmic – probability (log-probit) program. LC50 and medial lethal threshold concentrations (TLC) were calculated.	
		4 RESULTS	
4.1	Results test substance		
4.1.1	Effect data (Mortality)	See Tables 5-10	
4.1.2	Other effects	No	
4.2	Results of controls		
4.2.1	Number/ percentage of animals showing adverse effects		
4.3	Test with reference substance	Not performed	
		5 APPLICANT'S SUMMARY AND CONCLUSION	
5.1	Materials and methods	<p>Different species used for acute tests were eggs, fry and juveniles. Eggs and fry were randomly placed in test chambers of 20 l of test solution; eggs and fry were tested on screen bottomed acrylic cylinders covered with bakelite lid and held in 20 l chamber. Sodium cyanide from the stock solution was delivered to test chambers from the interminut-flow diluters. NaCN hydrolyzes to form free cyanide – CN⁻ ion and molecular HCN. At pH 6.0 – 8.0 in most natural water predominates the molecular (un-ionized) HCN, with less than 6 % free cyanide occurring in the ionic form below pH 8 at 25 °C. Eggs and fry were tested immediately on introduction to the test chambers; juveniles were held in test chambers for three days prior to HCN expose. Free cyanide concentrations in each chamber were determined daily.</p> <p>Observations on mortality were made daily. Acute toxicity of hydrogen cyanide was determined at temperatures from 4 °C to 30 °C and oxygen concentrations of 3.36 to 9.26 mg. l⁻¹ on different species life history stages, with single water source and using uniform test procedures. 337 acute toxicity tests were designed to determine the 96-hr median lethal HCN concentration (LC₅₀) and the median lethal threshold concentration (LTC).</p>	
5.2	Results and discussion	Acute toxicity varied from 0.057 mg. l ⁻¹ for juvenile rainbow trout to 0.191 mg. l ⁻¹ for field stocks of juvenile fathead minnows. Juvenile fish	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 3 of 8
			were more sensitive at lower temperatures and at oxygen levels below 5 mg. l ⁻¹ . The difference in median lethal concentration between field stock fathead minnows, the most resistant species tested, and rainbow trout juveniles was approximately threefold. Eggs of all species tested were the most resistant life history stage. Slope of the log-probit toxicity curves is smallest for egg tests and increases to that for juveniles one.	
5.2.1 LC ₅₀			Fathead minnow eggs : from 0.121 to 0.352 mg.l ⁻¹ Fathead minnow swim-up fry: from 0.081 to 0.122 mg.l ⁻¹ Fathead minnow juveniles: from 0.082 to 0.137 mg.l ⁻¹ Bluegill eggs: from 0.580 to 0.935 mg.l ⁻¹ (expressed as LTC) Bluegill swim-up fry: from 0.232 to 0.371 mg.l ⁻¹ Bluegill juveniles: from 0.075 to 0.125 mg.l ⁻¹ Oncorhynchus mykiss: 0.0572 mg.l⁻¹ (95% confidence limit was 0.0557 – 0.0587 mg.l ⁻¹).	
5.3 Conclusion			For most species juveniles were most sensitive and eggs more resistant to HCN. Temperature has a marked effect on acute toxicity of HCN with juvenile fish in general becoming more sensitive at lower temperatures Oxygen below 5 mg.l ⁻¹ result in increased sensitivity for all juveniles tested.	
5.3.1 Reliability			2	
5.3.2 Deficiencies			None	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 4 of 8
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Table 1: Dilution water

Criteria	Details
Source	Water from a deep well was transmitted to experiments through polyvinyl chloride pipe.
Alkalinity	approximately 235 mg.l ⁻¹ as CaCO ₃
Hardness	approximately 220 mg.l ⁻¹ as CaCO ₃
pH	6 to 8
Conductance	
Holding water different from dilution water	No

Table 2: Test organisms

Criteria	Details
Species/strain	<ol style="list-style-type: none"> 1. Fathead minnow, <i>Pimephales promelas</i> (Rafinesque) 2. Bluegill, <i>Lepomis macrochirus</i> (Rafinesque) 3. Oncorhynchus mykiss, <i>Salmo gairdneri</i> (Richardson).
Source	<ol style="list-style-type: none"> 1. Fathead minnow were cultured in test laboratory from brood stock originally obtained from the U.S. EPA's ERL, Duluth. Juvenile wild-stock fatheads were collected from Como Lake in St. Paul. 2. Bluegill was obtained from wild stock with eggs spawned and fry hatched in the laboratory. Juvenile bluegills were collected from local waters. 3. Oncorhynchus mykiss were obtained as newly hardened eggs or as 24-hr fry from state hatcheries.
Age/size	<ol style="list-style-type: none"> 1. Sac fry, length 5-6 mm; Swim-up, length 5-6 mm, Juveniles, length 26-45 mm 2. Sac fry, length 4 mm; Swim-up, length 4 mm, Juveniles, length 13-28 mm 3. Juveniles, length 40-68 mm
Pretreatment	Juveniles held at test conditions for seven days before being placed in test chambers. Juveniles from the field were given prophylactic treatment with neomycin and tetracycline at 20 mg. l ⁻¹ for 4-hr periods on three consecutive days.
Feeding of animals during test	No

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 5 of 8
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Table 3: Test system

Criteria	Details
Test type	Flow-through
Volume of test vessels	Test chambers for juveniles and trout swim-up were glass aquaria 50x24x20 cc high filled to 20 l of test solution. Eggs and fry were tested in screen bottomed acrylic cylinders each covered with a bakelite lid and held in a 20l chamber - the portion of water from each cycle flowed upward through the screen to the outlet.
Volume/animal	
Number of animals/vessel	1. 25-50 eggs; 25 sac fry; 25 swim-up fry; 10 juveniles 2. 25-50 eggs; 10-50 sac fry; 10-50 swim-up fry; 10-20 juveniles 3. 10 juveniles
Number of vessels/ concentration	1

Table 4: Test conditions

Criteria	Details
Test temperature	15 – 25°C
Dissolved oxygen	3 – 7 mg.l ⁻¹ See respective tests.
pH	about 7, see respective tests
Photoperiod	All tests were conducted under two fluorescent lamps (Luxor)

Table 5: Acute toxicity of HCN to fathead minnow eggs expressed as 96-hr LC₅₀ and median lethal concentrations at hatching

°C	DO mg.l ⁻¹	pH	96-hr LC ₅₀ mg. l ⁻¹	95% Confidence limits	Hatch LC ₅₀ mg. l ⁻¹	99% Confidence limits
15.2	6.36	7.86	0.352	274-453	0.126	90.9-174
20.0	6.13	7.88	0.273	162-463	0.118	97.3-142
24.9	3.51	7.72	0.202	130-314	0.116	86.6-157
24.8	4.46	7.95	0.121	77.3-190	0.113	83.0-154
25.0	5.52	7.90	0.184	115-293	0.180	122-266
25.0	6.34	8.00	0.196	140-274	0.162	135-193
24.9	7.25	7.99	0.202	-	0.187	-

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 6 of 8
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Table 6: Acute toxicity of HCN to fathead minnow swim-up fry expressed as 96-hr LC₅₀ and median lethal threshold concentrations

°C	DO mg.l ⁻¹	pH	96-hr LC ₅₀ mg. l ⁻¹	95% Confidence limits	LTC mg. l ⁻¹	95% Confidence limits
15.0	6.38	7.86	0.122	104-143	0.102	92.8-113
20.0	6.14	7.89	0.0991	88.9-111	0.0961	83.6-110
24.6	3.77	7.84	0.0816	71.2-93.6	0.0816	71.2-93.6
24.7	5.14	7.96	0.108	90.3-130	0.108	90.3-130
24.9	6.17	8.02	0.113	96.5-133	0.113	96.5-133

Table 7: Acute toxicity of HCN to fathead minnow juveniles expressed as 96-hr LC₅₀ and median lethal threshold concentrations

°C	DO mg.l ⁻¹	pH	96-hr LC ₅₀ mg. l ⁻¹	95% Confidence limits	LTC mg. l ⁻¹	95% Confidence limits
15.0	6.07	7.86	0.121	116-125	0.119	115-123
20.0	3.58	7.70	0.128	109-149	0.123	105-143
19.8	4.68	7.80	0.0824	76.4-88.9	0.0824	76.4-88.9
20.0	5.20	7.78	0.125	117-133	0.123	116-132
20.0	6.07	7.91	0.137	122-153	0.137	122-153
20.0	7.13	7.90	0.131	124-138	0.131	124-138
24.8	3.58	7.75	0.106	87.9-129	0.106	87.9-129
25.0	5.08	7.83	0.119	111-129	0.119	111-129
25.1	6.13	7.98	0.129	124-133	0.129	124-133
25.2	7.04	7.96	0.120	113-128	0.120	113-138

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 7 of 8
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Table 8: Acute toxicity of HCN to bluegill eggs and swim-up fry expressed as 96-hr LC₅₀ and median lethal threshold of hatching concentrations

°C	DO mg.l ⁻¹	pH	96-hr LC ₅₀ mg. l ⁻¹	95% Confidence limits	LTC mg. l ⁻¹	95% Confidence limits
Eggs						
25.2	3.39	7.70	-	-	0.690	461-1033
25.0	4.99	7.79	-	-	0.535	240-1192
25.1	6.09	7.92	-	-	0.693	572-841
25.0	6.90	7.90	-	-	0.580	343-980
Fry						
20.0	5.99	7.89	0.365	188-709	0.205	156-270
24.9	3.59	7.72	0.232	147-366	0.109	99.9-120
24.9	5.08	7.80	0.232	147-366	0.149	117-189
24.9	6.01	7.93	0.276	241-316	0.218	193-247
24.8	6.81	7.90	0.271	200-368	0.194	110-340

Table 9: Acute toxicity of HCN to bluegill juveniles expressed as 96-hr LC₅₀ and median lethal threshold of hatching concentrations

°C	DO mg.l ⁻¹	pH	96-hr LC ₅₀ mg. l ⁻¹	95% Confidence limits	LTC mg. l ⁻¹	95% Confidence limits
8.4	6.08	7.80	0.083	-	0.0617	59.3-64.2
9.7	8.35	7.94	<0.092	-	-	-
15.0	6.07	7.83	0.087	81.0-93.8	0.0871	81.0-93.8
15.1	7.03	7.92	0.075	66.0-85.2		
17.8	7.97	8.12	0.099	-		
20.0	6.06	7.86	0.108	103-112	0.108	103-112
25.1	3.48	7.71	0.0997	86.0-116	0.0997	86.0-116
25.0	5.05	7.78	0.113	55.8-227	0.113	55.8-227
24.9	6.17	7.92	0.120	109-133	0.120	109-133
24.9	6.90	7.86	0.125	115-135	0.125	115-135

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.1-3 Acute Toxicity to Fish	Page 8 of 8
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Table 10: Acute toxicity of HCN to *Oncorhynchus mykiss* juveniles expressed as 96-hr LC₅₀ and median lethal threshold concentrations

°C	DO mg.l ⁻¹	pH	96-hr LC ₅₀ mg. l ⁻¹	95% Confidence limits	LTC mg. l ⁻¹	95% Confidence limits
10	8.80	7.80	0.0572	55.7-58.7	-	-

Table 11: Effect data

Parameter	96 h
LC ₅₀ [mg.l ⁻¹] ¹	Fathead minnow eggs : from 0.121 to 0.352 mg. l ⁻¹ Fathead minnow swim-up fry: from 0.081 to 0.122 mg. l ⁻¹ Fathead minnow juveniles: from 0.082 to 0.137 mg. l ⁻¹ Bluegill eggs: from 0.580 to 0.935 mg. l ⁻¹ (expressed as LTC) Bluegill swim-up fry: from 0.232 to 0.371 mg. l ⁻¹ Bluegill juveniles: from 0.075 to 0.125 mg. l ⁻¹ Oncorhynchus mykiss: 57.2 µg. l ⁻¹ (95% confidence limit was 0.0557 – 0.0587 mg. l ⁻¹)
95 % c.l.	See Tables: 5-10

¹ Based on mean measured concentrations.

	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to Daphnia Magna	Page 1 of 7
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Section A7.4.1.2 Annex Point IIA VII.7.2	ACUTE TOXICITY TO DAPHNIA MAGNA			
	1 REFERENCE			Official use only
1.1 Reference	Hydrogen cyanide: An acute toxicity study with the daphnid <i>Daphnia magna Strauss</i> , Research Institute of Organic syntheses, Centre for ekotoxicology, toxicology an analytics, Pardubice – Rybitví, Czech Republic, Report No. 1514/L (unpublished), 2002-02-18 (DOC IV_72)			
1.2 Data protection	Yes			
1.2.1 Data owner	Lučební závody Draslovka, a. s. Kolín			
1.2.2 Companies with letter of access	No companies with letter of acces.			
1.2.3 Criteria for data protection	Data submitted to the CA MS after 13 may 2000 for the purpose of entry existing active substance into Annex I/IA			
	2 GUIDELINES AND QUALITY ASSURANCE			
2.1 Guideline study	Decree of Ministry of Environment No. 299 /1998 Coll., Patr 103, Method II – Acute toxicity to daphnia; OECD Test Guideline No. 202, 1984, EC Method C.2, Directive 67/548/EEC			
2.2 GLP	Yes			
2.3 Deviations	No			
	3 MATERIALS AND METHODS			
3.1 Test material	Hydrogen cyanide liquid stabilized			
3.1.1 Lot/Batch number	No. 15/02/22			
3.1.2 Purity	98.0 %			
3.1.3 Further relevant properties				
3.2 Preparation of TS solution for poorly soluble or volatile test substances	Solubility in water: very good			
3.3 Reference substance	Yes, an acute toxicity test was carried out (Report No. 1514/L) using the reference substance potassium dichromate (K ₂ Cr ₂ O ₇), Batch number K29239062, Certificate of analysis: 1.04862.1000 Potassium dichromate cryst. extra pure, Merck KgaA, 64271 Darmstadt.			
3.4 Testing procedure				
3.4.1 Dilution water	Reconstituted distilled water, see Table 1			
3.4.2 Test organisms	<i>Daphnia magna Strauss</i> , less than 24 hours old, see Table 2			
3.4.3 Test system	Static, see Table 3 . In order to obtain information about the range of concentrations to be used in the main test a range-finding test was proceeded with the definitive test. For each test one control test (with the dilution water) was carried out. Base (“primary”) solution of test substance: 15 mg.l ⁻¹ of disstilled water. Test media of the required concentration for both the range finding test and the definitive test were prepared from the base solution by serial dilution with dilution water. 7 and 8 concentrations were studied in the range-finding test and the			

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to Daphnia Magna	Page 2 of 7
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		definitive test, respectively. For the definitive test 20 animals at each test concentration divided into two batches of 10 animals each were studied.	
3.4.4	Test conditions	see Table 4	
3.4.5	Duration of the test	24 and 48 hours	
3.4.6	Test parameter	Immobility of animals	
3.4.7	Monitoring of TS concentration	Yes. At the beginning of the definitive test (before introduction of animals), and at the end of exposure period (after withdrawal of animals), the solutions of minimum and maximum substance concentrations were analysed by argentometric titration to confirm stability of the concentrations see Table 5 . Test (1 st run) and its duplicate (2 nd run) has been performed.	
3.4.8	Statistics	EC ₅₀ values were calculated by the use of the computational program TOXICITA (VÚV, Ostrava).	
		4 RESULTS	
4.1	Results test substance		
4.1.1	Initial concentrations of test substance	1. Range – finding test concentrations in mg.l ⁻¹ : 2.1, 1.8, 1.5, 1.2, 0.9, 0.6, 0.3 2. Definitive test concentrations in mg.l ⁻¹ : 1.8, 1.65, 1.50, 1.35, 1.20, 1.05, 0.90, 0.75	
4.1.2	Effect data (Immobilization)	1. Range – finding test, see Table 6 2. Definitive test, see Table 6	
4.1.3	Other effects	No abnormalities were observed at any of the test concentrations	
4.2	Results of controls	No immobility occurred in any control	
4.3	Test with reference substance	Sensitivity of the test organism and the accuracy of the test were regularly in a three month interval verified by test with reference substance, potassium dichromate. According to the results of ASLAB (2001) interlaboratory tests 48h-EC ₅₀ = 0.41 – 1.17 mg.l ⁻¹ : The results of the valid verified test for potassium dichromate carried-out on 12-21 Dec, 2001 are as follows: 24h-EC ₅₀ = 1.21 mg.l ⁻¹ and 48h-EC ₅₀ = 0.93 mg.l ⁻¹	
		5 APPLICANT'S SUMMARY AND CONCLUSION	
5.1	Materials and methods	Hydrogen cyanide liquid stabilized was tested for acute toxicity to water fleas (<i>Daphnia magna</i>) according to OECD guideline No. 202 (1984). For a range-finding test a total of 140 young daphnid (less than 24 hours old) were exposed to seven concentrations and control. For a definitive test a total 320 young daphnid (less than 24 hours old) were exposed to eight concentrations, controls and replicates. Duration of exposure was 24 and 48 hours under static conditions. Test concentrations were verified by argentometric titration.	
5.2	Results and discussion	Test results have been obtained by the use of computation program TOXICITA, VÚV, Ostrava. Based on mean measured concentrations, EC ₅₀ values of 1.23 mg.l ⁻¹ and 1.07 mg.l ⁻¹ at 24 and 48 hours respectively, were determined. See Table 7 .	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to <i>Daphnia</i> Magna	Page 3 of 7
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	The NOEC was not determined.	
5.2.1 EC ₅₀	24 h -EC ₅₀ = 1.23 mg.l ⁻¹ , 48 h - EC ₅₀ = 1.07 mg.l ⁻¹	
5.3 Conclusion	Hydrogen cyanide liquid stabilized is classified as toxic to <i>Daphnia magna, Strauss</i>	
5.3.1 Reliability	1	
5.3.2 Deficiencies	No remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to Daphnia Magna	Page 4 of 7
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Table 1: Dilution water

Criteria	Details
Source	Reconstituted dilution water was prepared at the start of test by mix of 2.5 ml of each of four A, B, C, D stock solutions and make up to 1,000 ml with distilled water: A) CaCl ₂ .2H ₂ O (calcium chloride dihydrate): 117.6 g; dissolved in, and make up 1,000 ml with distilled water B) MgSO ₄ .7H ₂ O (magnesium sulphate heptahydrate): 49.3 g; dissolved in, and make up 1,000 ml with distilled water C) NaHCO ₃ (sodium hydrogen carbonate): 25.9 g; dissolved in, and make up 1,000 ml with distilled water D) KCl (potassium chloride): 2.3 g; dissolved in, and make up 1,000 ml with distilled water
Alkalinity	-
Hardness	Concentration of Ca + Mg: 2.57 mmol.l ⁻¹
pH	7.64
Oxygen content	8.8 mg.l ⁻¹ (at the start of the test)
Conductance	0.81 μS.cm ⁻¹
Holding water different from dilution water	No

Table 2: Test organisms

Criteria	Details
Source	<i>Daphnia magna Straus</i> , from the own laboratory bred
Age	Less than 24 hours old, at the beginning of the test
Breeding method	Pregnant adult female daphnia are transferred into the vessels containing aerated reconstituted dilution water and the 24 hour's offsprings by means of screen (mesh 0.1 mm) eliminated and washed down into the handling vessel (care should be paid, no air enters under the shall). Test animals are obtained by acyclic parthenogenesis from the own laboratory bred, at least third genera.
Kind of food	Mixture of the algae.
Feeding frequency	-
Pretreatment	Eliminated 24 hours's offsprings were washed down into the handling vessel and numbered to use in the test. Sensitivity of the test animals is regularly monitoring and tested with the reference substance, potassium dichromate.
Feeding of animals during test	No

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to Daphnia Magna	Page 5 of 7
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Table 3: Test system

Criteria	Details
Renewal of test solution	No – static conditions
Volume of test vessels	50 ml test solution in a 100 ml beaker
Volume/animal	5 ml of test solution for each animal
Number of animals/vessel	10
Number of vessels/ concentration	3 beakers

Table 4: Test conditions

Criteria	Details
Test temperature	20 ± 2 °C; temperature constant within ± 1 °C at each single test
Dissolved oxygen	8.5 - 8.8 mg.l ⁻¹
pH	7.63 – 7.92
Adjustment of pH	No, just measurement pH and concentration of dissolved oxygen at the beginning and the end of the definitive test for each tested concentration.
Quality/Intensity of irradiation	Not relevant
Photoperiod	A light – dark cycle

Table 5: Test conditions (monitoring of concentrations)

Test run	Beginning of test calculated concentration HCN [mg.l ⁻¹]	Beginning of test measured concentration HCN [mg.l ⁻¹]	End of test measured concentration HCN [mg.l ⁻¹]	Difference of measured concentration HCN [%]
1. run	1.80	1.79	1.60	10.6
1. run	0.75	0.77	0.70	9.1
2. run	1.80	1.84	1.61	12.5
2. run	0.75	0.76	0.72	5.3

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to Daphnia Magna	Page 6 of 7
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Table 6: Immobilisation data

Test substance concentration (measured) [mg/l]										
	Immobile Daphnia				Oxygen [mg/l]		pH		T [*C]	
	Number		Percentage		0 h	24 h	0 h	24 h	0 h	24 h
	24 h	48 h	24 h	48 h						
Range-finding test										
2.1	10	10	100	100						
1.8	10	10	100	100						
1.5	7	9	70	90						
1.2	6	7	60	70						
0.9	3	5	30	50						
0.6	0	0	0	0						
0.3	1	1	10	10						
0	0	0	0	0						
Definitive test – 1. run										
1.80	20	20	100	100	8.6	8.5	7.70	7.92	20.5	21.0
1.65	16	19	80	95	8.7	8.6	7.70	7.90	20.5	21.0
1.50	13	17	65	85	8.7	8.6	7.69	7.90	20.5	21.0
1.35	12	14	60	70	8.8	8.6	7.65	7.91	20.5	21.0
1.20	11	13	55	65	8.8	8.6	7.67	7.90	20.5	21.0
1.05	10	11	50	55	8.8	8.6	7.67	7.88	20.5	21.0
0.90	5	8	25	40	8.8	8.6	7.66	7.87	20.5	21.0
0.75	3	3	15	15	8.8	8.6	7.64	7.84	20.5	21.0
0.00	0	0	0	0	8.8	8.6	7.64	7.84	20.5	21.0
Definitive test – 2. run										
1.80	20	20	100	100	8.7	8.6	7.70	7.90	19.7	21.3
1.65	14	17	70	85	8.8	8.6	7.68	7.89	19.7	21.3
1.50	12	15	60	75	8.8	8.7	7.68	7.89	19.7	21.3
1.35	11	13	55	65	8.8	8.6	7.67	7.88	19.7	21.3
1.20	10	12	50	60	8.8	8.6	7.66	7.86	19.7	21.3
1.05	8	10	40	50	8.8	8.6	7.66	7.86	19.7	21.3
0.90	4	6	20	30	8.8	8.7	7.65	7.83	19.7	21.3
0.75	2	3	10	15	8.8	8.6	7.63	7.82	19.7	21.3
0.00	0	0	0	0	8.8	8.6	7.64	7.82	19.7	21.3

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.2-1 Acute Toxicity to Daphnia Magna	Page 7 of 7
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Table 7(1.run): Effect data

	EC ₅₀ [mg.l ⁻¹]	95 % c.l.	Approximation function
24 h	1.18	0.88 – 1.47	log linear
48 h	1.03	0.90 – 1.16	log linear

Table 7(2.run): Effect data

	EC ₅₀ [mg.l ⁻¹]	95 % c.l.	Approximation function
24 h	1.27	0.92 – 1.62	log linear
48 h	1.11	0.95 – 1.26	log linear

Table 8: Validity criteria for acute daphnia immobilisation test according to OECD Guideline 202

	Fulfilled	Not fulfilled
Immobilisation of control animals <10%	x	
Control animals not staying at the surface	x	
Concentration of dissolved oxygen in all test vessels >3 mg/l	x	
Concentration of test substance ≥80% of initial concentration during test	x*	

* see Table 5

	Evaluation by Competent Authorities
Date	
Evaluation of applicant's justification	
Conclusion	
Remarks	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.3-1 Growth Inhibition Test on Algae	Page 1 of 7
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Section A7.4.1.3 Annex Point IIA VII.7.3	GROWTH INHIBITION TEST ON ALGAE			
	1 REFERENCE			Official use only
1.1 Reference	Growth Inhibition of Green Algae (<i>Scenedesmus subspicatus</i> Brinkmann 1953/SAG 86.81) by hydrogen cyanide liquid stabilized, Research Institute of Organic syntheses, Centre for ekotoxicology, toxicology an analytics, Pardubice – Rybitví, Czech Republic, Report No. 1522/L (unpublished), 2002-03-20 (DOC IV_73)			
1.2 Data protection	Yes			
1.2.1 Data owner	Lučební závody Draslovka, a. s. Kolín			
1.2.2 Companies with letter of access	No companies with letter of access.			
1.2.3 Criteria for data protection	Data submitted to the CA MS after 13 may 2000 for the purpose of entry existing active substance into Annex I/IA			
	2 GUIDELINES AND QUALITY ASSURANCE			
2.1 Guideline study	Annex to Decree of Ministry of Environment No. 299 /1998 Coll., Part 103, Method III, Growth Inhibition of Alga ; Test Guideline No. 201, Alga, Growth Inhibition Test, OECD, 1984; Method C.3, Alga Inhibition Test, EEC Directive 67/548/EEC, Annex V			
2.2 GLP	Yes			
2.3 Deviations	No			
	3 MATERIALS AND METHODS			
3.1 Test material	Hydrogen cyanide liquid stabilized			
3.1.1 Lot/Batch number	15/02			
3.1.2 Purity	98%			
3.1.3 Further relevant properties	Water solubility, vapour pressure, chemical stability, dissociation constant, biodegradability, partition coefficient n-octanol/water; see: Physical and chemical properties			
3.1.4 Method of analysis	Argentometric titration			
3.2 Preparation of TS	Solubility in water: very good			
3.3 Reference substance	Yes, an acute toxicity test was carried out (Report No. 1514/L) using the reference substance potassium dichromate (K ₂ Cr ₂ O ₇), Batch number K29239062, Certificate of analysis: 1.04862.1000 Potassium dichromate cryst. extra pure, Merck KgaA, 64271 Darmstadt.			
3.4 Testing procedure				
3.4.1 Culture medium	Before the use it was equilibrated with filtered air aeration for 30 minutes. pH of the medium was 7.85 ± 0.1. All chemicals were of p.a grade. Distilled water of the conductivity of 5 µS. cm ⁻¹ was used for the preparation of the solutions. Stock solutions were diluted to achieve the final nutrient concentrations in the test solution. Following four stock solutions were prepared:			

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.3-1 Growth Inhibition Test on Algae	Page 2 of 7
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	Nutrient	Concentration in the stock solution
	A) macronutrients:	
	NH ₄ Cl	1.5 g/l
	MgCl ₂ · 6H ₂ O	1.2 g/l
	CaCl ₂ · 2H ₂ O	1.8 g/l
	MgSO ₄ · 7H ₂ O	1.5 g/l
	KH ₂ PO ₄	0.16 g/l
	B) Fe-EDTA:	
	FeCl ₃ · 6H ₂ O	80 mg/l
	Na ₂ EDTA · 2H ₂ O	100 mg/l
	C) trace elements:	
	H ₃ BO ₃	185 mg/l
	MnCl ₂ · 4H ₂ O	415 mg/l
	ZnCl ₂	3 mg/l
	CoCl ₂ · 6H ₂ O	1.5 mg/l
	CuCl ₂ · 2H ₂ O	0.01 mg/l
	Na ₂ MoO ₄ · 2H ₂ O	7 mg/l
	D) NaHCO ₃	50 g/l
3.4.2 Test organisms	Freshwater green algae (<i>Scenedesmus subspicatus Brinkmann</i>), see Table 1 .	
3.4.3 Test system	Static; see Table 2	
3.4.4 Test conditions	See Table 3	
3.4.5 Duration of the test	72 hours	
3.4.6 Test parameter	Inhibition of growth of biomass Inhibition of growth rate	
3.4.7 Sampling	After 24, 48 and 72 hours, the cells counts were determined in the test concentrations and in the control. pH values were controlled at the beginning of the test and after 72 hours in the control and the test concentrations. Temperature was determined in the course of the test concentrations.	
3.4.8 Monitoring of TS concentration	Yes, see Table 4 Determination of the test substance concentration was performed at the beginning and the end of the test by argentometric titration. The highest concentrations tested were analysed. The lowest concentrations tested were not analysed due to limit of determination of the applied analytical method which was 0.1 mg · l ⁻¹ . Instead of that the nearest concentration responding to the limit of determination has been analysed. Test media were filtered through the inert membrane filter of 0.2 µm porosity and the algal free analysed for the test substance concentration.	

Lučební závody Draslovka, a. s. Kolín	May 2013	HCN	Doc III-A A7.4.1.3-1 Growth Inhibition Test on Algae	Page 3 of 7
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3.4.9	Statistics	<p>The mean value of the cell density for each three replicate test substance concentration was considered. To determine the concentration / effect relationship the following approach was used:</p> <p>a) comparison of area under the growth curves b) comparison of the growth rates.</p> <p>The percentage inhibition of the cell growth at each test substance concentration was calculated. For the estimation of the E_bC_{50} and E_rC_{50} for the interval of 0 – 72 hours the computation TOXICITA program of VÚV Ostrava was used.</p>	
		4 RESULTS	
4.1	Limit Test	Not performed	
4.2	Results test substance		
4.2.1	Initial concentrations of test substance	<p>Range – finding test concentrations (nominal): 2.55, 1.20, 0.75, 0.60, 0.30, 0.15, 0.045 and 0.015</p> <p>Definitive test concentrations (nominal): 1st and 2nd Run: 0.30, 0.15, 0.12, 0.09, 0.06, 0.03 and 0.015</p> <p>Test substance concentrations at the beginning of the test are identical with those calculated ones. See Table 5(01).</p>	
4.2.2	Actual concentrations of test substance	<p>Range – finding test concentrations (nominal): 2.55, 1.20, 0.75, 0.60, 0.30, 0.15, 0.045 and 0.015</p> <p>Definitive test concentrations (nominal): 1st and 2nd Run: 0.30, 0.15, 0.12, 0.09, 0.06, 0.03 and 0.015</p> <p>Test substance concentrations at the beginning of the test are identical with those calculated ones. See Table 5(01).</p>	x
4.2.3	Cell concentration data	Cell density measurements by using a microscope with counting chambers are presented in Tables 5 .	
4.2.4	Effect data (cell multiplication inhibition)	<p>The growth of biomass (E_bC_{50}) was found to be 0.04 mg. l⁻¹ after 72 h. The algae growth rate (E_rC_{50}) was found to be 0.12 mg. l⁻¹ after 72 h. See Table 6</p>	
4.3	Results of controls	Cell counts of the control in the range – finding test and definitive test are presented in Tables 5 .	
4.4	Test with reference substance	<p>Performed.</p> <p>Based on the results of an ASLAB (2001) inter-laboratory tests (presentation of 14 laboratories) following results were obtained: E_bC_{50} (0 – 72h) = 0.24 – 0.89 mg.l⁻¹ E_rC_{50} (0 – 72h) = 0.59 – 1.70 mg.l⁻¹</p> <p>The results of the valid verified test with K₂Cr₂O₇ performed on 17 – 20 Dec 2001 are: E_bC_{50} (0 – 72h) = 0.76 mg.l⁻¹ E_rC_{50} (0 – 72h) = 1.39 mg.l⁻¹</p> <p>Test culture algae growth inhibition for the media with the reference substance expressed as EC₅₀ showed the sensitivity of the test species has not changed significantly.</p>	