XIII. APPENDIX V

First Aid and Treatment Kits

Two physician's treatment kits should be immediately available to trained medical personnel at each plant where there is a potential for the release of, accidental or otherwise, or for contact with, hydrogen cyanide or cyanide salts. One kit should be portable in order that it may be carried by medical personnel while accompanying a patient to the hospital. The other kit should be kept under lock and key to assure that it is intact and available when and if needed. The key should be readily available at all times to the work supervisor on duty and the storage place should be of such construction as to allow accessibility in the event of loss of the key.

Both kits for use by the medical personnel servicing each firm should contain the following as a minimum.

(1) Two (2) boxes (2 dozen) ampules; each ampule containing 0.3 ml of amyl nitrite.

(2) Two (2) ampules of sterile sodium nitrite solution (10 ml of a 3% solution in each).

(3) Two (2) ampules of sterile sodium thiosulfate solution (50 ml of a 25% solution in each).

(4) 2 sterile 10-ml syringe with intravenous needles.

(5) 1 sterile 50-ml syringe with intravenous needle.

(6) 1 tourniquet

(7) 1 gastric tube (rubber).

(8) 1 non-sterile 100 ml syringe.

The medical personnel servicing a firm where there is a potential for hydrogen cyanide release or a potential for exposure to inorganic cyanide should be familiarized with the use of these kits.

First-aid kits should be immediately available at work places where there is a potential for the release, accidental or otherwise, of hydrogen cyanide or a potential for exposure to inorganic cyanide. This kit should contain as a minimum two (2) boxes of ampules (2 dozen), each containing 0.3 ml of amyl nitrite. Ampules should be replaced biannually or sooner if needed to ensure their potency. The amyl nitrite ampules should be protected from high temperatures. In all cases, the contents of the medical and first-aid kits should be replaced before the manufacturer's assigned expiration dates.

First-Aid Procedure

Speed in the rendering of first-aid treatment is of the utmost importance. The patient should be removed at once to an area free from HCN. The rescuer should wear respiratory protective equipment in order not to be overcome or weakened by the gas.

Many victims will have stopped breathing. In this case, it is imperative that efforts at resuscitation be instituted at once and continued without interruption even while other treatment is being administered.

A physician should be summoned immediately.

First-aid kits should be readily available at all times. They should be quickly accessible but should not be kept only in operating areas

where they may not be available in case of a spill.

(1) Contact with Skin and Mucous Membranes

(A) If liquid HCN or a cyanide salt (solid or solution) has contaminated the skin or clothing, the clothing should be removed and the skin flushed with copious amounts of water. Careful attention should be paid to underwear, shoes, and socks.

(B) Carry out the specific actions recommended in (3), below.

(2) When Taken Internally

(A) If the victim is conscious, induce vomiting by having the victim drink a glassful of lukewarm salt water, soapy water, or mustard water. If the victim is unconscious, omit this step. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

(B) Carry out the specific actions recommended in (1), above, and (3), below.

(3) Inhalation

(A) Administer amyl nitrite

A pearl (ampule), if not provided with a fabric sleeve, should be wrapped lightly in a handkerchief or gauze pad, broken, and held about 1 inch from the patient's mouth and nostrils for 15 seconds. Repeat 5 times at 15-second intervals. Use a fresh pearl every 5 minutes until 3 or 4 pearls have been administered.

WARNING: First-aiders should keep the pearls away from their own mouths and noses lest they become weak and dizzy and unable to give proper assistance to the victim. Amyl nitrite is flammable and

mixtures with air may be explosive if a source of ignition is present.

(B) Resuscitation

Before instituting artificial resuscitation, dentures and foreign objects, such as gum and tobacco, and any accumulated oropharyngeal fluids (saliva, etc) should be removed from the patient's mouth and pharynx and the tongue pulled forward.

If the patient's breathing is weak or has stopped, artificial resuscitation should be started at the earliest possible moment and continued without interruption until normal breathing has been established or the patient is pronounced dead.

Mouth-to-mouth resuscitation is the method of choice because of its simplicity and effectiveness. It is, however, impossible to administer amyl nitrite while using this method. Therefore, it is advisable to switch to other methods of artificial respiration, such as the Holger-Nielsen arm-lift back pressure method, during the periods when the amyl nitrite is being given.

If a mechanical resuscitator and personnel skilled in its use are available, this equipment may be used instead of other forms of resuscitation.

(C) The patient should be kept comfortably warm but not hot. Other drugs and stimulants are rarely necessary and should be administered only by a physician or trained medical personnel under the direction of a physician.

TABLE XIV-1

PROPERTIES AND CHARACTERISTICS OF HYDROGEN CYANIDE*

Molecular Formula	HCN
Molecular Weight	27.03
Physical state	Liquid or gas
Explosive limits	6% to 41% by volume in air, horizontal propagation
Flashpoint (closed cup)	-17.8 degrees C
Autoignition temperature	538 degrees C (1000 F)
Boiling point	26 degrees C (27.7 for 96% solution)
Color	Clear and colorless or bluish tinted liquid
Freezing point	-16.8 degrees C (for 96% solution)
Odor	Sweetish, not unpleasant, like bitter almond to some people
Reactivity	When not pure or stabilized, it can polymerize with explosive violence.
Specific gravity	0.703 (for 96% solution)
Vapor density	0.93 (Air = 1.0)
Conversion Factors:	
For HCN at 25 degrees C and 1 atmosphere pressure:	
ppm equals	(mg/cu m) x (0.90)
mg/cu m equals	(ppm) x (1.11)

*Derived from references 2,8,33,107,254

TABLE XIV-2

CHEMICAL AND PHYSICAL PROPERTIES OF SOME CYANIDE SALTS

Compound	Molecular Formula	Formula Weight	Melting Point, °C	Boiling Point, °C	Density	Solubility: g/100 cc Cold Water	Hot Water	Available Cyanide and Reference
Ammonium cyanide	NH4CN	44.06	Decomposes 36°	Sublimes 40°	1.02	Very soluble	Decomposes	At 36 degrees C decomposed to NH3 and HCN 28
Calcium cyanide	Ca(CN)2	92.12	Decomposes over 350°	....	....	Decomposes	"	Forms Ca(OH)2 and HCN in presence of H2O or humid air 31,42,89
Copper (I) cyanide	CuCN	89.56	473° (in N2)	Decomposes	2.92	Insoluble	Insoluble	Ksp = 3.2 x 10 exp(-20) 34
Copper (II) cyanide	Cu(CN)2	115.58	Decomposes	....	....	"	....	Decomposes to CuCN on boiling or drying 255
Gold (III) cyanide	Au(CN)3 3 H2O	329.07	Decomposes 50°	....	....	Very soluble	Decomposes, very soluble	....
Lead cyanide	Pb(CN)2	259.23	....	....	....	Slightly soluble	Soluble	....
Magnesium cyanide	Mg(CN)2	76.35	Decomposes 300° to MgCN2	Decomposes 600°	....	Soluble	Decomposes	....
Mercury (II) cyanide	Hg(CN)2	252.63	Decomposes	....	3.996	9.3	33	"Virtually non-ionized" 256
Potassium cyanide	KCN	65.12	634.5°	....	1.52	50	100	Kh (25C) = .0000254 28
Potassium cyanoaurite	K[Au(CN)2	288.10	....	....	3.45	14.3	200	Forms complex cyanides in aqueous solution 35
Silver cyanide	AgCN	133.84	Decomposes 320°	....	3.95	0.000023	....	Ksp (20 degrees C) = 1.2 x 10 exp(-16). 34
Sodium Cyanide	NaCN	49.01	563.7°	1496°	....	48	82	Kh (25 degrees C) = 0.0000251 28
Sodium cyanoaurite	Na[Au(CN)2	271.99	....	....	....	Soluble	....	Forms complex cyanides in aqueous solution 35
Zinc cyanide	Zn(CN)2	117.41	Decomposes 800°	....	1.852	.0005	....	"Insoluble in water" 257

Taken in part from Weast [1].

TABLE XIV-3

OCCUPATIONS WITH POTENTIAL EXPOSURE TO CYANIDES

Acid dippers
Acrylate makers
Acrylonitrile makers
Adipic acid makers
Adiponitrile makers
Aircraft workers
Almond flavor makers
Ammonium salt makers
Art printing workers
Blacksmiths
Blast furnace workers
Bone distillers
Bronzers
Browners, gun barrel
Cadmium platers
Case hardeners
Cellulose product treaters
Cement makers
Coal tar distillery workers
Coke oven operators
Cyanide workers
Cyanogen makers
Disinfectant makers
Dyemakers
Electroplaters
Executioners
Exterminators
Fertilizer makers
Fire fighters
Fulminate mixers
Fumigant makers
Fumigators of fruit trees, apiaries, soil, ships, railway cars, warehouses, stored foods
Galvanizers
Gas purifiers
Gas workers, illuminating
Gilders
Gold extractors
Gold refiners
Heat treaters
Hexamethylenediamine makers
Hydrocyanic acid makers
Hydrogen cyanide workers
Insecticide and rodenticide makers
Jewelers
Laboratory technicians
Metal cleaners
Metal polishers
Methacrylate makers
Mirror silverers
Mordanters
Nylon makers
Organic chemical synthesizers
Oxalic acid makers
Phosphoric acid makers
Photoengravers
Photographers
Pigment makers
Plastic workers
Polish makers
Rayon makers
Rubber makers
Silver extractors
Silver refiners
Solderers
Steel carburizers
Steel hardeners
Steel galvinizers
Tannery workers
Temperers
Tree sprayers
White cyanide makers
Zinc platers
Zinkers

Taken in part from references 44,58,237,258,259,260,261.

TABLE XIV-4

MECHANISM OF ACTION OF ACUTE OR SUBACUTE CYANIDE POISONING
AS POSTULATED BY RIEDERS [58]

Step 1 -	Through the formation of a relatively stable coordination complex with ferric iron, cyanide tends to keep this metal in its higher oxidation state and thus reduces its efficacy as an electron carrier in ferric to ferrous iron transitions. By such a complexation of iron, the respiratory enzyme ferricytochrome oxidase is changed to ferricytochrome oxidase-cyanide and its ability to catalyze the reaction of reduced cytochrome with oxygen is inhibited, with consequent impairment of cellular oxygen utilization
Step 2 -	Since numerous metabolic pathways converge at the cytochrome system, the impairment of the cells' ability to utilize oxygen reduces or even stops aerobic metabolism. True histotoxic (cytotoxic) hypoxia results with a shift to anaerobic metabolism with accumulation of lactate, pyruvate, and glucose.
Step 3 -	The cells are thus unable to use the oxygen brought to them as O_2Hb by the arterial blood. The oxyhemoglobin continues into the veins, the arteriovenous oxygen difference diminishes, and the venous blood is almost as bright a red as the arterial blood.
Step 4 -	The chemoreceptors in the carotid and aortic bodies, which are the tissues most sensitive to cellular hypoxia, trigger an inspiratory gasp and hyperpnea as an almost instantaneous pathophysiologic effect of cyanide absorption.

TABLE XIV-5

REPORTED (ESTIMATED) HUMAN RESPONSES TO VARIOUS CONCENTRATIONS OF HCN VAPOR

Responses	Airborne HCN Concentration	Primary Reference	Secondary Reference
Estimated LC50 for 1 minute exposure	3,404 ppm	68	—
Some nausea and difficulty in concentrating after 91 sec	500-625 ppm	86	—
No serious consequences in 1 minute	500 ppm	142	262
No injury in 1 minute	500 ppm	115	145
No injury in 1.5 minutes	375 ppm	115	145
Immediately fatal	270 ppm	Lehmann*	118
Rapidly fatal	300 ppm	240	263
Fatal in 6-8 minutes	270 ppm	118	—
No injury in 2 minutes	250 ppm	115	145
Fatal after 30 minutes	200-480 ppm	**	149
Fatal after 10 minutes	181 ppm	118,264	29
Fatal after 30 minutes	135 ppm	118,264	29
Fatal after 30-60 minutes	110-135 ppm	Lehmann*	118
Dangerous to life after 30-60 minutes	110-135 ppm	Hess*	118
Fatal after 30-60 minutes	100-240 ppm	**	149
Death after 60 minutes	90 ppm	142	262
Fatal or immed. dangerous to life	90 ppm	118	---
Numbness, weakness, vertigo, nausea, rapid pulse, flushing of face, headache, and gastric distress	More than 50 ppm	27	---
Tolerated for 30-60 min without immediate or late effects	45-54 ppm	Lehmann*	118
Complaints of headache, nausea, vomiting, and cardiac, symptoms	45 ppm	118	---
Minimal symptoms after several hours of exposure	20-40 ppm	118	149
"Effective after several hours of exposure"	18-36 ppm	Hess*	118
No symptoms after 6 hours	18-36 ppm	Lehmann*	118
Some headache, vertigo	5-18 ppm	143	262
No observed effect	0-17 (Mean 4.9)	150	---
Fatigue, headache, body weakness, tremor, pain, nausea	5-13 ppm	79	---
Headache, weakness, changes in taste and smell, throat irritation, nausea, effort dyspnea, enlarged thyroids, changes in blood chemistry	4.2-12.4 ppm (Mean 8.3)	110	---
Increased SCN excretion in urine, but to a lesser extent than in cigarette smokers; no other effects noted	2-8 ppm, (Mean 5)	76	---
None	0.1-0.9 ppm	***	262
Slight decrease in leukocytic activity of cytochrome oxidase, peroxidase, and succinyldehydrogenase after an average 5.4 years of exposure?	0.23 ppm	23	---

* The work of investigator cited appears only in the compilation of Flury and Zernick [118] or Kobert [240]

** Primary author not given in citation by Henderson and Haggard [149]

*** Attributed to Lazareff by Czechoslovak Committee of MAC [262]

TABLE XIV-6

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF HYDROGEN CYANIDE IN AIR

Animal	Concentration mg/cu m	Concentration ppm	Responses	Reference
Mouse	1450	1300	Fatal after 1-2 min	118
"	---	323	LC50 for 5-min exposure	133
"	---	250	First effects in as little as 20 sec, death within 40 min	115
"	---	200	Not fatal with 5-min exposure	133
"	140	127	Fell down in 45 sec	118
"	---	120	Fatal in 30 min	115
"	130	118	Fell down in 3 min	118
"	125	113	Fell down in 8 min	118
"	120	110	Fatal in 45 min	118
"	90	82	Fell down in 7.5 min	118
"	70	63	Fell down in 14 min	118
"	60	54	Fell down in 14 min	118
"	50	45	Fell down in 30 min	118
"	50	45	Fatal after 2.5-4 hrs	118
"	44	40	No serious symptoms in 7 hrs	118
"	---	10	Impaired movement and respiration in 2 hrs	84
Rat	---	About 1500	Fatal within 10 min	114
"	---	503	LC50 for 5-min exposure	133
"	---	About 500	31% died in 3 min	119
"	---	About 590	Fatal in 5-13 min	114
"	---	About 480	First effect in 2 min, death in 15 min	115
"	---	About 350	First effect in 4 min, death in 40 min	115
"	---	283	Not fatal in 5 min	133
"	---	About 250	First effect in 5-12 min, most survived exposures of 1 hr or less	115
"	225	204	Fell down in 5 min	118
"	---	About 180	First effects at 10 min, removed at 25 min, and recovered	115
"	140	127	Fell down in 9.5 min	118
"	---	About 120	No effect in 1 hr	115
"	120	110	Fatal in 1.5 hrs	118
"	100	90	"Safe" indefinitely?	86

TABLE XIV-6 (CONTINUED)

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF HYDROGEN CYANIDE IN AIR

Animal	Concentration mg/cu m	Concentration ppm	Responses	Reference
Rat	---	100	Fatal in 5.5 min	124
"	---	Around 50	Minimum lethal dose	124
"	---	30-40	Rapid respiration; survived	124
"	---	25	No observable effects	124
"	11	10	Motor disturbances in 2-5 hrs	84
Cat	1000	900	Fell down in 55 sec	118
"	700	635	Fell down in 1 min	118
"	430	390	Fell down in 2 min	118
"	---	About 350	First effect in 3 min	115
"	350	315	Respiratory paralysis in 2 min	264
"	Above 350	Above 315	Quickly lethal	118
"	---	About 250	First effect 5-9 min, one death in 33 min, one recovery after 1 hr	115
"	200	181	Fell down in 3 min, some as long as 12-27 min	118
"	200	180	Fatal	118
"	180	162	Safe indefinitely?	86
"	140	125	Markedly toxic in 6-7 min	264
"	140	127	Fell down in 5 min	118
"	130	118	Fell down in 6 min	118
"	---	120-150	Death after 30 min	113
"	100	91	Fell down in 7.5 min	118
"	90	82	Fell down in 10 min	118
"	70	63	Fell down in 11.5 min	118
"	60	54	Fell down in 22.5 min	118
"	50	45	Fell down in 25 min	118
"	50-60	45-54	Most died in 2.5-5 hrs	113
"	50	45	Respiratory distress, increased flow of saliva, vomiting, dilation of pupils, and convulsions after 1.5 hrs exposure	113

TABLE XIV-6 (CONTINUED)

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF HYDROGEN CYANIDE IN AIR

Animal	Concentration mg/cu m	Concentration ppm	Responses	Reference
Rabbit	---	About 450	12% died in 3 min	119
"	360	325	Fell down in 4 min	118
"	350	315	Fatal	118
"	300	272	Fell down in 15 min	118
"	284	256	Death with 30-min exposure	123
"	225	204	Fell down in 7.5 min	118
"	200	181	Fell down in 3.75 min	118
"	185	168	Fell down in 16 min	118
"	180	162	Safe indefinitely?	86
"	140	127	Fell down in 20 min	118
"	130	120	No symptoms of poisoning	118
Guinea pig	1100	1000	Fell down in 2 min	118
" "	1000	900	Fell down in 3 min	118
" "	---	About 900	40% died within 6 min	119
" "	---	About 480	First effect in 5 min, fatal in 20 min	115
" "	---	About 360	First effect in 35 min, recovered after 1-hr exposure	115
" "	350	315	Fell down in 10.5 min	118
" "	350	315	Fatal	118
" "	320	290	Fell down in 10 min	118
" "	300	272	Fell down in 5 min	118
" "	---	About 240	25% died after 1-hr exposure, no effects on others	115
" "	230	200	Tolerated for 1.5 hrs without symptoms	118
Pigeon	---	About 240	First effect in 8 min, death in 9 min	115
"	160	145	Fell down in 9 min	118
"	150	136	Fell down in 9 min	118
"	130	118	Fell down in 5 min	118
"	125-150	115-135	Lethal in 15 min or less	118
Monkey	180	162	Safe indefinitely?	86
"	140	127	Fell down in 12 min	118

TABLE XIV-6 (CONTINUED)

PHYSIOLOGIC RESPONSE OF ANIMALS TO VARIOUS CONCENTRATIONS OF HYDROGEN CYANIDE IN AIR

Animal	Concentration mg/cu m	Concentration ppm	Responses	Reference
Dog	350	315	Quickly fatal	118
"	About 300	About 270	Pretreated with sodium thiosulfate and sodium nitrite and survived	121
"	225	204	Fell down in 5 min	118
"	200	181	Fell down in 8 min	118
"	160	145	Fell down in 10.5 min	118
"	140	127	Fell down in 6.5 min	118
"	125	113	Fell down in 7 min	118
"	100	90	Fell down in 3 min	118
"	100	90	Safe indefinitely?	86
"	60	54	Fell down in 35 min	118
"	50	45	Dyspnea, nausea, exaggerated intestinal peristalsis, diarrhea, then nervousness, tremor, unsteadiness, convulsions, weight loss, 1 death	126
"	50	45	Fell down in 15 min	118
"	About 50	About 45	Onset of convulsions	121
Sparrow	---	About 240	First effect in 45 sec, death in as little as 2.5 min	115
"	---	About 180	First effect in 13 min, death in 20 min	115
"	---	About 120	Death in 40 min	115

Note: reference 264 may be an interpretation of data presented in reference 118

TABLE XIV-7

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF CYANIDE SALTS

Animal	Compounds Given	Route*	Dose (mg/kg)	Responses	Reference
Cat	NaCN	iv	0.05-0.10 mg/cat	Bradycardia	265
"	"	"	0.2-0.35	Hyperpnea, unconsciousness, pupil dilation, nystagmus, flaccidity, defecation and urination, vomiting, and confusion; recovery	266
"	"	"	0.38-0.52	Hyperpnea, loss of consciousness, motor disturbances, pupil dilation, respiratory pause, seizure, prolonged state of confusion; recovery	266
"	"	"	0.4	Reversible increase in brain lactic acid concentration; no convulsions.	267
"	"	"	0.5-1.2	Altered EEG patterns	268
"	"	"	0.8	Convulsions. Increased brain lactic acid concentration	267
"	"	"	0.8	Altered ECG patterns	269
"	"	"	1.2	Fatal	267
"	"	"	1.4-1.6	Altered ECG patterns in paralyzed animals supported by artificial ventilation	270
"	KCN	sc	2-35 mg/cat	Increased respiration, bowel movement, twitch, head tremor, nystagmus, and leg spasm at lower doses; paralysis, blindness, and convulsions	271

TABLE XIV-7 (CONTINUED)

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF CYANIDE SALTS

Animal	Compounds Given	Route*	Dose (mg/kg)	Responses	Reference
Dog	NaCN	iv	1.0	Increased SCN in urine	272
"	"	"	1.5	Apnea, gasping respirations, muscle incoordination; alive after 14 days	125
"	KCN	"	1.0-2.5	Poisoning symptoms plus increased adrenaline secretion	273
"	NaCN	"	2.25	Death in 48 hrs	125
"	KCN	Infusion	Approx 0.012 mg/kg/min	Sodium resorption in kidney decreased linearly with increased CN, (ie, with time)	274
"	"	Oral (stomach tube)	10.7	Death in 21 min	120
"	NaCN	sc	5.36	LD50	99
"	NaCN	sc	6	Lethal	275
"	"	"	6	Minimum lethal dose	276
"	KCN	Oral (stomach tube)	20.3	Death in 8 min	120
"	NaCN + methylene blue	sc	12	Survived	276
"	NaCN	"	6-18	Recovery when treated with Na3Co(NO2)6	275
Dog	NaCN + Na2S203	sc	18	Survived	276
"	NaCN + Na2S406	"	18	"	276

TABLE XIV-7 (CONTINUED)

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF CYANIDE SALTS

Animal	Compounds Given	Route*	Dose (mg/kg)	Responses	Reference
Dog	NaCN + $Na_2S_2O_3$	"	18.4	LD50	99
"	NaCN + amyl nitrite	"	24.5	"	99
"	NaCN + $NaNO_2$	"	24	Survived	276
"	"	"	27.1	LD50	99
"	NaCN + methylene blue + $Na_2S_4O_6$	"	36	Survived	276
"	NaCN + amyl nitrite + $Na_2S_2O_3$	"	60	"	276
"	"	"	60.9	LD50	99
"	NaCN + $NaNO_2$ + $Na_2S_4O_6$	"	78	Survived	276
"	NaCN + $NaNO_2$ + $Na_2S_2O_3$	"	96.7	LD50	99
"	"	"	120	Survived	276
Monkey	NaCN	iv	0.8	Altered ECG patterns, similar to those seen in humans	269
"	KCN	sc	2-35 mg/ animal	Increased respiration, vomiting, bowel movement, twitch, tremor of head, nystagmus, and leg spasms at lower doses; transitory leg paralysis, blindness, convulsions, and death at higher doses	271

TABLE XIV-7 (CONTINUED)

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF CYANIDE SALTS

Animal	Compound Given	Route*	Dose (mg/kg)	Responses	Reference
Mouse	KCN + HgC12	iv?	0.005 as CN 0.0005 as Hg	No changes	277
"	KCN	"	0.25 as CN	Rise in reticulocytes in 3rd and 4th mon of 5-mon experiment; 50% inhibition of blood catalase; changes in reflex activity	277
"	KCN + HgC12	"	0.25 as CN 0.05 as Hg	Rise in reticulocytes in 3rd and 4th mon of a 5-mon experiment; 50% inhibition of blood catalase changes in reflex-arc activity.	277
"	KCN	Oral (in drinking water)	0.5 mg/ml	Inhibition of liver catalase	278
"	"	Intraneural injection	0.6-4.0 μ g into one nerve bundle	Morphologic changes to nerve tissue visible under electron microscopy	279
"	"	iv?	3.2-3.4 as CN	4/30 dead within a few hours	277
"	KCN + HgC12	"	3.2-3.4 as CN 30-35 as Hg	9/30 dead within a few hours	277
"	KCN	ip	5	70-72% inhibition of liver cytochrome oxidase	57
"	"	"	5	40-50% inhibition of spleen cytochrome oxidase	57
"	"	"	5.5-8	Death; mortality decreased by iv injection of hydroxocobalamin	280

TABLE XIV-7 (CONTINUED)

PHYSIOLOGIC RESPONSES OF ANIMALS TO VARIOUS CONCENTRATIONS OF CYANIDE SALTS

Animal	Compound Given	Route*	Dose (mg/kg)	Responses	Reference
Mouse	KCN	Oral	8.5	LD50	281
"	"	"	10.8	"	282
"	"	sc	12.0	"	283
"	"	Oral	15.8	"	282
Pigeon	NaCN with and without various antidotes	iv	Various multiples of LD50?	1-6 times LD50 (3 mg/kg) survived with methemoglobin-producing agents	284
Rabbit	KCN	sc	1-3.3	Increased red cell count and hemoglobin values	285
"	"	im	1.23 as CN	LD50 males	134,
			1.31 as CN	LD50 females	135,136
"	"	sc	1-3.3	Increased tolerance with dosing	285
"	"	im	8	All dead; increased cyanide concentration in blood and nerve tissue	134,135, 136
Rat	KCN	Oral (in drinking water)	1 mg/ml	Reduced clearance of inhaled labled Fe203 after 5 mon of CN in water	286
"	"	ip	2	Reversible changes in ultra-structure of heart muscle	287
"	KCN + NaNO2 + Na2S203	sc	3-14	Cerebral changes in 10% of animals can be produced by SCN	288
"	KCN	ip	8	70-75% inhibition of liver cytochrome oxidase	57
"	NaCN	"	5	Rapid respiratory stimulation followed by agitation, incoordination, convulsions, and cessation of breathing	289
"	"	"	5	53% inhibition of brain cytochrome oxidase	289

TABLE XIV-7 (CONTINUED)

PHYSIOLOGIC RESPONSE OF ANIMALS TO VARIOUS CONCENTRATIONS OF CYANIDE SALTS

Animal	Compound Given	Route*	Dose (mg/kg)	Response	Reference
Rat	NaCN	sc	8	Comatose with seizures within 15 min; some died	290
"	KCN	ip	10	Death within 5-15 min	287
"	NaCN	sc	83.3 mg/kg/day	Retarded growth rate in growing rats. (Quantification of dose is suspect)	138
"	NaCN + $NaNO_2$	iv or im	6	Survived	284
"	KCN	Oral	15	19/20, 15/20, 7/20 deaths with solution volumes corresponding to 5%, 2.5%, and 1.25% of bodyweight, respectively	282
"	NaCN	sc	8 incremented to cumulative dose of 104.6 over 3 mon	10/12 dead; survivors blind and ataxic with necrotic callosal and optic nerve lesions	290
"	"	"	4 incremented to cumulative dose of 222.9 over 3 mon	72/104 dead; 42/104 dead within 3 weeks; survivors blind and ataxic with callosal and optic nerve lesions	290
"	"	"	8 incremented to cumulative dose of 291.6 over 3 mon	77/92 dead; 65/92 dead within 3 weeks. Survivors blind and ataxic with callosal and optic nerve lesions	290

* Key to abbreviations:
iv - intravenous injection
sc - subcutaneous injection
im - intramuscular injection
ip - intraperitoneal injection

TABLE XIV-8
HYDROGEN CYANIDE STANDARDS IN FORCE

Country	Standard			Reference
	mg/cu m	ppm	Type*	
USA 1) Federal Standard	11	10	TWA	29 CFR 1910.1000
2) ACGIH TLV	11	10	"	291
Bulgaria	0.3	--	Ceiling	292
Czechoslovakia	3	2.7	TWA	262
	15	13.5	Ceiling	262
Finland	11	10	"	292
Germany Federal Republic	11	10	TWA	262
Germany Democratic Republic	5	--	Ceiling	262
Great Britain	11	10	"	262
Hungary	0.3	--	"	292
Japan	11	10	"	292
Poland	0.3	--	"	292
Romania	0.3	--	"	292
UAR	--	10	"	292
USSR	0.3	--	"	292
Yugoslavia	11	10	"	292
USA - Florida	--	10	"	292
- Hawaii	--	20	"	292
- Massachusetts	--	10	"	292
- Mississippi	--	10	"	292
- Pennsylvania	--	10	TWA	292
- Pennsylvania (short)	--	20	30-min ceiling	292
- South Carolina	--	10	Ceiling	292

*Those specified as only MAC are assumed to be ceiling values.

TABLE XIV-9

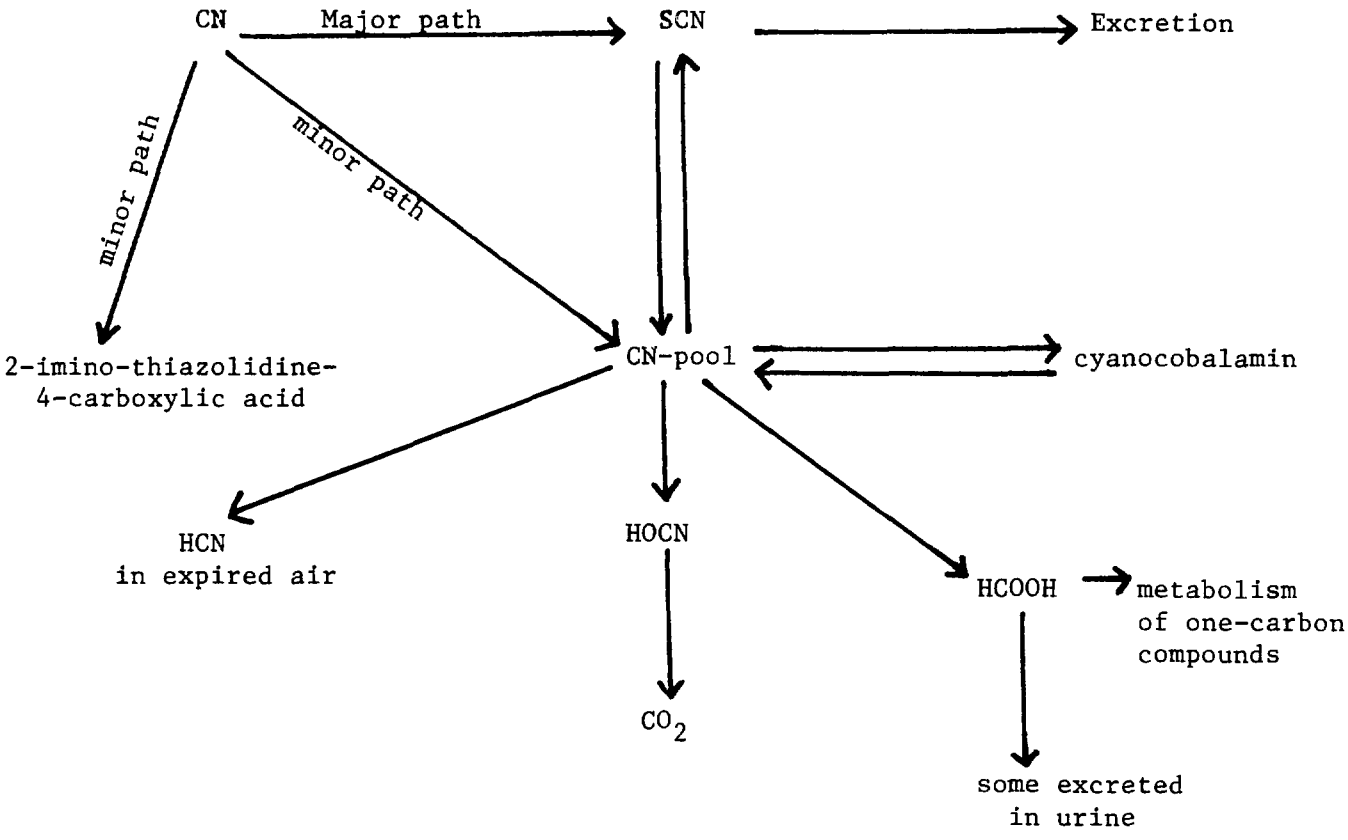
INORGANIC CYANIDE STANDARDS IN FORCE

Country	Standard mg/cu m	Type*	Reference
USA 1) Federal Standard	5	TWA	29 CFR 1910.1000
2) ACGIH TLV	5	"	291
Bulgaria	0.3	Ceiling	292
Czechoslovakia	3	TWA	262
	15	Ceiling	262
Finland	7	"	292
Federal Republic of Germany	5	TWA	292
Hungary	0.3	Ceiling	292
Poland	0.3	"	292
Romania	0.3	"	292
USSR	0.3	"	292
Yugoslavia	5	"	292
USA - Florida	5	"	292
- Massachusetts	5	"	292
- Mississippi	5	"	292
- Pennsylvania	5	TWA	292
- " (Short time limit)	5	30-min Ceiling	292
- South Carolina	5	Ceiling	292

*Those specified as only MAC are assumed to be ceiling values.

FIGURE XIV-1

CYANIDE METABOLISM



Adapted from references 66, 67

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