DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998

CF98-1-12

June 18, 1998

Office of the Secretary
Consumer Product Safety Commission
Room 502
4330 East-West Highway
Bethesda, Maryland 20814

Dear Sir//Madam:

The National Institute for Occupational Safety and Health (NIOSH) has reviewed the Consumer Product Safety Commission (CPSC) notice of public hearing and request for comments on flame retardant chemicals that may be suitable for use in upholstered furniture [63 FR 13017], including the list of 16 flame retardant chemicals published by CPSC. As requested in the *Federal Register* notice, we are submitting the enclosed data that addresses two areas of interest to CPSC:

II. Toxicity, and IV. Occupational Issues. This data was gathered by NIOSH technical information specialists through searching the following databases:

1. National Toxicology Program (NTP)
2. Registry of Toxic Effects of Chemical Substances (RTECS)
3. Hazardous Substances Database (HSDB)
4. Integrated Risk Information System (IRIS)
5. Coast Guard Hazardous Review Information System (CHRIS)
6. NIOSH Pocket Guide
7. New Jersey Hazardous Substance Fact Sheets
8. Meditext
9. Hazardtext
10. Toxline

In addition, enclosed is a tabulation of exposure limits from the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), and NIOSH for these 16 chemicals, also requested in the *Federal*

Register notice. We hope this information is useful to CPSC in determining whether to propose a standard to address the hazard associated with small open flame ignitions of upholstered furniture.

If you have any questions, please call me at 513/533-8302.

Sincerely yours,

Paul A. Schulte, Ph.D.
Director
Education and Information Division

2 Enclosures

EXPOSURE LIMITS

	FR Chemical/CAS #	NIOSH	OSHA	ACGIH	Other
1	Decabromodiphenyl oxide 1163-19-5	No	No	No	NTP Technical Report #309
2	Hexabromocyclododecane 3194-55-6	No	No	No	
3	Pyrovatex™ 20120-33-6	No	No	No	
4	Urea 57-13-6	No	No	No	
5	Phenyl Isopropylated Phosphate 68937-41-7	No	No	No	
6	Triphenyl Phosphate 115-86-6	3mg/m^3	3mg/m^3	3mg/m^3 A4 Not Classifiable as a Human Carcinogen	
7	Melamine 108-78-1	No	No	No	
8	Proban 115-93-5	No	No	No	
9	Ammonium Polyphosphate 68333-79-9	No	No	No	
10	Tetrakis (hydroxymethyl) Phosphonium Salt - Urea Polymer 27104-30-9 (also 124-64-1)	No	No	No	NTP Technical Report #296
11	Boric Acid 10043-35-3	No	No	No	• NTP Technical Report #324 • 1982 Nordic Expert Group Criteria Document
12	Ammonium Bromide 12124-97-9	No	No	No	
13	Antimony Trioxide 1309-64-4	No	No	Production is classified A2 Suspected Human Carcinogen	
14	Fyrol FR-2 13674-87-8	No	No	No	
15	Fyrol PCF 6145-73-9	No	No	No	
16	Ammonium Sulfamate 7773-06-0	• 5 mg/m^3 respirable dust • 10 mg/m^3 total dust	• 5 mg/m^3 respirable dust • 15 mg/m^3 total dust	10 mg/m^3	

Phenol, isopropylated, phosphate (3:1)

RTECS - Registry of Toxic Effects of Chemical Substances

1.0 SUBSTANCE IDENTIFICATION

RTECS Number: SL5980000
Chemical Name: Phenol, isopropylated, phosphate (3:1)
CAS Number: 68937-41-7
Last Revision Date: 1997

2.0 SYNONYM(S)/TRADENAME(S)

1 Durad 100
2 Durad MP280(sup R) hydraulic fluid
3 Duran MP280(sup R)

3.0 HEALTH HAZARD DATA

ACUTE TOXICITY

OTHER LD/LC - OTHER LETHAL DOSE/CONC

Rat

LC - ROUTE: Inhalation; **DOSE:** >6350 mg/m3/4H *CODEN: ATDAEI Bibliographic Data: Acute Toxicity Data. Journal of the American College of Toxicology, Part B. (Mary Ann Liebert, Inc., 1651 Third Ave., New York, NY 10128) V.1- 1990- CODEN Reference: 1:209,1992*

LD - ROUTE: Intraperitoneal; **DOSE:** >5 gm/kg *CODEN: ATDAEI Bibliographic Data: Acute Toxicity Data. Journal of the American College of Toxicology, Part B. (Mary Ann Liebert, Inc., 1651 Third Ave., New York, NY 10128) V.1- 1990- CODEN Reference: 1:209,1992*

LD - ROUTE: Oral; **DOSE:** >5 gm/kg *CODEN: ATDAEI Bibliographic Data: Acute Toxicity Data. Journal of the American College of Toxicology, Part B. (Mary Ann Liebert, Inc., 1651 Third Ave., New York, NY 10128) V.1- 1990- CODEN Reference: 1:209,1992*

Rabbit

LD - ROUTE: Skin; **DOSE:** >2 gm/kg *CODEN: ATDAEI Bibliographic Data: Acute Toxicity Data. Journal of the American College of Toxicology, Part B. (Mary Ann Liebert, Inc., 1651 Third Ave., New York, NY 10128) V.1- 1990- CODEN Reference: 1:209,1992*

5.0 NIOSH DOCUMENTS

National Occupational Exposure Survey 1983: Hazard Code X9028; Number of Industries 28; Total Number of Facilities 1573; Number of Occupations 34; Total Number of Employees 46945; Total Number of Female Employees 14355

7.0 STATUS IN U.S.

1 EPA TSCA Section 8(b) CHEMICAL INVENTORY
2 EPA TSCA Section 8(d) unpublished health/safety studies
3 EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, SEPTEMBER 1997

Urea

RTECS - Registry of Toxic Effects of Chemical Substances

Document Outline

1.0 SUBSTANCE IDENTIFICATION
2.0 SYNONYM(S)/TRADENAME(S)
3.0 HEALTH HAZARD DATA
5.0 NIOSH DOCUMENTS
7.0 STATUS IN U.S.

1.0 SUBSTANCE IDENTIFICATION

RTECS Number: YR6250000
Chemical Name: Urea
CAS Number: 57-13-6
Molecular Formula: C-H4-N2-O
Molecular Weight: 60.07
Wiswesser Notation: ZVZ
Substance Investigated as: Tumorigen, Drug, Mutagen, Human Data, Primary Irritant, Reproductive Effector
Last Revision Date: 1997

2.0 SYNONYM(S)/TRADENAME(S)

1 B-I-K
2 Carbamide
3 Carbamide resin
4 Carbamimidic acid
5 Carbonyl diamide
6 Carbonyldiamine
7 Harnstoff (German)
8 Isourea
9 Mocovina (Czech)
10 NCI-C02119
11 Prespersion, 75 urea
12 Pseudourea
13 Supercel 3000
14 Ureaphil
15 Ureophil
16 Urevert
17 Varioform II

3.0 HEALTH HAZARD DATA

ACUTE TOXICITY

LDLO/LCLO - LOWEST PUBLISHED LETHAL DOSE/CONC

Mouse

LDLo - ROUTE: Intraperitoneal; **DOSE:** 6608 mg/kg
TOXIC EFFECTS:
Behavioral - Convulsions or effect on seizure threshold
Behavioral - Coma

Rabbit

LDLo - ROUTE: Intravenous; **DOSE:** 4800 mg/kg
LDLo - ROUTE: Subcutaneous; **DOSE:** 3 gm/kg

Dog

LDLo - ROUTE: Intravenous; **DOSE:** 3 gm/kg
LDLo - ROUTE: Subcutaneous; **DOSE:** 3 gm/kg

Domestic Animals - Goat, Sheep

LDLo - ROUTE: Oral; **DOSE:** 511 mg/kg
TOXIC EFFECTS:
Behavioral - Tetany
Lung, Thorax, or Respiration - Dyspnea
Gastrointestinal - Changes in structure or function of salivary glands

Pigeon

LDLo - ROUTE: Subcutaneous; **DOSE:** 14800 mg/kg

Frog

LDLo - ROUTE: Subcutaneous; **DOSE:** 600 mg/kg

LD50/LC50 - LETHAL DOSE/CONC 50% KILL

Rat

LD50 - ROUTE: Intraperitoneal; **DOSE:** >5 gm/kg
LD50 - ROUTE: Intratracheal; **DOSE:** 567 mg/kg
TOXIC EFFECTS:
Behavioral - Convulsions or effect on seizure threshold
Lung, Thorax, or Respiration - Dyspnea
Blood - Methemoglobinemia-Carboxyhemoglobin
LD50 - ROUTE: Intravenous; **DOSE:** 5300 mg/kg
TOXIC EFFECTS:
Behavioral - Altered sleep time (including change in righting reflex)
Behavioral - Change in motor activity (specific assay)
Behavioral - Antipsychotic
LD50 - ROUTE: Oral; **DOSE:** 8471 mg/kg
LD50 - ROUTE: Subcutaneous; **DOSE:** 8200 mg/kg
TOXIC EFFECTS:
Behavioral - Altered sleep time (including change in righting reflex)
Behavioral - Change in motor activity (specific assay)
Behavioral - Antipsychotic

Mouse

LD50 - ROUTE: Intravenous; **DOSE:** 4600 mg/kg
TOXIC EFFECTS:
Behavioral - Altered sleep time (including change in righting reflex)
Behavioral - Change in motor activity (specific assay)
Behavioral - Antipsychotic
LD50 - ROUTE: Oral; **DOSE:** 11 gm/kg
LD50 - ROUTE: Subcutaneous; **DOSE:** 9200 mg/kg
TOXIC EFFECTS:
Behavioral - Altered sleep time (including change in righting reflex)
Behavioral - Change in motor activity (specific assay)
Behavioral - Antipsychotic

Behavioral - Antipsychotic

IRRITATION

SKIN - STANDARD DRAIZE TEST

Human

ROUTE: Skin; **DOSE:** 22 mg/3D intermittent; **REACTION:** Mild

REPRODUCTIVE EFFECTS

Woman

ROUTE: Intraplacental; **DOSE:** 1600 mg/kg; **DURATION:** female 16W of pregnancy
TOXIC EFFECTS:
Effects on Fertility - Abortion
ROUTE: Intraplacental; **DOSE:** 1600 mg/kg; **DURATION:** female 16W of pregnancy
TOXIC EFFECTS:
Effects on Fertility - Abortion
ROUTE: Intraplacental; **DOSE:** 1400 mg/kg; **DURATION:** female 16W of pregnancy
TOXIC EFFECTS:
Effects on Fertility - Abortion

Monkey

ROUTE: Intrauterine; **DOSE:** 6 gm/kg; **DURATION:** female 18W of pregnancy
TOXIC EFFECTS:
Effects on Fertility - Abortion

GENETIC EFFECTS

DNA DAMAGE

Mouse

CELL TYPE: lymphocyte; **DOSE:** 628 mmol/L

Hamster

CELL TYPE: fibroblast; **DOSE:** 8 mol/L

DNA INHIBITION

Human

CELL TYPE: lymphocyte; **DOSE:** 600 mmol/L

MUTATIONS IN MAMMALIAN SOMATIC CELLS

Mouse

CELL TYPE: lymphocyte; **DOSE:** 265 mmol/L

CYTOGENETIC ANALYSIS

Human

CELL TYPE: leukocyte; **DOSE:** 50 mmol/L

Mouse

ROUTE: oral; **DOSE:** 100 gm/kg/5D continuous

Hamster

CELL TYPE: fibroblast; **DOSE:** 16 gm/L/24H
CELL TYPE: lung; **DOSE:** 13 gm/L

TUMORIGENIC EFFECTS

Rat

ROUTE: Oral; **DOSE:** 821 gm/kg/1Y continuous
TOXIC EFFECTS:
Tumorigenic - Neoplastic by RTECS criteria
Blood - Tumors
Blood - Lymphomas including Hodgkin's disease

Mouse

ROUTE: Oral; **DOSE:** 394 gm/kg/1Y continuous
TOXIC EFFECTS:
Tumorigenic - Carcinogenic by RTECS criteria
Blood - Tumors
Blood - Lymphomas including Hodgkin's disease

OTHER MULTIPLE DOSE TOXICITY DATA

Rat

ROUTE: Inhalation; **DOSE:** 288 mg/m3/17W intermittent
TOXIC EFFECTS:
Kidney, Ureter, and Bladder - Other changes in urine composition
Blood - Other changes
Nutritional and Gross Metabolic - CI
ROUTE: Skin; **DOSE:** 37800 mg/kg/25W continuous
TOXIC EFFECTS:
Brain and Coverings - Changes in brain weight
Others - Changes in prostate weight
ROUTE: Skin; **DOSE:** 3024 mg/kg/4W continuous
TOXIC EFFECTS:
Liver - Changes in liver weight
Endocrine - Changes in thymus weight
Others - Changes in testicular weight

5.0 NIOSH DOCUMENTS

1 National Occupational Exposure Survey 1983: Hazard Code 80231; Number of Industries 204; Total Number of Facilities 31269; Number of Occupations 164; Total Number of Employees 783504; Total Number of Female Employees 326824
2 National Occupational Exposure Survey 1983: Hazard Code X7915; Number of Industries 1; Total Number of Facilities 9; Number of Occupations 1; Total Number of Employees 63; Total Number of Female Employees 9
3 National Occupational Hazard Survey 1974: Hazard Code 80231; Number of Industries 156; Total Number of Facilities 22367; Number of Occupations 119; Total Number of Employees 284911

7.0 STATUS IN U.S.

1 EPA GENETOX PROGRAM 1988, Inconclusive: E coli polA without S9
2 EPA GENETOX PROGRAM 1988, Negative: Sperm morphology-mouse
3 EPA GENETOX PROGRAM 1988, Positive: In vitro cytogenetics-human lymphocyte
4 EPA TSCA Section 8(b) CHEMICAL INVENTORY
5 EPA TSCA Section 8(d) unpublished health/safety studies
6 EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, SEPTEMBER 1997

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6

UREA

CHRIS - Chemical Hazard Response Information System

OVERVIEW

Material name:

UREA
CHRIS Code URE

Common synonyms:

Carbamide
Carbonyldiamide

Characteristics:

Solid crystals or pellets White Odorless
Sinks and mixes with water.

Emergency actions:

Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire:

Combustible.
Extinguish with water.

Exposure:

Not harmful.

Water pollution:

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

RESPONSE TO DISCHARGE

Disperse and flush

LABEL

Category: None
Class: Not pertinent

CHEMICAL DESIGNATIONS

CG compatibility class: Not listed
Formula: NH(2)CONH(2)
IMO/UN designation: Not listed
DOT id no.: Data not available
CAS registry no.: 57-13-6

OBSERVABLE CHARACTERISTICS

Physical state: Solid
Color: White
Odor: Odorless, or slight ammonia odor

HEALTH HAZARDS

Personal protective equipment: Goggles or face shield; dust mask.
Symptoms following exposure: May irritate eyes.
Treatment of exposure: Wash eyes with water.
Threshold limit value: Data not available
Short term inhalation limits: Not pertinent
Toxicity by ingestion: Data not available
Late toxicity: None
Vapor (gas) irritant characteristics: Non-volatile
Liquid or solid irritant characteristics: None
Odor threshold: Not pertinent
IDLH value: Data not available

FIRE HAZARDS

Flash point: Not flammable
Flammable limits in air: Not flammable
Fire extinguishing agents: Water
Fire extinguishing agents NOT to be used: Not pertinent
Special hazards of combustion products: Not pertinent
Behavior in fire: Melts and decomposes, generating ammonia.
Ignition temperature: Not flammable
Electrical hazard: Not pertinent
Burning rate: Not flammable
Adiabatic flame temperature: Data not available
Stoichiometric air to fuel ratio: Data not available
Flame temperature: Data not available

CHEMICAL REACTIVITY

Reactivity with water: No reaction
Reactivity with common materials: No reaction
Stability during transport: Occurs only above melting point (132 degrees C), yielding ammonia and other products. The decomposition is not explosive.
Neutralizing agents for acids and caustics: Not pertinent
Polymerization: Not pertinent
Inhibitor of polymerization: Not pertinent
Molar ratio (reactant to product): Data not available
Reactivity group: Data not available

WATER POLLUTION

WATER POLLUTION

Aquatic toxicity: 30,000 mg/l/24 hr/creek chub/all died/fresh water 16,000 mg/l/24 hr/creek chub/all survived/fresh water
Waterfowl toxicity: Data not available
Biological oxygen demand (BOD): 9%, 5 days
Food chain concentration potential: None

SHIPPING INFORMATION

Grades of purity: Various grades and purities, which depend on manufacturing process and intended use. All have essentially the same hazardous properties.
Storage temperature: Ambient
Inert atmosphere: No requirement
Venting: Open

HAZARD CLASSIFICATIONS

Code of federal regulations: Not listed

NAS hazard rating for bulk water transportation: Not listed

NFPA hazard classification: Not listed

PHYSICAL AND CHEMICAL PROPERTIES

Physical state at 15 degrees C. and 1 ATM: Solid
Molecular weight: 60.06
Boiling point at 1 ATM: Decomposes
Freezing point: 271 degrees F = 133 degrees C = 406 degrees K
Critical temperature: Not pertinent
Critical pressure: Not pertinent
Specific gravity: 1.34 at 20 degrees C (solid)
Liquid surface tension: Not pertinent
Liquid water interfacial tension: Not pertinent
Vapor (gas) specific gravity: Not pertinent
Ratio of specific heats of vapor (gas): Not pertinent
Latent heat of vaporization: Not pertinent
Heat of combustion: -3913 Btu/lb = -2174 cal/g = -91.02 X 10(5) J/kg
Heat of decomposition: Not pertinent
Heat of solution: -108 Btu/lb = -60.1 cal/g = -2.52 X 10(5) J/kg
Heat of polymerization: Not pertinent
Heat of fusion: Data not available
Limiting value: Data not available
REID vapor pressure: Data not available

UREA

OHM/TADS - Oil and Hazardous Materials/Technical Assistance Data System

SUBSTANCES INCLUDED

Material name: UREA
Synonyms: CARBAMIDE CARBONYLDIAMIDE
CAS number: 57-13-6
Chemical formula: NH2CONH2
SIC CODE: 2871; 3872; 3255; 2621; 2833; 2052; 2042; 2821; 2833; 2844
Tradename(s):

Production sites: SOLAR NITROGEN CO., INC., SAVANNAH, GA; AMERICAN CYANAMID CO., FORTIER, LA; ARMOUR AGRICULTURAL CHEMICAL CO., SHEFFIELD, AL; COLLIER CARBON AND CHEMICAL CORP., BREA, CA; COLUMBIA NITROGEN CORP., AUGUSTA, GA; COOPERATIVE FARM CHEMICALS ASSOC., LAWRENCE, KS; JOHN DEERE CHEMICAL CO., PRYOR, OK; E.I. DU PONT DE NEMOURS AND CO., INC., BELLE, WV; ESCAMBIA CHEMICAL CORP., PENSACOLA, FL; FARMERS CHEMICAL ASSOCIATION, INC., CHATTANOOGA, TN; FEL-TX, INC., FREMONT, NEB. GRACE, W.R., AND CO., MEMPHIS, TN; HAWKEYE CHEMICAL CO., CLINTON, IA; SPENCER CHEMICAL CO., VICKSBURG, MS; KETONA KETONA CHEMICAL CORP., KETONA, AL; LONE STAR PRODUCING CO., KERENS, TX; SUN OIL CHEMICAL CO., NORTH CLAYMONT, DE; MONSANTO CO., EL DORADO, AR; NITRIN INC., CORDOVA, IL; OLIN MATHIESON CHEMICAL CORP., LAKE CHARLES, LA; PHILLIPS PACIFIC CHEMICAL CO., KENNEWICK, WA; PREMIER PETROCHEMICAL CO., PASADENA, TX; SHELL CHEMICAL CO., VENTURA, CA; MISSISSIPPI CHEMICAL CORP., YAZOO CITY, MS; PASCAGOULA, MS; HERCULES POWDER CO., INC., HERCULES, CA; LOUISIANA, MO; BIRMINGHAM, AL; ALLIED CHEMICAL CORP. NITROGEN DIVISION SOUTH POINT, OH; LA PLATTE, NE.

Species in mixture: 45-46% UREA

COMMON USES

FERTILIZE 2819, PLASTICS, PAPER, HOSPITALS, VETERINARY, BAKERIES, ANIMAL FEED, RESINS, BARBITURIC ACID, TOOTHPASTE

TRANSPORT/STORAGE/HANDLING

Transport:

Rail(%): 58.7
Barge(%): 13.2
Truck(%): 24.7

Storage:

Containers: 80, 100 LB BAGS; 100, 225 LB DRUMS; SOLUTION IN TANK CARS AND TRUCKS.

LABORATORY

Field detection limits (ppm): 10, UREAS SPOT TEST, (BNW 420299)
Laboratory detection limits (ppm): .02, C7C, (BNW 220200)

PHYSICOCHEMICAL PARAMETERS

Physical parameters:

Location/state of material: COLORLESS CRYSTALS OR SOLUTION. WILL DISSOLVE.

Color in water: COLORLESS

Color in water: COLORLESS
Melting point (degrees C): 132.7
Specific gravity: 1.335

Chemical parameters:

Solubility (ppm 25 degrees C): 1000000
Reactivity:
Binary reactants: HYPOCHLORITES

FIRE/EXPLOSION/CORROSION HAZARDS

Fire hazard:
Standard codes: NFPA - 0,-,-; CFR-NONE; USCG-NONE.
Toxic combustion products: NO GREAT HAZARD
Personnel protection: IF INTENSE HEAT PREVAILS, WEAR CANISTER MASK.

ENVIRONMENTAL HAZARDS

Pollution hazard:

Water pollution:
Persistency: WILL RELEASE NH3 AND EVENTUALLY DEGRADE TO NITRATE
Water uses threatened: FISHERIES
Air pollution: NONE

Aquatic toxicity:

Freshwater toxicity text (Conc. in ppm):

Conc.	Expos (Hr)	Specie	Effect	Test Environment
17.1(MG/L)	24	MINNOWS	NOT NOTICEABLE	STABLIZED TOP WATER
30,000 MG/L	24	CREEK CHUB	ALL DIED	WELL-AERATED WATER
16,000 MG/L	24	CREEK CHUB	ALL SURVIVED	WELL-AERATED WATER

Toxicity to animals:

Animal toxicity text (Value in mg of material/kg body wt):

Value	Time	Species	Param.	Route
> 5000		MAMMALS	LD50	ORL
12,000		RAT	NO DEATH	ORL

RANGE OF TOXICITY

General sensation: DEVELOPS AMMONIA ODOR. COOLING SALINE TASTE.

HUMAN HEALTH HAZARDS

Acute hazard level: CAN ACT AS SOURCE OF NH3 WHICH WILL BECOME A TOXIC HAZARD TO FISH.

Chronic hazard level: RAT 50 MG/KG NO EFFECT . CAN ACT AS NITROGEN SOURCE AND THUS SPONSOR EUTROPHICATION.
Public health hazard: NO REAL HAZARD. MAY EMIT SLIGHTLY TOXIC VAPORS WHEN HEATED TO DECOMPOSITION.
Action levels: ISOLATE FROM HEAT
Mutagenicity: TESTS ON BACILLUS SUBTILIS WERE NEGATIVE.

CLEANUP PROCEDURES

In situ amelioration: CARBON WILL BE MOST EFFECTIVE. SEEK PROFESSIONAL ENVIRONMENTAL ENGINEERING ASSISTANCE THROUGH EPA'S ENVIRONMENTAL RESPONSE TEAM (ERT), EDISON, NJ, 24-HOUR NO. 201-321-6660.
Beach/shore restoration: DO NOT BURN
Countermeasure material availability: CARBON - WATER TREATMENT PLANTS, SUGAR REFINERIES
Disposal method(s): DUMP INTO LANDFILL OR RELEASE TO AIR
Disposal notification(s): LOCAL SOLID WASTE OR AIR AUTHORITY

DATA ADEQUACY EVALUATION

FAIR

UREA

HSDB - Hazardous Substances Data Bank

0.0 ADMINISTRATIVE INFORMATION

Hazardous Substances Data Bank Number: 163
Last Revision Date: 970917
Review Date: Reviewed by SRP on 1/10/93
Update History:

1 Complete Update on 09/17/97, 1 field added/edited/deleted.
2 Complete Update on 03/27/97, 1 field added/edited/deleted.
3 Complete Update on 03/11/97, 3 fields added/edited/deleted.
4 Complete Update on 02/26/97, 1 field added/edited/deleted.
5 Complete Update on 01/09/97, 1 field added/edited/deleted.
6 Complete Update on 10/12/96, 1 field added/edited/deleted.
7 Complete Update on 01/18/96, 1 field added/edited/deleted.
8 Complete Update on 03/09/95, 1 field added/edited/deleted.
9 Complete Update on 12/19/94, 1 field added/edited/deleted.
10 Complete Update on 06/08/94, 1 field added/edited/deleted.
11 Complete Update on 11/01/93, 1 field added/edited/deleted.
12 Complete Update on 04/30/93, 1 field added/edited/deleted.
13 Complete Update on 01/19/93, 23 fields added/edited/deleted.
14 Field update on 12/11/92, 1 field added/edited/deleted.
15 Complete Update on 10/27/92, 68 fields added/edited/deleted.
16 Complete Update on 08/17/92, 12 fields added/edited/deleted.
17 Field Update on 05/29/92, 1 field added/edited/deleted.
18 Complete Update on 05/07/91, 11 fields added/edited/deleted.
19 Field Update on 05/14/90, 1 field added/edited/deleted.
20 Field Update on 05/04/90, 1 field added/edited/deleted.
21 Complete Update on 10/14/86

1.0 SUBSTANCE IDENTIFICATION

Name of Substance: UREA
CAS Registry Number: 57-13-6
Synonyms:

1 AQUADRATE [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*
2 CARBAMIDE [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 2713*
3 CARBONYLDIAMIDE [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*
4 Carbonyl diamide [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.1 (1985)*
5 Carbonyldiamine [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 2713*
6 NCI-C02119 [Peer Reviewed] *U.S. Department of Health, Education & Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety & Health. Registryof Toxic Effects of Chemical Substances. 1977 edition. Washington, D. C.: U.S. Government Prin*
7 PRESPERSION, 75 UREA [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989*

7
Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553

8 UREOPHIL [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

9 UREVERT [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

10 Ureacin-10 lotion [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. V-691*

11 Ureacin-20 [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. V-691*

12 Ureacin-40 Creme [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. V-691*

13 AI3-01202 [Peer Reviewed]

14 Alphadrate [Peer Reviewed]

15 Aqua Care [Peer Reviewed]

16 Aqua Care HP [Peer Reviewed]

17 B-I-K [Peer Reviewed]

18 CARBAMIDE RESIN [Peer Reviewed]

19 CARBAMIMIDIC ACID [Peer Reviewed]

20 Carbaderm [Peer Reviewed]

21 Caswell No. 902 [Peer Reviewed]

22 EPA Pesticide Chemical Code 085702 [Peer Reviewed]

23 ISOUREA [Peer Reviewed]

24 Keratinamin [Peer Reviewed]

25 Mocovina (Czech) [Peer Reviewed]

26 PSEUDOUREA [Peer Reviewed]

27 UR [Peer Reviewed]

28 Ultra Mide [Peer Reviewed]

29 Urea ammonium nitrate solution [Peer Reviewed]

30 Urea-13C [Peer Reviewed]

31 Ureaphil [Peer Reviewed]

32 Urepearl [Peer Reviewed]

33 Varioform II [Peer Reviewed]

Molecular Formula: C-H4-N2-O [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*
Wiswesser Line Notation: ZVZ [Peer Reviewed] *U. S. Department of Health, Education, & Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety & Health. Registry of Toxic Effects ofChemical Substances. 1976 edition. Washington, DC: U.S. Government Print*
RTECS Number: NIOSH/YR6250000
OHM-TADS Number: 7216943

2.0 MANUFACTURING/USE INFORMATION

Methods of Manufacturing:

1 DEHYDRATION OF AMMONIUM CARBONATE WHICH IS SYNTHESIZED FROM AMMONIA AND CARBON DIOXIDE. [Peer Reviewed] *SRI*

2 ... FROM AMMONIA, CARBON MONOXIDE & SULFUR IN METHANOL. [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

3 LIQ AMMONIA & LIQ CARBON DIOXIDE @ 1750-3000 PSI & 160-200 DEG C REACT TO FORM AMMONIUM CARBAMATE, NH4CO2NH2, WHICH DECOMP @ LOWER PRESSURE (ABOUT 80 PSI) TO UREA & WATER. METHOD OF PURIFICATION: CRYSTALLIZATION. [Peer Reviewed] *Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1209*

Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1209

Impurities:

1 Cyanates are present as an impurity /American Research Products Co/ [Peer Reviewed] *CHEMCYCLOPEDIA 1986 p.207*

2 0.3-2.0 wt% of biuret is typically present in solid urea [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V23 573 (1983)*

Formulations/Preparations:

1 DOSAGE FORMS--STERILE USP: 40 & 90 G. [Peer Reviewed] *Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 864*

2 Ultrahigh purity grades; solutions at 5M /American Research Products Co/ [Peer Reviewed] *CHEMCYCLOPEDIA 1986 p.207*

3 ACS & USP grades /Heico Chemicals Div, Whittaker Corp./ [Peer Reviewed] *CHEMCYCLOPEDIA 1986 p.207*

4 Solid and liquid complex forms [Peer Reviewed] *FARM CHEM HDBK 1986 p.B65*

5 Urea-Ammonium Nitrate Liquor typically contains 6% urea [Peer Reviewed] *FARM CHEM HDBK 1986 p.B65*

6 UAL-37 contains 35% urea [Peer Reviewed] *FARM CHEM HDBK 1986 p.B65*

7 N-Dure contains 26% urea [Peer Reviewed] *FARM CHEM HDBK 1986 p.B66*

8 UF Concentrate-85 contains 26% urea [Peer Reviewed] *FARM CHEM HDBK 1986 p.B66*

9 Urea is pelletized or prilled to avoid caking and to make it easy to handle. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V2 442 (1978)*

10 Available as commercial, technical and fertilizer grade [Peer Reviewed] *CHEMICAL PRODUCTS SYNOPSIS: Urea, 1980*

11 A normal epoxy-amine ratio for epoxy-urea resins is 70:30 [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V9 285 (1980)*

12 Ureacin-20 Creme contains urea at 20%; Ureacin-40 Creme contains urea at 40%; Ureacin-10 lotion contains urea at 10%. [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. V-691*

Manufacturers:

1 Agricultural Minerals Corp, Hq, 5100 E Skelly Drive, Suite 800, Tulsa, OK 74135-6549, (918) 660-0050, (800) 523-9083; Production site: Blytheville, AK 72319; Verdigris, OK 74015 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1045*

2 Air Products and Chemicals, Inc, Hq, 7201 Hamilton Blvd, Allentown, PA 18195-1501, (215) 481-4911; Chemicals Group (800) 345-3148; Industrial Chemicals Division; Production site: Pace, FL 32571 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1045*

3 American Cyanamid Company, Hq, One Cyanamid Plaza, Wayne, NJ 07470, (201) 831-2000; Chemical Products Division; Production site: Fortier Plant, Avondale, LA 70094 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1045*

4 Arcadian Corp, Hq, 6750 Poplar Avenue, Suite 600, Memphis, TN 38138-7419, (901) 758-5200; Production sites: Augusta, GA 30903; Clinton, IA 52732; Geismar, LA 70734; Lake Charles, LA 70602; La Platte, NE 68005; Memphis, TN 38127 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1045*

5 Borden Chemicals and Plastics Partnership, Hq, Highway 73, Geismar, LA 70734, (504) 387-5101; Production site: Geismar, LA 70734 [Peer Reviewed] *SRI. 1992 Directory of*

5
387-5101; Production site: Geismar, LA 70734 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1045*

6 BP America, Inc, Hq, 200 Public Sq, Cleveland, OH 44114-2375, (216) 586-4141; Subsidiary: BP Chemicals America, Inc; Production site: Lima, OH 45802 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

7 CF Industries, Inc, Hq, Salem Lake Dr, Long Grove, IL 60047, (312) 438-9500; Production site: Donaldsonville, LA 70346 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

8 Chevron Corporation, Hq, 225 Bush St, San Francisco, CA 94104, (415) 894-7700; Subsidiarie: Chevron Chemical Company; Chevron Fertilizer Division, 6001 Bolinger Canyon Rd, San Ramon, CA 94583-0947; Production site: St Helens, OR 97051 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

9 The Coastal Corp, Hq, Coastal Tower, 9 Greenway Plaza, Houston, TX 77046-0995, (713) 877-1400; Subsidiary: Coastal Chem, Inc; Productions site: Cheyeme, WY 82003 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

10 Cominco American Inc, Hq, 601 West Riverside, Spokane, WA 99201, (509) 747-6111; Cominco Fertilizers Division; Production site: Borger, TX 79008 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

11 Farmland Industries, Inc, Hq, 3315 North Oak Trafficway, PO Box 7305, Kansas City, MO 64116, (816) 459-6000; Production sites: Beatrice, NE 68310; Dodge City, KS 67801; Enid, OK 73702; Lawrence, KS 66044 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

12 Freeport-McMoRan Resource Partners, Hq, 1615 Poydras, New Orleans, LA 70112, (504) 582-4000; Agrico Chemical Co, PO Box 60031; New Orleans, LA 70160; Production site: Donaldsonville, LA 70346 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

13 Inspiration Resources Corporation, Hq; Subsidiary: Terra International, Inc, Terra Centre, 600 Fourth St, Sioux City, IA 51101, (712) 277-1340; Production site: Sergeant Bluff, IA 51054 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

14 La Roche Holdings Inc, Hq, La Roche Industries, Inc, Perimeter 400 Center, 1100 Johnson Ferry Rd NE, Atlanta, GA 30342, (404) 851-0300; Production site: Cherokee, AL 35616 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

15 Mississippi Chemical Corporation, Hq, PO Box 388, Yazoo City, MS 39194, (601) 746-4131; Production site: Yazoo City, MS 39194 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

16 Nitrogen Products, Inc, Hq, PO Box 825, Helena, AR 72342, (501) 338-9111; Production site: Helena, AR 72342 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

17 Triad Chemical, Hq, PO Box 388, Yazoo City, MS 39194, (601) 746-4131; Production site: Donaldsonville, LA 70346 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

18 Unocal Corp, Hq, 1201 West Fifth St, PO Box 7600, Los Angeles, CA 90051, (213) 977-7600; Unocal Minerals and Chemicals Division; Agricultural Products Group; Production site: Kenai, AK 99611 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

19 The Vigoro Corporation, Hq, 225 N Michigan Ave, Suite 2416, Chicago, IL 60601, (312) 819-2020; Phoenix Chemical Company, 11675 Highway 20 West, PO Box 229, East Dubuque, IL 61025-0229; Production site: East Dubuque, IL 61025-0229 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI*

International, 1992. 1046

20 Willard Feed and Grain, Hq, Route 2, Box 41, Celina, TX 75009, (214) 382-2367; Wil-Gro Fertilizer, Inc, division, Pryor, OK 74362 [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

21 Columbia Nitrogen Corporatin, Hq, PO Box 1483, Augusta, GA 30903, (404) 823-4300 [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

22 Mississippi Chemical Corporation, Hq, PO Box 388, Yazoo City, MS 39194, (601) 746-4131 [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

23 Olin Corporation, Hq, 120 Long Ridge Road, Stanford, CT 06904, (203) 354-2000 [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

24 JR Simplot Company, Hq, PO Box 912, Pocatello, ID 83204, (208) 336-2110 [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

25 Triad Chemical, Hq, PO box 310, Donaldsonville, LA 70346, (504) 473-9231 [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

26 Tennessee Valley Authority, Hq, Muscle Shoals, AL 35660, (205) 386-3521; Division of Developmental Production [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

27 Union Oil Company of California, 1201 W Fifth Street, Los Angeles, Ca 90017, (213) 977-5131 [Peer Reviewed] *United States International Trade Commission. Synthetic Organic Chemicals-United States Production and Sales, 1989. USITC Publication 2338, 1990. Washington, DC:United States International Trade Commission, 1990.,p. 14-10*

Other Manufacturing Information:

1 OCCURS IN URINE & OTHER BODY FLUIDS. FIRST ORG CMPD TO BE SYNTHESIZED ... [Peer Reviewed] *Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1209*

2 PURE UREA SHOULD NOT GIVE THE BIURET REACTION UNLESS HEATED ABOVE MELTING POINT. IN PRACTICE ALL REAGENT GRADE UREA GIVES POSITIVE BIURET REACTION. [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

3 ALTHOUGH UREA ... HAS BEEN EMPLOYED IN THE PAST AS ORAL DIURETICS FOR TREATMENT OF CHRONIC EDEMA ... IT HAS BEEN REPLACED BY SUPERIOR AGENTS. [Peer Reviewed] *Goodman, L.S., and A. Gilman. (eds.) The Pharmacological Basis of Therapeutics. 5th ed. New York: Macmillan Publishing Co., Inc., 1975. 821*

4 UREA, THE DIAMIDE OF CARBONIC ACID, IS MOST IMPORTANT DEGRADATION OF PROTEIN CATABOLISM IN MAN, IN OTHER MAMMALS & IN CERTAIN OTHER ANIMAL SPECIES. UREA IS FORMED IN LIVER & FORMS THE MAJOR PART OF ORGANICS IN URINE. [Peer Reviewed] *Bergmeyer, H.W. (ed.). Methods of Enzymatic Analysis. 2nd English ed. New York City: Academic Press, 1974. 1791*

5 Sodium hydrogen zirconium phosphate is an ion exchange material used in portable kidney dialysis systems ... which picks up urea during dialysis. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V24 771 (1986)*

Major Uses:

1 MFR OF RESINS & PLASTICS; CONDENSED WITH MALONIC ESTER TO FORM BARBITURIC ACID; CELLULOSE SOFTENER; IN AMMONIATED DENTIFRICES. [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

2 CHEMICAL INTERMEDIATE; STABILIZER IN EXPLOSIVES; IN MEDICINE (DIURETIC); SEPARATION OF HYDROCARBONS; SULFAMIC ACID PRODUCTION; FLAMEPROOFING AGENTS. [Peer Reviewed] *Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1209*

3 LIQUID & OTHER FERTILIZER APPLICATIONS; LIVESTOCK NUTRIENT; MONOMER FOR UREA-FORMALDEHYDE RESINS; CHEMICAL INTERMEDIATE FOR MELAMINE [Peer Reviewed] *SRI*

4 Incorporation of high concentrations of urea > 300 g/l in a print paste greatly accelerates the fixation of low molecular weight dyes on wool. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V24 612 (1984)*

5 45% urea solutions are used in dentifrices [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V7 522 (1979)*

6 Urea is dehydrated and condensed to produce melamine [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V7 303 (1979)*

7 Urea is a decomposition inhibitor for ammonium perchlorate [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V5 650 (1979)*

8 Urea is reacted with alcohols to form alkylcarbamates [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V4 475 (1978)*

9 Urea is a building block for amino resins [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V2 442 (1978)*

10 Urea is reacted with fatty acids from coconut oil to produce amides in 90% yields [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V2 253 (1978)*

11 Urea is used with zinc formaldehyde sulfoxylate to remove permanent hair dye [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V12 109 (1980)*

12 Urea is reacted with alpha-diketones or dialdehydes to form hydantoins [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V12 702 (1980)*

13 Urea is used to partially reverse the methylolamine chain reaction in glue gellation processes [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V11 913 (1980)*

14 Urea and phosphoric acid mixtures impart flame resistance to cotton fabrics [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V10 421 (1980)*

15 Concentrated urea solutions are used to promote the rate of reaction between reactive dyes and wools [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V8 387 (1979)*

16 Urea is used as a moisture resistant paper additive [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V16 791 (1981)*

17 Ammonolysis of urea and ammonium thiocyanate produces guanidine [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. S 519 (1984)*

John Wiley and Sons, 1978-1984.,p. S 519 (1984)

18 Urea is used as a deicing compound on airport runways [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. V21 219 (1983)*

19 Formulation and fermentation aid in yeast-raised bakery products, alcoholic beverages, and gelatin products. [Peer Reviewed] *21 CFR 184.1923 (4/1/91)*

20 Urea and other organic and inorganic sources of nitrogen such as biuret and ammonium phosphate are added to ruminant rations as a source of nonprotein nitrogen. However, urea is the most widely used. It is also used as a fertilizer and a substitute for salts in melting of snow and ice in residential areas. [Peer Reviewed] *Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames, Iowa: Iowa State University Press, 1982. 1029*

21 UREA HAS BEEN USED AS AN INSECT (MOSQUITO) REPELLENT. [QC Reviewed] *HILL JA ET AL; MOSQ NEWS 39 (2): 307-310 (1979)*

22 MEDICATION [QC Reviewed]

Consumption Patterns:

1 37% AS A LIQUID FERTILIZER; 24% FOR OTHER FERTILIZER USES; 22% AS A LIVESTOCK NUTRIENT; 17% FOR RESINS AND OTHER INDUSTRIAL USES (1973) [Peer Reviewed] *SRI*

2 Fertilizer, solid, 39%; Fertilizer solutions, 32%; Exports, 19%; Urea-formaldehyde resins and adhesives, 6%; Others, including animal feeds and melamine, 4% (1985) [Peer Reviewed] *CHEMICAL PROFILE: Urea, 1985*

3 CHEMICAL PROFILE: Urea. Fertilizer, solid, 42%; fertilizer solutions, 31%; exports, 13%; urea-formaldehyde resins and adhesives, 5%; other, including animal feeds and melamine, 9%. [Peer Reviewed] *Kavaler AR; Chemical Marketing Reporter 234 (13): 54 (1988)*

4 CHEMICAL PROFILE: Urea. Demand: July 1987-June 1988: 7.46 million tons; 1988-1989: 8.17 million tons; 1992-1993 /projected/: 8.5 million tons per year. (Includes exports, but not imports, which totaled 2.1 million tons in 1987-1988.) [Peer Reviewed] *Kavaler AR; Chemical Marketing Reporter 234 (13): 54 (1988)*

U.S. Production:

1 (1972) 3.2X10+12 G [Peer Reviewed] *SRI*

2 (1975)3.8X10+9 G (EST) [Peer Reviewed] *SRI*

3 (1985) 5.95X10+12 g [Peer Reviewed] *Chem Eng News 64(23): 35 (1986)*

4 (1990) 16.24 billion lb [Peer Reviewed] *Chem Eng News 70 (15): 17 (4/13/92)*

5 (1991) 16.27 billion lb [Peer Reviewed] *Chem Eng News 71 (15): 11 (4/12/93)*

6 (1991) 6.972X10+6 metric tons [Peer Reviewed] *SRI. 1992 Directory of Chemical Producers-United States of America. Menlo Park, CA: SRI International, 1992. 1046*

7 (1992) 17.96 billion lb [Peer Reviewed] *Chem & Engineering News 72 (15): 13 (4/11/94)*

8 (1993) 15.66 billion lb [Peer Reviewed] *Chem & Engineering News 72 (15): 13 (4/11/94)*

U.S. Imports:

1 (1975) 6.6X10+8 G [Peer Reviewed] *SRI*

2 (1972) 5.1X10+11 G [Peer Reviewed] *SRI*

3 (1984) 2.0X10+10 G [Peer Reviewed] *BUREAU OF THE CENSUS. U.S. IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1984 p.1-387*

U.S. Exports:

1 (1975) 6.5X10+8 G [Peer Reviewed] *SRI*

2 (1972) 4.5X10+11 G [Peer Reviewed] *SRI*

3 (1984) 1.11X10+13 G [Peer Reviewed] *BUREAU OF THE CENSUS. U.S. EXPORTS, SCHEDULE E, 1984 p.2-117*

3.0 CHEMICAL AND PHYSICAL PROPERTIES

3.0 CHEMICAL AND PHYSICAL PROPERTIES

Color/Form:

1 WHITE CRYSTALS [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 2713*

2 TETRAGONAL PRISMS [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

3 COLORLESS TO WHITE, PRISMATIC CRYSTALS OR WHITE CRYSTALLINE POWDER [Peer Reviewed] *Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 864*

Odor: ALMOST ODORLESS; MAY GRADUALLY DEVELOP SLIGHT ODOR OF AMMONIA, ESP IN PRESENCE OF MOISTURE [Peer Reviewed] *Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 864*

Taste:

1 Detection by taste of urea in water is as follows: 1.20 x 10-1 m/l (purity not specified); Taste values of chemically pure urea: 2.51 x 10-1 moles/liter, 3.16 x 10-1 moles/liter, 3.98 x 10-1 moles/liter, 3.63 x 10-1 moles/liter, 5.01 x 10-1 moles/liter. [Peer Reviewed] *ASTM; Compilation of Odor and Taste Threshold Values Data p.162 (1978)*

2 COOLING, SALINE TASTE [Peer Reviewed] *Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 864*

Melting Point: 132.70 deg C [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

Molecular Weight: 60.06 [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

Density/Specific Gravity: 1.3230 @ 20 DEG C/4 DEG C [Peer Reviewed] *Lide, D.R. (ed). CRC Handbook of Chemistry and Physics. 72nd ed. Boca Raton, FL: CRC Press, 1991-1992.,p. 3-509*

Dissociation Constants: PKA: 0.1 @ 21 DEG C [Peer Reviewed] *Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 864*

Octanol/Water Partition Coefficient: log Kow = -2.11 [QC Reviewed] *Hansch, C., Leo, A., D. Hoekman. Exploring QSAR - Hydrophobic, Electronic, and Steric Constants. Washington, DC: American Chemical Society., 1995. 3*

pH: 7.2 (10% solution) [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.4 (1985)*

Solubilities:

1 1 G DISSOLVES IN 1 ML WATER, 10 ML 95% ALC, 6 ML METHANOL, 1 ML BOILING 95% ALC, 20 ML ABS ALC, 2 ML GLYCEROL; ALMOST INSOL IN CHLOROFORM, ETHER; SOL IN CONCN HCL [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

2 INSOL IN BENZENE; SOL IN ACETIC ACID [Peer Reviewed] *Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. C-536*

3 Sol in pyrimidine [Peer Reviewed] *Lide, D.R. (ed). CRC Handbook of Chemistry and Physics. 72nd ed. Boca Raton, FL: CRC Press, 1991-1992.,p. 3-509*

Spectral Properties:

1 MAX ABSORPTION (SODIUM HYDROXIDE): BELOW 220 NM; SADTLER REF NUMBER: 447 (IR, PRISM) [Peer Reviewed] *Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. C-536*

2 IR: 123 (Sadtler Research Laboratories IR Grating Collection) [Peer Reviewed] *Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V2 415*

3 UV: 1-3 (Organic Electronic Spectral Data, Phillips et al, John Wiley & Sons, New York) [Peer Reviewed] *Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds.*

3 Reviewed] *Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V2 415*

4 NMR: 16982 (Sadtler Research Laboratories Spectral Collection) [Peer Reviewed] *Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V2 415*

5 MASS: 7 (Aldermaston, Eight Peak Index of Mass Spectra, UK) [Peer Reviewed] *Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V2 415*

Vapor Pressure: 1.2X10-5 mm Hg at 25 deg (est) [Peer Reviewed] *SRC; Jones AH; J Chem Eng Data 5: 196-200 (1960)*

Viscosity: 1.78 mPas 46% solution at 20 deg C; 1.81 mPas at 137 deg C; 1.90 mPas (saturated solution at 20 deg C) [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.3 (1985)*

Other Chemical/Physical Properties:

1 ON FURTHER HEATING IT DECOMP TO BIURET, NH3, CYANURIC ACID; PH OF 10% WATER SOLN: 7.2; DENSITY OF WATER SOLN (WT/WT): 1.027 @ 10%; 1.054 @ 20%; 1.145 @ 50% [Peer Reviewed] *Budavari, S. (ed.). The Merck Index - Encyclopedia of Chemicals, Drugs and Biologicals. Rahway, NJ: Merck and Co., Inc., 1989. 1553*

2 ON STANDING OR ON HEATING, DECOMP INTO NH3 AND CO2 [Peer Reviewed] *Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 864*

3 Ionization potential: 9 ev [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.4 (1985)*

4 Latent heat of fusion: 15.1 kJ/mole (at melting point) [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.4 (1985)*

5 Latent heat of sublimation: 87.9 kJ/mole at 25 deg C [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.4 (1985)*

6 Heat of formation: -333.7 kJ/mole at 25 deg C [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.4 (1985)*

7 Decomposition temperature 135 deg C [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.3 (1985)*

8 Boiling point: urea decomposes before boiling. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.1 (1985)*

9 The possibility of improving the dissolution of chlorthalidone (Hygroton) via solid dispersion techniques was investigated by means of phase diagrams. Physical mixtures and melts of various compositions of chlorthalidone and urea were prepared. Substantial increases in dissolution rate were found for molten discs and compressed molten discs with a chlorthalidone concn of 35% w/w, as compared to physical mixtures. Urea generally enhanced dissolution in all forms. Thermodynamic parameters of the interaction between chlorthalidone and urea are also reported. [Peer Reviewed] *Bloch DW et al; Drugs Made Ger 25: 231-235 (1982)*

10 The effect of urea (1), thiourea (2), niacinamide (3), succinamide (4), succinimide sodium (5), saccharin sodium (6), caffeine citrate (7), ... caffeine (8) on the solubility of hydrochlorothiazide and chlorothiazide in water was studied with the exception of (4), all of the tested compounds increased the solubility of both diuretics. Solubility in (5), (6), (7), and (8) was better than in (1), (2), or (3). ... [Peer Reviewed] *Ammar HO et al; Pharm Ind 43 (3): 292-295 (1981)*

11 1.73 kPa at 20 deg C; 5.33 kPa at 40 deg C (saturated solutions in water) [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.4 (1985)*

12 Henry's Law constant: 1.74X10-12 atm cu m/mole (est) [Peer Reviewed] *SRC;; Lyman WJ et al; Handbook of Chemical Property Estimation Methods Washington, DC: Amer Chem Soc pp. 15-15 to 15-29 (1990)*

4.0 SAFETY AND HANDLING

FLAMMABLE PROPERTIES

Fire Potential:

NONCOMBUSTIBLE [Peer Reviewed] *Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1209*

HAZARDOUS REACTIONS

Reactivities and Incompatibilities:

1 REACTS VIOLENTLY WITH GALLIUM PERCHLORATE. [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 5th ed. New York: Van Nostrand Rheinhold, 1979. 467*

2 ... Urea ... /is/ excreted in human urine, react /s/ with chlorine to form chloramines. [Peer Reviewed] *Seiler, H.G., H. Sigel and A. Sigel (eds.). Handbook on the Toxicity of Inorganic Compounds. New York, NY: Marcel Dekker, Inc. 1988. 229*

Decomposition:

When heated to decomposition it emits toxic fumes of nitrogen oxides. [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 2713*

WARNING PROPERTIES

Skin, Eye and Respiratory Irritations:

Urea causes redness and irritation of skin and eyes. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.2 (1985)*

PREVENTIVE MEASURES

Other Preventative Measures:

SRP: The scientific literature for the use of contact lenses inindustry is conflicting. The benefit or detrimental effects of wearing contact lenses depend not only upon the substance, but also on factors including the form of the substance, characteristics and duration of the exposure, the uses of other eye protection equipment, and the hygiene of the lenses. However, there may be individual substances whose irritating or corrosive properties are such that the wearing of contact lenses would be harmful to the eye. In those specific cases, contact lenses should not beworn. In any event, the usual eye protection equipment should be worn even when contact lenses are in place. [Peer Reviewed]

OTHER SAFETY AND HANDLING

Cleanup Methods:

1 Water Spill: Contain by damming, water diversion or natural barriers. Remove and treat contaminated liquids. Absorb small amounts of liquid spill with natural or synthetic sorbents, shovel into containers and cover. [Peer Reviewed] *Environment Canada; Tech Info for*

shovel into containers and cover. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.2 (1985)*

2 If urea is spilled in solid form, shovel material into containers and cover. Construct barriers to contain solutions or divert to impermeable holding area. Remove material by manual or mechanical means. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.1 (1985)*

Disposal Methods:

1 Urea is a waste chemical stream constituent which may be subjected to ultimate disposal by controlled incineration. Incinerator is equipped with a scrubber or thermal unit to reduce nitrogen oxide emissions. [Peer Reviewed] *USEPA; Engineering Handbook for Hazardous Waste Incineration p.2-10 (1981) EPA 68-03-3025*

2 The following wastewater treatment technology has been investigated for urea: Concentration process: Biological treatment. [Peer Reviewed] *USEPA; Management of Hazardous Waste Leachate, EPA Contract No.68-03-2766 p.E-36 (1982)*

5.0 TOXICITY/BIOMEDICAL EFFECTS

SUMMARY

Antidote and Emergency Treatment:

1 This should involve the use of weak acid as a chemical antidote, demulcents and stimulants. ... Recommended 2.5-5 l of 5% acetic acid as an effective antidote to urea poisoning in cattle. ... /It was/ also shown that weak acids such as acetic and propionic acid offer some protection against the harmful effects of urea. Drenching with acetic acid those animals showing signs of intoxication does not lower their blood ammonia concentration within 120 minutes ... . However, administration of 2 mol of acetic acid per mol of urea at 15 minutes, and 1 mol per mol 180 minutes after giving 0.44 g/kg body weight of urea ... resulted in the survival of 28 of 29 pregnant cows ... . Emptying the rumen of fistulated cattle showing clinical signs of poisoning results in a rapid fall in their blood ammonia concentration and recovery within one to two hours ... . [Peer Reviewed] *Humphreys, D.J. Veterinary Toxicology. 3rd ed. London, England: Bailliere Tindell, 1988. 18*

2 In animals that are not too ill, the cold water acetic acid treatment may work. the adult cow is given 19-38 liters cold water and 3.8 liters 5% acetic acid (or vinegar) orally. This treatment limits absorption of ammonia from the rumen by diluting the rumen contents and slowing the rate of hydrolysis of urea by decreasing rumen pH and temperature. The treatment also promotes urine flow that, if maintained by fluid therapy, may assure recovery from urea toxicosis. Gaseous or fluid bloat should be relieved before pumping water into the rumen. [Peer Reviewed] *Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames, Iowa: Iowa State University Press, 1982. 1033*

3 This involves chemical examination of the suspect fertilizer, feed or rumen contents. In most cases of urea poisoning the ammonial level in the rumen contents will be greater than 80 mg/100 ml (47 mmol/l) and may be as high as 200 mg/100 ml (117 mmol/l). It should be remembered that rumen contents should be examined quickly after death or kept frozen until they can be analysed. The reason for this is that microbial decomposition can produce ammonia and thus lead to misleading results. The possible uneven distribution of the causal agent in feed and rumen contents must be borne in mind when collecting samples for chemical examination. Blood and serum ammonia nitrogen concentrations between 2 and 4 mg/100 ml (1.17 and 2.35 mmol/l) or greater which are associated with urea poisoning may also have diagnostic applications. [Peer Reviewed] *Humphreys, D.J. Veterinary Toxicology. 3rd ed. London, England: Bailliere Tindell, 1988. 18*

TOXICITY EXCERPTS

Human Toxicity Excerpts:

1 ADVERSE REACTIONS INCLUDE HEADACHE, NAUSEA, VOMITING, SYNCOPE, DISORIENTATION, TRANSIENT CONFUSION, & ELECTROLYTE DEPLETION (HYPONATREMIA & HYPOKALEMIA). [Peer Reviewed] *GENNARO. REMINGTON'S PHARM SCI 17TH ED 1985 p 935*

2 BECAUSE THE EYE IS PERMEABLE TO UREA, REBOUND ELEVATION IN INTRAOCULAR PRESSURE & VITREOUS VOL MAY OCCUR AFTER OCULAR HYPOTENSIVE EFFECT HAS TERMINATED (ABOUT 8 TO 12 HR AFTER ADMIN). [Peer Reviewed] *American Medical Association, AMA Department of Drugs, AMA Drug Evaluations. 3rd ed. Littleton, Massachusetts: PSG Publishing Co., Inc., 1977. 936*

3 THE SYSTEMIC TOXICITY OF UREA IS SIMILAR TO THAT OF MANNITOL. UREA IS IRRITATING TO TISSUES; IT CAUSES PAIN AT SITE OF INFUSION & NECROSIS MAY RESULT IF EXTRAVASATION OCCURS. SUPERFICIAL & DEEP THROMBOSIS MAY RESULT IF UREA IS INFUSED IN VEINS OF LOWER EXTREMITIES. [Peer Reviewed] *American Medical Association, AMA Department of Drugs, AMA Drug Evaluations. 3rd ed. Littleton, Massachusetts: PSG Publishing Co., Inc., 1977. 936*

Non-Human Toxicity Excerpts:

1 INTRAVITREAL INJECTION OF 0.2 ML OF 10 MOLAR /SOLN INTO VITREOUS HUMOR OF/ RABBITS HAS CAUSED INFLAMMATION, CHORIORETINITIS, & DEGENERATION OF RETINA. [Peer Reviewed] *Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 965*

2 UREA MIXED WITH SOYA MEAL IS PARTICULARLY DANGEROUS, AS UREASE IN LATTER LEADS TO FORMATION OF AMMONIA ... POISONING OF CATTLE MAY ALSO BE CAUSED BY UREA AS FERTILIZER & SPREAD UNEVENLY ON PASTURE [Peer Reviewed] *Clarke, E.G., and M. L. Clarke. Veterinary Toxicology. Baltimore, Maryland: The Williams and Wilkins Company, 1975. 30*

3 LAMBS GIVEN 2 G/KG OF UREA DIED IN 90-200 MIN. ADULT SHEEP GIVEN SAME DOSE EXHIBITED ALMOST CONTINUOUS CONVULSIONS AFTER 165 MIN ... SHEEP CAN CONSUME UP TO 100 G OF UREA A DAY PROVIDED THAT CONCN OF UREA IN RATION DOES NOT EXCEED 6% ... LIVER DYSFUNCTION INCR SUSCEPTIBILITY TO POISONING. [Peer Reviewed] *Clarke, E.G., and M. L. Clarke. Veterinary Toxicology. Baltimore, Maryland: The Williams and Wilkins Company, 1975. 30*

4 ... ORAL ADMIN OF 50 G OF UREA KILLED 4 OUT OF 5 GOATS WITHIN 30 MIN, 450 G GIVEN BY MOUTH KILLED 7 PONIES OUT OF 8 ... [Peer Reviewed] *Clarke, E.G., and M. L. Clarke. Veterinary Toxicology. Baltimore, Maryland: The Williams and Wilkins Company, 1975. 30*

5 TOXIC DOSE IN CATTLE GIVEN UREA FOR FIRST TIME IS VARIOUSLY CONSIDERED TO BE 0.45 G/KG ... OR TOTAL OF 100-200 G ... SLOWLY INCR UREA CONTENT OF FEED, MATURE BULLOCKS CAN DIGEST AS MUCH AS 400 G A DAY WITHOUT ILL EFFECT. AS LITTLE AS 50 G MAY CAUSE POISONING IN CATTLE NOT ACCUSTOMED TO IT ... . [Peer Reviewed] *Clarke, E.G., and M. L. Clarke. Veterinary Toxicology. Baltimore, Maryland: The Williams and Wilkins Company, 1975. 30*

6 Urea was tested for mutagenicity in the Salmonella/microsome preincubation assay using the standard protocol approved by the National Toxicology Program. Urea was tested at doses of 0.10, 0.33, 1.0, 3.3, and 10 mg/plate in as many as 5 Salmonella typhimurium strains (TA1535, TA1537, TA97, TA98, and TA100) in the presence and absence of rat or hamster liver S-9. Urea was negative in these tests and the highest ineffective dose tested in any Salmonella typhimurium strain was 10 mg/plate. [Peer Reviewed] *Mortelmans K et al; Environ Mutagen 8:1-119 (1986)*

7 Single doses of 16 g/kg body weight and 10% of urea in the feed has been reported to have no apparent effect on ten week old piglets ... . Although the highest level made the feed unpalatable, incorporation of 0.4, 0.6 or 1.0 g of urea per kg body weight into the ration of 18 month old pigs weighing 120-140 kg also failed to produce intoxication ... . [Peer Reviewed]

month old pigs weighing 120-140 kg also failed to produce intoxication ... . [Peer Reviewed] *Humphreys, D.J. Veterinary Toxicology. 3rd ed. London, England: Bailliere Tindell, 1988. 17*

8 Administration of 450 g of urea, which caused the death of seven of eight ponies, resulted in an increase in blood urea, ammonia, alphaketoglutarate, glucose and pyruvate concentrations. The sequence and nature of the changes produced suggested that inhibition of alphaketoglutarate decarboxylation may be the primary site of ammonia intoxication. [Peer Reviewed] *Humphreys, D.J. Veterinary Toxicology. 3rd ed. London, England: Bailliere Tindell, 1988. 17*

9 Urea poisoning has been reported in sheep which drank a 21% solution used as a fertilizer for cotton ... and in those consuming treated rations ... . Sheep grazing pastures low in protein are particularly susceptible to urea poisoning ... . The short term feeding of protein concentrates before giving urea supplements can increase sheep's tolerance to urea ... . Experimental administration of 0.5 g/kg of urea has been shown to cause intoxication in the heaviest, while 0.8 g/kg resulted in poisoning in all the treated sheep ... . Urea poisoning in sheep is associated with an elevated blood ammonia concentration, increased erythrocyte counts and packed cell volume values, and decreased leucocyte counts ... . Detailed clinical biochemical studies on experimental urea poisoned sheep have been reported ... . The blood ammonia concentration of the fetus in fatally poisoned sheep is lower than that of the dam at death, and the ammonia concentrations in their livers, kidneys, spleen and muscles are similarly different. [Peer Reviewed] *Humphreys, D.J. Veterinary Toxicology. 3rd ed. London, England: Bailliere Tindell, 1988. 17*

10 On rabbit eyes saturated urea solution causes loss of epithelium from the cornea after five minutes contact, and produces moderate grayness of the stroma, with subsequent slow regeneration of the epithelium. A rabbit's cornea can return to normal in several weeks after exposure for an hour to 40% urea solution. [Peer Reviewed] *Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 965*

11 Intravenous urea in monkeys has not damaged the ciliary epithelium, supporting a belief that reduction of intraocular pressure in glaucomatous patients is accomplished by an osmotic, rather than a toxic mechanism. However, intracarotid injection of concentrated urea in monkeys has done dramatic damage to the retina and the ciliary body. Retinal pigment epithelial cells are affected and blood-retina barrier broken down. The blood-aqueous barrier is broken down secondary to changes in the capillaries and selective damage to the ciliary body epithelium. Intraocular pressure is strikingly reduced and the aqueous outflow system rapidly shows swelling of the connective tissue of the inner wall of Schlemm's canal, and then edema of the trabecular meshwork. However, in several weeks there is general return to normal, except for failure of pigmented ciliary epithelium to regenerate. [Peer Reviewed] *Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 965*

12 Serine-specific reagents, anticholinesterase organophosphorus compounds like VX provoke, in the micromolar range, digitalis-like ventricular arrhythmias of non-cholinergic origin in rodent hearts. The sensitivities of the two rat cardiac sodium + or - potassium ATPase isoforms (alpha 1 and alpha 2) to VX (0.1-100 uM) were measured in sarcolemma vesicles. At 1 microM VX, the inhibition of the total activity averaged 18% but never exceeded 75% with 100 uM. When the alpha 2 isoform activity was inhibited by 0.1 uM ouabain, alpha 1 was 35% inhibited by 1 uM VX, i.e. a 16 + or - 4% inhibition of the total activity The cardiac alpha 1 being related to the digitalis-induced toxicity, its selective inhibition by a micromolar dose of VX fully accounts for the cardiotoxicity of VX. Inasmuch as VX had no effect on the rat kidney alpha 1, differentially inactivated the cardiac isozymes and specifically reacted with serine residues, the putative binding-site(s) of the organophosphorus compound on the sodium + or - potassium ATPase molecules has been indicated. [Peer Reviewed] *Robineau P et al; FEBS Lett 281 (1-2): 145-8 (1991)*

13 Accidental urea intoxication resulted in the death of 17 of 29 suckler cows within six hours after the contamination of their drinking water with urea fertiliser. The other cows showed no lasting ill effects and neither their three-month-old calves nor the stock bull were affected. The urea concentration in the water was 86 mmol/litre, and the concentrations of ammonia nitrogen in the rumen fluid of two of the cows which were examined after death were 1825

nitrogen in the rumen fluid of two of the cows which were examined after death were 1825 and 957 mg/litre. [Peer Reviewed] *Caldow GL, Wain EB; Vet Rec 128 (21): 489-91 (1991)*

TOXICITY VALUES

Human Toxicity Values:

Human, skin 22 mg/3 days intermittent, toxic effects: mild irritation [Peer Reviewed] *NIOSH; Current Awareness Listing (1985)*

Non-Human Toxicity Values:

1 LD100 Sheep 500 mg/l; mean survival time: 165 minutes [Peer Reviewed] *Edjtehad; M et al; Canadian J Comp Med 64 (1): 63-68 (1978) as cited in Environment Canada; Tech Info for Problem Spills: Urea p.46 (1985)*

2 LD50 Sheep acute oral 28.5 g/100 kg [Peer Reviewed] *Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames, Iowa: Iowa State University Press, 1982. 1029*

Ecotoxicity Values:

1 Toxicity threshold: Scenedesmus quadricauda (green algae) >10,000 mg/l, toxic effect: multiplication inhibition of cell. /Time not specified/ [Peer Reviewed] *Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1179*

2 Toxicity threshold: Entosiphon sulcatum (protozoa) >29 mg/l, toxic effect: inhibition of cell multiplication. /Time not specified/ [Peer Reviewed] *Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1179*

3 Toxicity threshold: Pseudomonas putida >10,000 mg/l; toxic effect: inhibition of cell multiplication. /Time not specified/ [Peer Reviewed] *Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1178*

PHARMACOKINETICS

Absorption, Distribution and Excretion:

1 SOME SMALL, WATER SOL, BUT NONIONIZABLE COMPD SUCH AS UREA READILY TRAVERSE MAMMALIAN MEMBRANES, PROBABLY ALONG WITH WATER, BY WAY OF THE PORES. THIS FILTRATION PROCESS IS PARTICULARLY RAPID BETWEEN CAPILLARIES & EXTRACELLULAR FLUID. [Peer Reviewed] *Hayes, W. J., Jr. Toxicology of Pesticides Baltimore: Williams & Wilkins, 1975. 130*

2 ... UREA ... PENETRATES OTHER CELLS RAPIDLY, ENTERS THE BRAIN ONLY VERY SLOWLY ... [Peer Reviewed] *LaDu, B.N., H.G. Mandel, and E.L. Way. Fundamentals of Drug Metabolism and Disposition. Baltimore: Williams and Wilkins, 1971. 51*

3 ... DISTRIBUTED APPROX IN TOTAL BODY WATER ... HAVE BEEN USED FOR MEASUREMENT OF TOTAL BODY WATER. [Peer Reviewed] *LaDu, B.N., H.G. Mandel, and E.L. Way. Fundamentals of Drug Metabolism and Disposition. Baltimore: Williams and Wilkins, 1971. 53*

4 EXCRETION OF UREA DURING SWEATING IN MAN: 1.84 SWEAT/PLASMA RATIO WITH PKA @ 13.8. /FROM TABLE/ [Peer Reviewed] *LaDu, B.N., H.G. Mandel, and E.L. Way. Fundamentals of Drug Metabolism and Disposition. Baltimore: Williams and Wilkins, 1971. 143*

5 Regional variations in the absorption of benzoic acid, cortisone, urea, and water in sections obtained from the back and abdominal skin of male and female Osborne-Mendel rats were

obtained from the back and abdominal skin of male and female Osborne-Mendel rats were determined using in vitro diffusion cell techniques. Skin permeability constants and lag times were determined for the substances. Benzoic acid was absorbed from a petrolatum vehicle, and the other compounds were applied to the skin samples in an aqueous solution. Differences in absorption were compared with skin thickness measurements. The mechanism of sex related permeability differences was studied in castrated rats with subsequent permeability and histological examination of the skin. Results showed a sex related difference in variation of absorption in the back and abdominal skin of both sexes. In general, female back skin was approximately twice as permeable as male back skin. Abdominal skin, particularly in the male rat, was more permeable than back skin. The male rat back stratum corneum was approximately twice as thick as that of the female, correlating with the observed permeability differences. Similar stratum corneum thicknesses were observed in the abdominal skin from both sexes. The back skin of castrated males was similar in permeability and thickness to that of the females. [Peer Reviewed] *Bronaugh RL et al; J Soc Cosmet Chem 34: 127-35 (1983)*

6 The maternal and newborn renal function in 84 normal pregnant women delivering at term was investigated. There was no difference between maternal and newborn plasma concentrations of urea (3.9 + or - 1.0 vs. 3.9 + or - 1.2 mmol/l) and creatinine (65.8 + or - 13.3 vs. 65.3 + or - 11.6 mumols/l). Newborn urea with maternal urea concentrations (p = 0.0001), and newborn creatinine with maternal creatinine concentrations (p = 0.0001). [Peer Reviewed] *Lao TT et al; Gynecol Obstet Invest 28 (2): 70-2 (1989)*

Mechanism of Action:

... The primary mechanism of ammonia toxicosis appears to be inhibition of the citric acid cycle. There is an increase in anaerobic glycolysis, blood glucose, and blood lactate ... . Acidosis is manifested. The exact means by which ammonia blocks the citric acid cycle is not known. It is postulated that ammonia saturation of the glutamine-synthesizing system causes a backing-up in the citrate cycle, a decrease in its intermediates, and a decrease in energy production and cellular respiration, which leads to convulsions ... . The decrease of citrate cycle intermediates is postulated to result from reamination of pyruvic, ketoglutaric, and oxaloacetic acids. [Peer Reviewed] *Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames, Iowa: Iowa State University Press, 1982. 1031*

Interactions:

1 A case of sudden collapse after the intra-amniotic injection of 5 mg dinoprostone (Prostaglandin E2) and 40 g urea for pregnancy termination in a 36 yr old woman after the diagnosis of fetal Down's syndrome is reported. Within one minute of injection of a test dose of one mg of dinoprostone, the patient collapsed. Intravenous injections of 100 mg hydrocortisone and 10 mg chlorpheniramine maleate were administered and the patient was given oxygen by a face mask. Within 10 minutes blood pressure had returned to 110/68 mm Hg, and after a further 15 minutes pulse rate was normal. [Peer Reviewed] *Cameron IT, Baird DT; Lancet 2: 1046-7 (1984)*

2 TREATMENT OF GUINEA PIGS WITH UREA INCR THE EFFECT OF THEIR SUBSEQUENT SENSITIZATION WITH EPOXY RESIN (EGK-19) OR K2CR207. UREA TREATMENT INCR PERCENTAGE OF ANIMALS SENSITIZED BY EPOXY RESINS FROM 50-87%. UREA ALONE DID NOT SENSITIZE SKIN. [Peer Reviewed] *ZIGLER F, ROETER A; DERMATOL VENEROL (SOFIA) 18 (1): 25-28 (1979)*

3 The hemolytic action on human red blood cells (RBC) and the aggregations of human and rat red blood cells in the presence of sodium alginate were studied. Sodium alginate had no hemolytic action on human red blood cells. Human and rat red blood cells showed a marked aggregation by sodium alginate in a neutral medium. Sodium alginates having larger molecular weights showed more pronounced activities for aggregation of red blood cells as compared with those having smaller molecular weights, and the aggregation of red blood cells increased with an increase in the concentration of sodium alginate. The aggregation was inhibited by urea, suggesting the aggregation of red blood cells is caused by hydrogen

was inhibited by urea, suggesting the aggregation of red blood cells is caused by hydrogen bonding. When sodium alginate was added to human or rat blood rouleaux formation of red blood cells covered with fibrin net was observed in the coagulation cruor (blood clot). [Peer Reviewed] *Daigo K et al; Yakugaku Zasshi 102 (6): 573-578 (1982)*

4 Osmotic diuretics (mannitol, urea) decrease the effect on serum lithium level; significant increase in lithium excretion. /Lithium-drug interactions; from table/ [Peer Reviewed] *Ellenhorn, M.J. and D.G. Barceloux. Medical Toxicology - Diagnosis and Treatment of Human Poisoning. New York, NY: Elsevier Science Publishing Co., Inc. 1988. 1043*

6.0 PHARMACOLOGY

Therapeutic Uses:

1 UREA IS /USED LESS COMMONLY THAN OTHER OSMOTIC AGENTS/ FOR THE SHORT-TERM REDUCTION OF INTRAOCULAR PRESSURE & VITREOUS VOL ... IN ANGLE-CLOSURE GLAUCOMA .. PRIOR TO SURGERY ... IN CHRONIC GLAUCOMA ... PRE- AND POSTOPERATIVE TREATMENT. [Peer Reviewed] *American Medical Association. AMA Drug Evaluations Annual 1991. Chicago, IL: American Medical Association, 1991. 1825*

2 DOSE--USUAL, IV INFUSION, 100 MG TO 1 G/KG DAILY, AS 30% SOLN IN DEXTROSE INJECTION @ RATE NOT EXCEEDING 4 ML/MIN. [Peer Reviewed] *GENNARO. REMINGTON'S PHARM SCI 17TH ED 1985 p 935*

3 USED TOPICALLY IN THE TREATMENT OF PSORIASIS, ICHTHYOSIS, ATOPIC DERMATITIS, AND OTHER DRY, SCALY CONDITIONS. [Peer Reviewed] *GENNARO. REMINGTON'S PHARM SCI 17TH ED 1985 p 785*

4 Experimental: A study was made in which 57 symmetrically affected psoriatic patients applied to their lesions on opposite sides either 0.1% dithranol (anthralin) /urea cream (Psordrate 0.1%) or 0.1% beta-methasone valerate (Betnovate). After six weeks the dithranol/ urea cream proved to be more effective. [Peer Reviewed] *Ferguson A, Maden CJ; Br J Clin Prac 36: 60-67 (1982)*

5 The efficacy of oral urea in producing a sufficiently high osmotic diuresis was studied in 7 patients with the syndrome of inappropriate secretion of antidiuretic hormone. In all patients, urea corrected the hyponatremia despite a normal fluid intake. Five patients were controlled with a dose of 30 g daily. The patients who needed 30 g drank up to 2 liters of fluid daily, while those who needed 60 g drank up to 3 liters/day. No major side effects were noted, even after treatment periods of up to 270 days. It was concluded that urea is a safe and efficacious treatment of the syndrome of inappropriate secretion of antidiuretic hormone. [Peer Reviewed] *Decaux G, Genette F; Br Med 283: 1081-1083 (1981)*

6 Experimental: Use of urea kinetics in the estimation of protein balance of nutritionally unstable renal failure patients, and for optimal management of nutrition therapy. [Peer Reviewed] *Bennett N; Nutr Support Serv 4: 21-25 (1984)*

7 Experimental: A number of studies evaluating an osmotic cervical dilator consisting of polyvinyl foam saturated with magnesium sulfate in women undergoing mid trimester abortion with intra-amniotic hyperosmolar urea plus prostaglandin F2A were completed. Comparisons with women receiving no pre-treatment with a laminaria tent or with one laminaria indicate that their use appears to shorten injection-abortion intervals, particularly in parous women, and reduce risk of endometritis and cervical laceration compared to women not receiving any type of device. The data suggests that two osmotic dilators may be more effective than one. Also, magnesium toxicity does not appear to be a substantial risk with their use. [Peer Reviewed] *Atienza MF et al; Contraception 30 (3): 215-223 (1984)*

8 EXPTL: REPORTED HELPFUL IN TREATING SICKLE-CELL CRISIS [Peer Reviewed] *Hawley, G.G. The Condensed Chemical Dictionary. 9th ed. New York: Van Nostrand Reinhold Co., 1977. 905*

9 In patients with squamous cell carcinoma of palpebral and bulbar conjunctiva, repeated applications of urea powder have been made to eradicate the malignant growth. [Peer Reviewed] *Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas*

Reviewed] *Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 965*

10 A sterile preparation of urea (UREAPHIL) is available that may be reconstituted for intravenous use. When administered in this manner, the solution contains 30% urea and either 5 or 10% dextrose or invert sugar (equal parts of dextrose and fructose). Intravenous doses of 1 to 1.5 g of urea per kilogram of body weight are optimal in preparation for neurosurgical procedures or for reduction of intraocular pressure. On a molar basis urea is less effective as a diuretic than is mannitol, since approximately 50% of the compound is reabsorbed from the tubular fluid. [Peer Reviewed] *Gilman, A.G., T.W. Rall, A.S. Nies and P. Taylor (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 8th ed. New York, NY. Pergamon Press, 1990. 715*

11 UREA HAS BEEN USED AS AN INSECT (MOSQUITO) REPELLENT. [QC Reviewed] *HILL JA ET AL; MOSQ NEWS 39 (2): 307-310 (1979)*

Minimum/Potential Fatal Human Dose:

In ruminants unaccustomed to urea, ingestion of 0.3-0.5 g urea/kg may be toxic ... The toxic dose of urea in (presumably unaccustomed) cattle is 0.45 g/kg (50 g total dose) but that animals can ingest more urea than this if the dose is increased gradually. [Peer Reviewed] *Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames, Iowa: Iowa State University Press, 1982. 1029*

Drug Warning:

1 UREA SHOULD NOT BE USED IN PATIENTS WITH SEVERELY IMPAIRED RENAL FUNCTION. [Peer Reviewed] *American Medical Association, AMA Department of Drugs, AMA Drug Evaluations. 3rd ed. Littleton, Massachusetts: PSG Publishing Co., Inc., 1977. 936*

2 UREA IS OFTEN RECONSTITUTED WITH INVERT SUGAR SOLN. INVERT SUGAR CONTAINS FRUCTOSE, WHICH CAN CAUSE SEVERE REACTION (HYPOGLYCEMIA, NAUSEA, VOMITING, TREMORS, COMA, & CONVULSIONS) IN PATIENTS WITH HEREDITARY FRUCTOSE INTOLERANCE (ALDOLASE DEFICIENCY). [Peer Reviewed] *American Medical Association, AMA Department of Drugs, AMA Drug Evaluations. 3rd ed. Littleton, Massachusetts: PSG Publishing Co., Inc., 1977. 936*

Drug Tolerance:

Many factors alter the toxicity of urea. Degree of adaptation is very important. Animals that are adapted to ingesting urea can tolerate 1 g urea/kg/day, but if they go off feed for a few days and then come back on full feed at the same rate of urea intake, toxicosis can result, since urea adaptation can wear off quickly. [Peer Reviewed] *Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames, Iowa: Iowa State University Press, 1982. 1029*

7.0 ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

SUMMARY

Environmental Fate/Exposure Summary:

Urea occurs naturally in urine and animal waste and can be formed naturally in the environment through protein metabolism. It is artificially released to the environment through direct application to soil as a nitrogen-release fertilizer. If released to the atmosphere, urea will degrade rapidly in the vapor-phase by reaction with photochemically produced hydroxyl radicals (half-life of 9.6 hr). If released to soil, urea is hydrolyzed to ammonium through soil urease activity (the basis of its use as a fertilizer). The rate of hydrolysis can be fast (24 hr); however, a number a variables (such as increasing the pellet size of the fertilizer) can decrease the degradation rate from days to weeks. If

released to water, urea can degrade readily through biotic hydrolysis as demonstrated by various screening studies. The presence of naturally-occurring phytoplankton increases the degradation rate because phytoplankton use urea as a nitrogen source and because urea is decomposed by phytoplankton photosynthesis. In phytoplankton-rich waters, degradation occurs much faster in sunlight than in the dark. Abiotic hydrolysis of urea occurs very slowly in relation to biotic hydrolysis. Occupational exposure to urea occurs through dermal contact and inhalation of dust, especially to workers applying urea fertilizers. (SRC) [Peer Reviewed]

POLLUTION SOURCES

Natural Occurring Sources:

Urea is a natural product of nitrogen and protein metabolism(1,3); it occurs in urine(2) and animal waste(3). Urea can be formed in natural waters as a result of protein decomposition(3). [Peer Reviewed] *(1) Windholz M; The Merck Index 10th ed. Rahway, NJ: Merck & Co p. 1410 (1983) (2) Mavrovic I, Shirley AR Jr; Kirk-Othmer Encycl Chem Technol 3rd ed, NY: John Wiley & Sons Inc 23: 548 (1983) (3) Brockett OD; Water Res 11: 317-21 (1977)*

Artificial Sources:

In its primary use, urea is released to the environment through direct application to soil as a nitrogen-release fertilizer(1). Small amounts of urea can be released in wastewater effluents from manufacturing and use sites(1). [Peer Reviewed] *(1) Mavrovic I, Shirley AR Jr; Kirk-Othmer Encycl Chem Technol 3rd ed. NY: John Wiley & Sons Inc 23: 548-75 (1983)*

ENVIRONMENTAL FATE

1 Terrestial Fate: A forest fertilization study led to the conclusion that application rates less than 224 kg/ha (200 lb N2/acre) were ineffective in supplying nitrogen. Urea applications above this threshold brought about increases in soil nitrogen, pH, absorbed ammonia, and cation exchange capacity, the latter especially in surface and litter material. Addition of urea appeared to have adverse effects on the uptake of phosphorus. [Peer Reviewed] *Baker J; Some Effects of Urea Fertilization on Soil Characteristics and Tissue Mineral Content in Overstocked Western Hemlock Stands. Canadian Forestry Service Report No. BC-X-39 (1970) as cited in Environment Canada; Tech Info for Problem Spills: Urea p*

2 Terrestrial Fate: Urea fertilizer was applied to a pasture and the runoffs were measured. Maximum concn of runoff was attained for ammonia nitrogen 3 weeks after application and for nitrate nitrogen 1 week after application. In the runoff, ammonia-nitrogen was only 0.3% of that applied, nitrogen nitrate was 1.0%, and total nitrogen was 7.1% of that applied. It was concluded that most of the applied urea will not run off. [Peer Reviewed] *Sharpley AN et al; Water, Air and Soil Pollution 14 (3): 425-430 (1983) as cited in Environment Canada; Tech Info for Problem Spills: Urea p.47 (1985)*

3 Terrestrial and Aquatic Fate: If the soil surface is saturated with moisture at the time of the spill, as might be the case after a rainfall, the spilled /urea/ may run off into the surface water. ... Upon reaching the groundwater table, the contaminant will continue to move, now in the direction of groundwater flow. A contaminated plume will be produced, with diffusion and dispersion serving to reduce the acid concn. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.37 (1985)*

4 Terrestrial Fate: When solid urea is spilled, only a limited groundwater contamination hazard exists if the soil is dry and if no precipitation falls prior to cleanup. ... Concentrated solutions of /urea/ can infiltrate the soil. Some interaction between urea and the soil will occur. However, much of the urea exchanged ions will migrate downward /SRP: as well as lateral/ through the soil. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.37 (1985)*

soil. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.37 (1985)*

5 TERRESTRIAL FATE: Various field and laboratory studies have demonstrated that urea degrades rapidly in most soils(1-3). In general, urea is rapidly hydrolyzed to ammonium through soil urease activity(1). In various soils, the hydrolysis may near completion within 24 hrs(2); however, the rate of hydrolysis can be much slower depending upon soil type, moisture content, and urea formulation(1). For example, increasing the pellet size of urea fertilitizers can decrease the urea decomposition rate from days to weeks(1). Soil adsorption studies have demonstrated that urea adsorbs very weakly to soil(4); therefore, leaching is possible(SRC). Ultimate urea degradation produces ammonia and CO2 as volatile products(5). [Peer Reviewed] *(1) Malhi SS, Nyborg M; Plant Soil 51: 177-86 (1979) (2) Sankhayan SD, Shukla UC; Geoderma 16: 171-8 (1976) (3) Scheunert I et al; Chemosphere 16: 1031-41 (1987) (4) Hance RJ; Weed Res 5: 98-107 (1965) (5) Mavrovic I, Shirley AR Jr; Kirk-Othmer Encycl Ch*

6 AQUATIC FATE: Biodegradation is expected to be the major fate process in the aquatic ecosystem. Various screening studies have demonstrated that urea can biodegrade readily(1-5) with the release of CO2 and ammonia. The rate of biodegradation generally decreases with decreasing temperatures(4); under cold winter-like conditions, biodegradation may be relatively slow (0-6% per day)(4). The presence of naturally-occurring phytoplankton increases the degradation rate(2,5) because phytoplankton use urea as a nitrogen source(2) and because urea is decomposed by phytoplankton photosynthesis(5); in phytoplankton-rich waters, degradation occurs much faster in sunlight than in the dark(5). Abiotic hydrolysis of urea occurs very slowly in relation to biotic hydrolysis(6); abiotic hydrolysis yields ammonium carbamate which decomposes to form CO2 and ammonia(6); the enzyme urease catalyzes urea hydrolysis(6). Volatilization, bioconcentration and adsorption to sediment are not expected to be important fate processes(SRC). [Peer Reviewed] *(1) Freitag D et al; Chemosphere 14: 1589-616 (1985) (2) Remsen CC; Ecology 53: 921-6 (1972) (3) Scheunert I et al; Chemosphere 16: 1031-41 (1987) (4) Evans WH et al; Water Res 7: 975-85 (1973) (5) Mitamura O, Saijo Y; Marine Biology 58: 147-152 (1980) (*

7 ATMOSPHERIC FATE: Based upon a vapor pressure of 1.2X10-5 mm Hg at 25 deg C(1), urea can exist in both the vapor and particulate-phases in the ambient atmosphere, although the vapor-phase can be expected to dominate(2,SRC). It will degrade rapidly in the vapor-phase by reaction with photochemically produced hydroxyl radicals with an estimated half-life of 9.6 hr(3,SRC). Particulate-phase urea and aerosols released to air during spray applications of urea fertilizers will be removed from air physically by dry and wet deposition(SRC). [Peer Reviewed] *(1) Jones AH; J Chem Eng Data 5: 196-200 (1960) (2) Bidleman TF; Environ Sci Technol 22: 361-7 (1988) (3) Atkinson R; Environ Toxicol Chem 7: 435-42 (1988)*

ENVIRONMENTAL TRANSFORMATIONS

Biodegradation:

1 Waste water treatment: degradation rate by psychrophilic bacteria: at 20 deg C: maximum: 11.6 mg/l/hr with an average of 10.9 mg/l/hr; at 2 deg C: maximum: 4.0 mg/l/hr with an average of 3.2 mg/l/hr. [Peer Reviewed] *Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1178*

2 At 100 mg/l, no inhibition of NH3 oxidation by Nitrosomonas sp /was observed/. [Peer Reviewed] *Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1178*

3 /Urea concentrations/ from 1 to 15 mg/l for up to 14 days in river water at < 8 deg C exhibited negligible degradation; the same concentrations at 4 to 6 days in river water a 20 deg C exhibited complete degradation. /Data derived from table/ [Peer Reviewed] *Evans WH, Patterson S; Water Res 7: 975-985 (1973) as cited in Environment Canada; Tech Info for Problem Spills: Urea p.48 (1985)*

4 Using an activated sludge seed, a CO2 evolution of 85.9% was measured over a 5-day

4 Using an activated sludge seed, a CO2 evolution of 85.9% was measured over a 5-day incubation period(1). At the relatively high concns of 20-100 ppm, 5-day theoretical BODs of 0% were measured in freshwater and synthetic seawater to which a raw wastewater seed was added(2). In a river die-away, 1.05-2.20% of added urea hydrolyzed after 10-days while only 0.35% hydrolyzed in sterile controls(3). Urea was completely biodegraded in aerobic biodegradation studies using activated sludge and a 14-day incubation period(4). In degradation studies using estuary and coastal waters from Georgia, avg urea degradation rates of 6.2 to 19.6 nmoles/L-hr were observed(5); phytoplankton in the waters were responsible for the major urea decomposition(5). In a 5-day CO2 evolution study using a suspended soil inocula, CO2 evolution was 70.1% in anaerobic conditions and 66.3% in aerobic conditions(6). [Peer Reviewed] *(1) Freitag D et al; Chemosphere 14: 1589-616 (1985) (2) Takemoto S et al; Suishitsu Odaku Kenkyu 4: 80-90 (1981) (3) Atkinson R; Water Treat Exam 20: 193-203 (1971) (4) Ebisuno T et al; Seitai Kagaku 7: 27-34 (1984) (5) Remsen CC; Ecology 53: 921-6 (197*

5 The degradation of urea was examined in a river die-away study using various river waters and various test conditions(1); the degradation rate increased with increasing temperatures; at 20 deg C, degradation was general complete within 6-14 days of incubation while in some waters at lower temperatures (4-12 deg C) little or no degradation occurred in 10-14 days(1); below 8 deg C (simulating winter conditions), a maximum daily degradation of 3-6% was observed during the first 7 days of incubation(1); depending upon the source of the water, degradation under aerobic conditions varied from slightly faster to more than twice as fast as compared to anaerobic conditions(1). In 4-day CO2 evolution tests using waters collected from three regions of the Pacific Ocean, CO2 evolution was observed to occur much faster in sunlight than in dark controls (the ratio of light to light+dark was 61.6-86.4%)(2); the reason for the accelerated rate in sunlight is that urea is actively decomposed by photosynthesis of phytoplankton that occur in seawater(2). [Peer Reviewed] *(1) Evans WH et al; Water Res 7: 975-85 (1973) (2) Mitamura O, Saijo Y; Marine Biology 58: 147-152 (1980)*

Abiotic Degradation:

1 The rate constant for the vapor-phase reaction of urea with photochemically produced hydroxyl radicals has been estimated to be 4X10-11 cu cm/molecule-sec at 25 deg C which corresponds to an atmospheric half-life of about 9.6 hr at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm(1,SRC). The rate constant for the reaction between photochemically produced hydroxyl radicals in water and urea is reported to be 7.9X10+5 L/mole-sec(2); assuming that the conc of hydroxyl radicals in brightly sunlit natural water is 1X10-17 M(3), the half-life would be in excess of 3000 yrs of continuous (24 hr/day) sunlight(SRC). In one photodegradation study using a silica gel adsorbent(4), only 0.2% of applied urea photomineralized after a 17-hr irradiation with a UV lamp (>290 nm). [Peer Reviewed] *(1) Atkinson R; Environ Toxicol Chem 7: 435-42 (1988) (2) Buxton GV et al; J Phys Chem Ref Data 17: 727 (1988) (3) Mill T et al; Sci 207: 886-7 (1980) (4) Freitag D et al; Chemosphere 14: 1589-616 (1985)*

2 In aqueous solution, urea is in equilibrium with ammonia and isocyanate ions(1); in the absence of microorganisms, urea hydrolyzes very slowly to yield ammonium carbamate which decomposes to form ammonia and carbon dioxide(2). The hydrolysis is catalyzed by increasing temperatures, increasing alkalinity, and especially, by the presence of the enzyme urease(1); in hydrolysis studies where urease was artificially added to aqueous urea solutions, 20 to 50% of initial urea hydrolyzed in 3 hr at respective temperatures of 2 to 10 deg C(1); at 0 deg C (with added urease), hydrolysis ranged from 25 to 100% after 24 hr at respective pHs of 6.4 to 8.4(1). At 5 deg C in demineralized/distilled water, only 0.35% of added urea hydrolyzed during a 10-day test period(3). [Peer Reviewed] *(1) Stiff MJ, Gardiner DK; Water Treat Exam 22: 259-68 (1973) (2) Mavrovic I, Shirley AR Jr; Kirk-Othmer Encycl Chem Technol 3rd ed. NY: John Wiley & Sons Inc 23: 548 (1983) (3) Atkinson R; Water Treat Exam 20: 193-203 (1971)*

ENVIRONMENTAL TRANSPORT

ENVIRONMENTAL TRANSPORT

Bioconcentration:

In 6 to 72 hr bioaccumulation studies using carp (Cyprinus carpio) and a static flow system, the concn of urea was found to be equally distributed in all organs and in the water at all time periods(1); thus, the BCF would be only 1(SRC). In 3-day static-system tests using golden ide fish (Leuciscus idus melanotus), the BCF of urea was less then 10(2). [Peer Reviewed] *(1) Gluth G et al; Comp Biochem Physiol 81C: 273-7 (1985) (2) Freitag D et al; Chemosphere 14: 1589-616 (1985)*

Soil Adsorption/Mobility:

1 Urea is essentially non-volatile. [Peer Reviewed] *Environment Canada; Tech Info for Problem Spills: Urea p.21 (1985)*

2 The adsorption of urea was measured in six different British soils with organic carbon contents ranging from 1.76 to 36.5%(1); no adsorption was measurable in five of the soils(1); in the sixth soil (36.5% organic carbon), a KOC of 8 can be determined from the measured Freundlich isotherm(1,SRC); according to a suggested classification scheme(2), a Koc value of 8 indicates high mobility in soil(SRC). It has been reported that urea can adsorb to humic acids through a free-radical addition interaction to form a complex(3). [Peer Reviewed] *(1) Hance RJ; Weed Res 5: 98-107 (1965) (2) Swann RL et al; Res Rev 85: 23 (1983) (3) Choudhry GG; Toxicol Environ Chem 6: 127-71 (1983)*

Volatilization from Soil/Water:

Based upon a measured water solubility of 5.45X10+5 mg/L(1) and an extrapolated vapor pressure of 1.2X10-5 mm Hg at 25 deg C(2,SRC), the Henry's Law constant for urea can be estimated to be 1.74X10-12 atm cu m/mole(SRC); a Henry's Law constant of this magnitude indicates that urea is essentially non-volatile from environmental waters(3,SRC). [Peer Reviewed] *(1) Yalkowsky SH; Arizona Database of Aqueous Solubilities. Univ of AZ, College of Pharmacy (1989) (2) Jones AH; J Chem Eng Data 5: 196-200 (1960) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods Washington, DC: Amer Chem Soc pp. 15-1*

ENVIRONMENTAL CONCENTRATIONS

Water Concentrations:

SURFACE WATER: Urea concns in surface waters off the continental shelf between Panama and Callao, Peru varied from 0.54-5.00 ug/L(1); along the continental shelf of the northeast US between Cape Cod and Cape May, urea concn varied from a low of 0.25 ug/L (in a deep water sample) to a high of 11.20 ug/L in New York Harbor(1). In monitoring conducted in Mar 1971, urea concns ranged from 36 to 535 ug/L in the Savannah-Wilmington-Ogeechee estuaries and adjacent coastal waters in Georgia(2). The following urea concns were detected in water samples collected from three regions of the Pacific Ocean(3): 0.85-1.43 ug/L (Sagami Bay, Japan), 0.19-0.51 ug/L (northwestern Pacific central waters), and 0.17-0.40 ug/L (subarctic Pacific waters)(3). [Peer Reviewed] *(1) Remsen CC; Limnol Oceanogr 16: 732-40 (1971) (2) Remsen CC; Ecology 53: 921-6 (1972) (3) Mitamura O, Saijo Y; Marine Biology 58: 147-152 (1980)*

Effluents Concentrations:

Contents of domestic sewage: 2-6 mg/L; domestic sewer effluent: 0.020 mg/L; primary domestic sewage plant effluent: 0.016-0.043 mg/L [Peer Reviewed] *Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 1178*

HUMAN EXPOSURE

Probable Routes of Human Exposure:

1 Occupational exposure to urea occurs through dermal contact and inhalation of dust, especially to workers applying urea fertilizers(1). [Peer Reviewed] *(1) Parmeggiani L; Encyl Occup Health & Safety 3rd ed. Geneva, Switzerland: International Labour Office p. 846-8 (1983)*

2 The National Occupational Hazard Survey conducted by NIOSH estimated that 855,894 workers may be exposed to urea; 7% from actual observed use, 31% from observed use of a tradename product known to contain this chemical, and 62% from observed use of a product in some type of general use which leads NIOSH to suspect that this chemical may be contained in the product. [Peer Reviewed] *NIOSH National Hazard Exposure Survey (1972-1974)*

3 NIOSH (NOES Survey 1981-1983) has statistically estimated that 661,00 workers are potentially exposed to urea in the USA(1). NIOSH (NOHS Survey 1972-1974) has statistically estimated that 855,894 workers are potentially exposed to urea in the USA(2). [Peer Reviewed] *(1) NIOSH; National Occupational Exposure Survey (NOES) (1983) (2) NIOSH; National Occupational Hazard Survey (NOHS) (1974)*

8.0 EXPOSURE STANDARDS AND REGULATIONS

STANDARDS AND REGULATIONS

Allowable Tolerances:

1 Residues of urea are exempted from the requirement of a tolerance when used as a stabilizer or inhibitor in accordance with good agricultural practices as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest. [Peer Reviewed] *40 CFR 180.1001(c) (7/1/91)*

2 Urea is exempted from the requirement of a tolerance when used as a adjuvant/intensifier for herbicides in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops only. [Peer Reviewed] *40 CFR 180.1001(d) (7/1/91)*

3 Urea is exempted from the requirement of a tolerance when used as a stabilizer or inhibitor in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to animals. [Peer Reviewed] *40 CFR 180.1001(e) (7/1/91)*

OTHER STANDARDS AND REGULATIONS

Atmospheric Standards:

This action promulgates standards of performance for equipment leaks of Volatile Organic Compounds (VOC) in the Synthetic Organic Chemical Manufacturing Industry (SOCMI). The intended effect of these standards is to require all newly constructed, modified, and reconstructed SOCMI process units to use the best demonstrated system of continuous emission reduction for equipment leaks of VOC, considering costs, non air quality health and environmental impact and energy requirements. Urea is produced, as an intermediate or a final product, by process units covered under this subpart. [Peer Reviewed] *40 CFR 60.489 (7/1/91)*

FIFRA Requirements:

1 Residues of urea are exempted from the requirement of a tolerance when used as a stabilizer or inhibitor in accordance with good agricultural practices as inert (or occasionally

stabilizer or inhibitor in accordance with good agricultural practices as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities after harvest. [Peer Reviewed] *40 CFR 180.1001(c) (7/1/91)*

2 Urea is exempted from the requirement of a tolerance when used as a adjuvant/intensifier for herbicides in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops only. [Peer Reviewed] *40 CFR 180.1001(d) (7/1/91)*

3 Urea is exempted from the requirement of a tolerance when used as a stabilizer or inhibitor in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to animals. [Peer Reviewed] *40 CFR 180.1001(e) (7/1/91)*

4 In 1988, Congress amended FIFRA to strengthen and accelerate EPA's reregistration program. The nine-year reregistration scheme mandated by "FIFRA 88" applies to each registered pesticide product containing an active ingredient initially registered before November 1, 1984. Pesticides for which EPA had not issued Registration Standards prior to the effective date of FIFRA '88 were divided into three lists based upon their potential for exposure and other factors, with List B being of highest concern and D of least. List: D; Case: Urea; Case No.: 4096; Pesticide type: Antimicrobial: Active Ingredient (AI): Urea; Case Status: The producer(s) of the pesticide has not made or honored a commitment to seek reregistration, conduct the necessary studies, or pay the requisite fees. Unless some other interested party makes and meets such commitments, products containing the pesticide will be cancelled. [Peer Reviewed] *USEPA/OPP; Status of Pesticides in Reregistration and Special Review p.262 (Mar, 1992) EPA 700-R-92-004*

FDA Requirements:

Substance added directly to human food affirmed as generally recognized as safe (GRAS). [Peer Reviewed] *21 CFR 184.1923 (4/1/91)*

9.0 MONITORING AND ANALYSIS METHODS

Analytical Laboratory Methods:

1 THIN-LAYER CHROMATOGRAPHIC IDENTIFICATION FEASIBILITY OR SEMIQUANTITATIVE DETERMINATION OF UREA IN AQ MODEL SOLN. [Peer Reviewed] *THIELEMANN H; ACTA HYDROCHIM HYDROBIOL 7 (1): 125-6 (1979)*

2 A technique for hydrolyzing urea using 78% w/w sulfuric acid (20 minute refluxing). ... This assay can be used to determine urea in creams. [Peer Reviewed] *Dreyer-van der Glas SM, Dingjan HA; Pharm Weekbl 118: 575-6 (1983)*

3 Determination of urea in fertilizers using urease method. [Peer Reviewed] *Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. and Supplements. Washington, DC: Association of Analytical Chemists, 1990,p. V1 21*

4 Sample is ground to pass 40 mesh sieve, extracted with water and filtered. Urea, methylenediurea, and dimethylenetinurea are determined by liquid chromatography using external standards and refractive index detection. [Peer Reviewed] *Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. and Supplements. Washington, DC: Association of Analytical Chemists, 1990,p. V1 21-22*

5 Determination of urea in animal feeds and its ingredients by using colorimetric method; and determination of urea and ammoniacal nitrogen in animal feed using urease method. [Peer Reviewed] *Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed and Supplements. Washington, DC: Association of Analytical Chemists, 1990,p. V1 76-7*

6 Urea can be analyzed in deodorants by using titrimetric method. [Peer Reviewed] *Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. and Supplements. Washington, DC: Association of Analytical Chemists, 1990,p. V1 365*

7 Determination of urine stains on foods and containers by using (a) ultraviolet light examination (applicable to suspect urine stains on all materials except seeds); (b) Urease test for urea (applicable to urine residues on materials with significant amounts of interfering substances, ie fats and oils); (c) Xanthydrol test for urea (not applicable in presence of dried

substances, ie fats and oils); (c) Xanthydrol test for urea (not applicable in presence of dried skim milk; applicable to fluorescing urine residues on materials without significant amounts of interfering substances.) [Peer Reviewed] *Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. and Supplements. Washington, DC: Association of Analytical Chemists, 1990,p. V1 407-9*

8 Determination and stability studies of urea in urea creams by high-performance liquid chromatography using a UV-spectrometer at 200 nm. [Peer Reviewed] *Yasuda T et al; Yakugaku Zasshi 112 (2): 141-5 (1992)*

Clinical Laboratory Methods:

1 Three analytical techniques for determining urea serum levels were evaluated. A colorimetric method was found to give identical results to an enzymatic method. The Merckognost urea test gave results acceptable in a clinical laboratory practice. [Peer Reviewed] *Ivanovic I et al; Arch Farm 31 (3): 101-6 (1981)*

2 Urea detn milk by enzymic hydrolysis and photometry [Peer Reviewed] *Andersson G et al; Zentralbl Veterinaermed Reihe A 33 (1): 53-8 (1986)*

10.0 ADDITIONAL REFERENCES

Special Reports:

1 Environment Canada; Tech Info for Problem Spills: Urea (1985)

2 Haliburton JC, Morgan SE; Nonprotein Nitrogen-induced Ammonia Toxicosis and Ammoniated Feed Toxicity Syndrome; Vet Clin North Am Food Anim Pract 5 (2): 237-49 (1989)

3 WHO/IPCS; Toxicological Evaluation of Certain Food Additives and Contaminants WHO Food Additives Series 32 (1993)

Sulfamic acid, monoammonium salt

RTECS - Registry of Toxic Effects of Chemical Substances

1.0 SUBSTANCE IDENTIFICATION

RTECS Number: WO6125000
Chemical Name: Sulfamic acid, monoammonium salt
CAS Number: 7773-06-0
Molecular Formula: H3-N-O3-S.H3-N
Molecular Weight: 114.14
Wiswesser Notation: ZSWQ &ZH
Substance Investigated as: Agricultural Chemical
Last Revision Date: 1997

2.0 SYNONYM(S)/TRADENAME(S)

1 Amicide
2 Ammat
3 Ammate
4 Ammate X
5 Ammonium amidosulfonate
6 Ammonium amidosulphate
7 Ammonium sulfamate (ACGIH:OSHA)
8 Ammonium sulphamate Ammonium sulphamidate
9 Ammoniumsalz der amidosulfonsaure (German)
10 AMS
11 Feliderm K
12 Fyran 200 K
13 Fyran J 3
14 Ikurin
15 Monoammonium sulfamate
16 Sulfaminsaure (German)

3.0 HEALTH HAZARD DATA

ACUTE TOXICITY

LDLO/LCLO - LOWEST PUBLISHED LETHAL DOSE/CONC

Rat

LDLo - ROUTE: Intraperitoneal; **DOSE:** 800 mg/kg *CODEN: JIHTAB Bibliographic Data: Journal of Industrial Hygiene and Toxicology. (Cambridge, MA) V.18-31, 1936-49. For publisher information, see AEHLAU. CODEN Reference: 25:26,1943*
TOXIC EFFECTS:
Behavioral - Somnolence (general depressed activity)
Lung, Thorax, or Respiration - Respiratory stimulation

LD50/LC50 - LETHAL DOSE/CONC 50% KILL

Rat

LD50 - ROUTE: Oral; **DOSE:** 2 gm/kg *CODEN: AMIHAB Bibliographic Data: AMA*

LD50 - ROUTE: Oral; **DOSE:** 2 gm/kg *CODEN: AMIHAB Bibliographic Data: AMA Archives of Industrial Health. (Chicago, IL) V.11-21, 1955-60. For publisher information, see AEHLAU. CODEN Reference: 14:178,1956*

Mouse

LD50 - ROUTE: Oral; **DOSE:** 3100 mg/kg *CODEN: GTPZAB Bibliographic Data: Gigiena Truda i Professional'nye Zabolevaniya. Labor Hygiene and Occupational Diseases. (V/O Mezhdunarodnaya Kniga, 113095 Moscow, USSR) V.1-36, 1957-1992. For publisher information, see MTPEEI CODEN Reference: 7(5):56,1963*
TOXIC EFFECTS:
Behavioral - General anesthetic
Behavioral - Convulsions or effect on seizure threshold
Lung, Thorax, or Respiration - Dyspnea

OTHER LD/LC - OTHER LETHAL DOSE/CONC

Mouse

LD - ROUTE: Intraperitoneal; **DOSE:** >500 mg/kg *CODEN: CBCCT* Bibliographic Data: "Summary Tables of Biological Tests," National Research Council Chemical-Biological Coordination Center. (National Academy of Science Library, 2101 Constitution Ave., NW, Washington, DC 20418) CODEN Reference: 4:316,1952*

OTHER MULTIPLE DOSE TOXICITY DATA

Rat

ROUTE: Oral; **DOSE:** 39 gm/kg/90D intermittent *CODEN: TXCYAC Bibliographic Data: Toxicology. (Elsevier Scientific Pub. Ireland, Ltd., POB 85, Limerick, Ireland) V.1- 1973- CODEN Reference: 13:45,1979*
TOXIC EFFECTS:
Nutritional and Gross Metabolic - Weight loss or decreased weight gain

4.0 STANDARDS AND REGULATIONS

1 EPA FIFRA 1988 PESTICIDE SUBJECT TO REGISTRATION OR RE-REGISTRATION *CODEN: FEREAC Bibliographic Data: Federal Register. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) V.1- 1936- CODEN Reference: 54:7740,1989*
2 MSHA STANDARD-air:TWA 10 mg/m3 *CODEN: DTLVS* Bibliographic Data: The Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) booklet issues by American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, OH, 1996 CODEN Reference: 3:12,1971*
3 OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV
4 OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGIH TLV
5 OEL-AUSTRALIA:TWA 10 mg/m3 JAN 1993
6 OEL-AUSTRIA:TWA 15 mg/m3 JAN 1993
7 OEL-BELGIUM:TWA 10 mg/m3 JAN 1993
8 OEL-DENMARK:TWA 10 mg/m3 JAN 1993
9 OEL-FINLAND:TWA 10 mg/m3;STEL 20 mg/m3 JAN 1993
10 OEL-FRANCE:TWA 10 mg/m3 JAN 1993
11 OEL-GERMANY:TWA 15 mg/m3 (total dust) JAN 1993
12 OEL-RUSSIA:STEL 10 mg/m3 JAN 1993
13 OEL-SWITZERLAND:TWA 10 mg/m3 JAN 1993
14 OEL-THE NETHERLANDS:TWA 10 mg/m3 JAN 1993
15 OEL-THE PHILIPPINES:TWA 15 mg/m3 JAN 1993
16 OEL-TURKEY:TWA 15 mg/m3 JAN 1993
17 OEL-UNITED KINGDOM:TWA 10 mg/m3;STEL 20 mg/m3 JAN 1993
18 OSHA PEL (Construc):8H TWA 15 mg/m3, total dust *CODEN: CFRGBR Bibliographic Data:*

18
Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 29:1926.55,1994

19 OSHA PEL (Construc):8H TWA 5 mg/m3, respirable fraction *CODEN: CFRGBR Bibliographic Data: Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 29:1926.55,1994*

20 OSHA PEL (Fed Cont):8H TWA 15 mg/m3 *CODEN: CFRGBR Bibliographic Data: Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 41:50-204.50,1994*

21 OSHA PEL (Gen Indu):8H TWA 15 mg/m3, total dust *CODEN: CFRGBR Bibliographic Data: Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 29:1910.1000,1994*

22 OSHA PEL (Gen Indu):8H TWA 5 mg/m3, respirable fraction *CODEN: CFRGBR Bibliographic Data: Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 29:1910.1000,1994*

23 OSHA PEL (Shipyard):8H TWA 15 mg/m3, total dust *CODEN: CFRGBR Bibliographic Data: Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 29:1915.1000,1993*

24 OSHA PEL (Shipyard):8H TWA 5 mg/m3, respirable fraction *CODEN: CFRGBR Bibliographic Data: Code of Federal Regulations. (U.S. Government Printing Office, Supt. of Documents, Washington, DC 20402) CODEN Reference: 29:1915.1000,1993*

5.0 NIOSH DOCUMENTS

1 NIOSH REL TO AMMONIUM SULFAMATE, respirable dust-air:10H TWA 5 mg/m3

2 NIOSH REL TO AMMONIUM SULFAMATE, total dust-air:10H TWA 10 mg/m3

3 National Occupational Exposure Survey 1983: Hazard Code 06190; Number of Industries 7; Total Number of Facilities 288; Number of Occupations 14; Total Number of Employees 9676; Total Number of Female Employees 4583

4 National Occupational Hazard Survey 1974: Hazard Code 06190; Number of Industries 5; Total Number of Facilities 232; Number of Occupations 7; Total Number of Employees 2131

6.0 REVIEWS

ACGIH TLV-TWA 10 mg/m3 *CODEN: DTLVS* Bibliographic Data: The Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) booklet issues by American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, OH, 1996 CODEN Reference: TLV/BEI,1996*

7.0 STATUS IN U.S.

1 EPA TSCA Section 8(b) CHEMICAL INVENTORY

2 On EPA IRIS database

AMMONIUM SULFAMATE

HSDB - Hazardous Substances Data Bank

0.0 ADMINISTRATIVE INFORMATION

Hazardous Substances Data Bank Number: 703
Last Revision Date: 970811
Review Date: SRP review on 12/09/87
Update History:

1 Complete Update on 08/11/97, 1 field added/edited/deleted.
2 Complete Update on 07/11/97, 1 field added/edited/deleted.
3 Complete Update on 04/01/97, 2 fields added/edited/deleted.
4 Complete Update on 02/27/97, 1 field added/edited/deleted.
5 Complete Update on 10/12/96, 1 field added/edited/deleted.
6 Complete Update on 04/12/96, 1 field added/edited/deleted.
7 Complete Update on 04/09/96, 7 fields added/edited/deleted.
8 Field Update on 01/19/96, 1 field added/edited/deleted.
9 Complete Update on 01/18/95, 1 field added/edited/deleted.
10 Complete Update on 12/22/94, 1 field added/edited/deleted.
11 Complete Update on 06/29/94, 1 field added/edited/deleted.
12 Complete Update on 05/05/94, 1 field added/edited/deleted.
13 Complete Update on 03/25/94, 1 field added/edited/deleted.
14 Complete Update on 08/07/93, 1 field added/edited/deleted.
15 Field update on 12/14/92, 1 field added/edited/deleted.
16 Complete Update on 04/27/92, 1 field added/edited/deleted.
17 Complete Update on 01/23/92, 1 field added/edited/deleted.
18 Complete Update on 10/22/90, 3 fields added/edited/deleted.
19 Field Update on 01/15/90, 1 field added/edited/deleted.
20 Complete Update on 01/11/90, 2 fields added/edited/deleted.
21 Field Update on 05/05/89, 1 field added/edited/deleted.
22 Complete Update on 12/09/88, 2 fields added/edited/deleted.
23 Complete Update on 06/22/88, 60 fields added/edited/deleted.
24 Complete Update on 10/14/86

1.0 SUBSTANCE IDENTIFICATION

Name of Substance: AMMONIUM SULFAMATE
CAS Registry Number: 7773-06-0
Synonyms:

1 Ammonium sulphamidate [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*
2 Sulfamate d'ammonium [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*
3 AMMONIUM AMIDOSULFATE [Peer Reviewed]
4 AMMONIUM AMIDOSULFONATE [Peer Reviewed]
5 AMMONIUM AMIDOSULPHATE [Peer Reviewed]
6 AMMONIUM AMINOSULFONATE [Peer Reviewed]
7 AMMONIUM SULPHAMATE [Peer Reviewed]
8 AMMONIUMSALZ DER AMIDOSULFONSAURE (GERMAN) [Peer Reviewed]
9 AMS [Peer Reviewed]

8
9 AMS [Peer Reviewed]
10 AMS [SALT] [Peer Reviewed]
11 MONOAMMONIUM SULFAMATE [Peer Reviewed]
12 SULFAMATE [Peer Reviewed]
13 SULFAMIC ACID, MONOAMMONIUM SALT [Peer Reviewed]
14 SULFAMINSAURE [GERMAN] [Peer Reviewed]

Molecular Formula: H3-N-O3-S.H3-N [QC Reviewed]
RTECS Number: NIOSH/WO6125000
OHM-TADS Number: 7215089

2.0 MANUFACTURING/USE INFORMATION

Methods of Manufacturing:

1 PRODUCED BY CONVERTING SULFAMIC ACID, MADE BY ACTION OF FUMING SULFURIC ACID ON UREA, TO THE AMMONIUM SALT (US PATENT 2102350; 2487480) OR BY ACTION OF NON-GASEOUS SULFUR TRIOXIDE ON LIQUID AMMONIA (US PATENT 2426420) ... [Peer Reviewed] *Worthing, C. R. (ed.). Pesticide Manual. 6th ed. Worcestershire, England: British Crop Protection Council, l979. 16*
2 Prepared by neutralizing sulfamic acid with ammonium hydroxide. [Peer Reviewed] *KIRK-OTHMER ENCYC CHEM TECH 3RD ED 1978-PRESENT V21 p.951*

Formulations/Preparations:

1 'AMMATE' BRAND WEED KILLER IS BROWNISH-GRAY CRYSTALLINE MATERIAL CONTAINING MIN 80% AMMONIUM SULFAMATE [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*
2 Water soluble crystals (Ammate X-NI weed and brush killer) [Peer Reviewed] *Farm Chemicals Handbook 87. Willoughby, Ohio: Meister Publishing Co., 1987. 16*
3 Ammate X; Ammate X-NI (950 g ai/kg); Amicide, sp (970 g/kg) [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*
4 Grades of purity: Reagent, 99.0%; commercial, 80% [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*
5 Ammate X is at least 95% ammonium sulfamate [Peer Reviewed] *Spencer, E. Y. Guide to the Chemicals Used in Crop Protection. 7th ed. Publication 1093. Research Institute, Agriculture Canada, Ottawa, Canada: Information Canada, 1982. 16*
6 FELIDERM K [Peer Reviewed]
7 FYRAN 206K [Peer Reviewed]
8 IKURIN [Peer Reviewed]
9 AMCIDE [Peer Reviewed]
10 AMICIDE [Peer Reviewed]
11 AMMAT [Peer Reviewed]
12 AMMATE [Peer Reviewed]
13 AMMATE X [Peer Reviewed]
14 TECHNICAL PRODUCT ... IS GREATER THAN OR EQUAL TO 97% PURE. [Peer Reviewed] *Worthing, C. R. (ed.). Pesticide Manual. 6th ed. Worcestershire, England: British Crop Protection Council, l979. 16*

Manufacturers:

1 E I du Pont de Nemours & Co, Inc, 1007 Hq, Market St, Wilmington, DE 19898 (302) 774-1000; Chemicals and Pigments Department; Production site: Grasselli, NJ 07036 [QC Reviewed] *SRI. 1989 Directory of Chemical Producers - United States of America. Menlo Park, CA: SRI International, 1989. 827*
2 Whittaker Corporation, Hq, 10880 Wilshire Blvd, Los Angeles, CA 90024, (213) 475-9411;

2 Whittaker Corporation, Hq, 10880 Wilshire Blvd, Los Angeles, CA 90024, (213) 475-9411; Chemicals Group; Heico Division; Production site: Route 611, Delaware Water Gap, PA 18327 [QC Reviewed] *SRI. 1989 Directory of Chemical Producers - United States of America. Menlo Park, CA: SRI International, 1989. 827*

Other Manufacturing Information:

1 TECHNICAL PRODUCT ... IS GREATER THAN OR EQUAL TO 97% PURE. ... IT FORMS ADDITION PRODUCTS WITH ALDEHYDES & IS READILY OXIDIZED BY BROMINE & CHLORINE. [Peer Reviewed] *Worthing, C. R. (ed.). Pesticide Manual. 6th ed. Worcestershire, England: British Crop Protection Council, l979. 16*

2 Decomposes at 160 deg C, the gases acting as a fire retardant. ... It is a non-selective herbicide applied as a foliar spray of aq solution or oil-water emulsion to control woody plants, certain annual and perennial herbaceous weeds. ... [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*

3 WHEN USED IN ACCORDANCE WITH DIRECTIONS, IT IS NOT HAZARDOUS TO LIVESTOCK. HIGH RATES MAY CAUSE TEMPORARY NON-PRODUCTIVITY OF SOIL. [Peer Reviewed] *Farm Chemicals Handbook 1986. Willoughby, Ohio: Meister Publishing Co., 1986.,p. C-15*

4 WEED KILLING PREPN: CUPERY, TANDERG, US PATENT 2,277,744 (1941 TO DU PONT). [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

5 Is the largest volume commercial salt /of sulfamic acid/. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 949-61*

6 Used direct, generally at 0.75 lb/gal. [Peer Reviewed] *Spencer, E. Y. Guide to the Chemicals Used in Crop Protection. 7th ed. Publication 1093. Research Institute, Agriculture Canada, Ottawa, Canada: Information Canada, 1982. 16*

Major Uses:

1 MFR OF FIRE-RETARDANT COMPOSITIONS FOR FLAME-PROOFING TEXTILES & PAPER PRODUCTS; MFR OF WEED KILLING COMPOSITIONS; FOR GENERATION OF NITROUS OXIDE GAS; IN ELECTROPLATING SOLN [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

2 FLAMEPROOFING WOOD [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-123*

3 Contact and translocated herbicide [Peer Reviewed] *Farm Chemicals Handbook 87. Willoughby, Ohio: Meister Publishing Co., 1987.,p. C-16*

4 Catalyst for the acetylation of cellulose [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 5(79) 118-43*

5 Scale removing and chemical cleaning operations. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 949-61*

6 Cigarette paper is treated with ammonium sulfamate to reduce the hazard of tumor formation from tobacco smoke. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 22(83) 1-45*

7 EFFECTIVE IN KILLING MOST WOODY PLANTS INCL HARDWOOD & CONIFEROUS SPECIES SUCH AS ALDER, ASH, BIRCH, CEDAR, ELM, GUM, HICKORY, MAPLE, OAK, PINE, WILLOW ... ALSO ... EFFECTIVE CONTACT SPRAY FOR CONTROL OF HERBACEOUS PERENNIALS SUCH AS LEAFY SPURGE, BITTER DOCK, GOLDENROD, PERENNIAL RAGWEED, MILKWEED & BLUEGRASS. ... [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.22 (1983)*

8 ... MOST WIDELY USED FOR CONTROL OF WOODY PLANTS IN AREAS ADJACENT TO COTTON, GRAPES, TOMATOES, & OTHER PLANTS ... SUSCEPTIBLE TO PHENOXY

8 COTTON, GRAPES, TOMATOES, & OTHER PLANTS ... SUSCEPTIBLE TO PHENOXY CMPD. IT WILL PREVENT STUMPS FROM SPROUTING WHEN APPLIED TO CUT SURFACE AND WILL KILL LARGE TREES & SPROUTING STUMPS WHEN CRYSTALS OR CONCN SOLN ARE USED IN CUPS (AX CHIPS) MADE AROUND BASE OF TREE STUMP. [Peer Reviewed] *Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 1210*

9 Used /for weed control/ on power line rights-of-ways, and on drainage ditch banks. [Peer Reviewed] *Purdue University; National Pesticide Information Retrieval System (1987)*

10 Used /for weed control/ for noncrop areas as frill treatment, on tennis courts, driveways, brick, cobblestone and flagstone walks. Used on industrial storage areas, parking areas, and dumps. [Peer Reviewed] *Purdue University; National Pesticide Information Retrieval System (1987)*

11 Used as soil treatment /for weed control/ on apples, pears, fruit trees and ornamental trees. Used on wasteland as foliar treatment. [Peer Reviewed] *Purdue University; National Pesticide Information Retrieval System (1987)*

12 Application of crystals or concentrated solutions to frills, notches or cups cut in bark, controls undesirable trees and prevents resprouting of freshly-cut stumps. Poison ivy in orchards is controlled by localized application /methods/. [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*

Consumption Patterns:

1 42% AS A HIGHWAY HERBICIDE; 38% FOR INDUSTRIAL, COMMERCIAL, & INSTITUTIONAL GENERAL MAINTENANCE OF GROUNDS; 10% BY UTILITIES; & 10% IN WATER MANAGEMENT (1972) [Peer Reviewed] *SRI*

2 (1972) 2.18X10+9 GRAMS (CONSUMPTION) [Peer Reviewed] *SRI*

3 (1975) 2.04X10+9 GRAMS (CONSUMPTION) [Peer Reviewed] *SRI*

U.S. Production:

(1986) ND [Peer Reviewed]

U.S. Imports:

1 (1972) ND [Peer Reviewed] *SRI*

2 (1975) ND [Peer Reviewed] *SRI*

3 (1986) ND [QC Reviewed]

U.S. Exports:

1 (1972) ND [Peer Reviewed] *SRI*

2 (1975) ND [Peer Reviewed] *SRI*

3.0 CHEMICAL AND PHYSICAL PROPERTIES

Color/Form:

1 CRYSTALS (LARGE PLATES) [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

2 COLORLESS, WHITE CRYSTALLINE SUBSTANCE [Peer Reviewed] *American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 28*

3 Brownish-gray [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

4 Bright yellow-orange crystalline solid [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical*

J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1

5 Colorless to white crystalline solid. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

Odor:

1 ODORLESS [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.22 (1983)*

2 Odorless. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

Melting Point: 131 DEG C [QC Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

Molecular Weight: 114.13 [QC Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

Corrosivity: CORROSIVE TO SPRAY EQUIPMENT [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*

Density/Specific Gravity: MORE THAN 1 @ 20 DEG C (SOLID) [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

pH: 4.9 (0.2 MOLAR SOLN IN WATER) [QC Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

Solubilities:

1 166.6 G/100 ML WATER @ 10 DEG C; 357 G/100 ML WATER @ 50 DEG C [Peer Reviewed] *Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87.,p. B-72*

2 SLIGHTLY SOL IN ETHANOL; MODERATELY SOL IN GLYCEROL, GLYCOL, & FORMAMIDE [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

3 2.16 KG/KG WATER @ 25 DEG C [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*

Vapor Pressure: APPROX 0 MM HG @ 20 DEG C [Peer Reviewed] *American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values and Biological Exposure Indices. 5th ed. Cincinnati, OH:American Conference of Governmental Industrial Hygienists, 1986. 28*

Other Chemical/Physical Properties:

1 DECOMP AT 160 DEG C [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

2 HYDROLYZES IN ACID [Peer Reviewed] *Sunshine, I. (ed.). CRC Handbook of Analytical Toxicology. Cleveland: The Chemical Rubber Co., 1969. 499*

3 MELTING POINT: 131-132 DEG C /TECHNICAL PRODUCT/ [Peer Reviewed] *Worthing, C. R. (ed.). Pesticide Manual. 6th ed. Worcestershire, England: British Crop Protection Council, 1979. 16*

4 PH: 5.2 (50 G/KG WATER) /TECHNICAL PRODUCT/ [Peer Reviewed] *Worthing, C. R. (ed.). Pesticide Manual. 6th ed. Worcestershire, England: British Crop Protection Council, 1979. 16*

5 DELIQUESCENT [Peer Reviewed] *Weast, R.C. (ed.) Handbook of Chemistry and Physics. 67th ed. Boca Raton, FL: CRC Press, Inc., 1986-87.,p. B-72*

6 HYGROSCOPIC /AMMATE BRAND WEED KILLER/ [Peer Reviewed] *The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 81*

7 Boiling point: 107 deg C /60 wt % solution/ [Peer Reviewed] *Kirk-Othmer Encyclopedia of*

7 Boiling point: 107 deg C /60 wt % solution/ [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 951*

8 Dehydrates liquid or solid amides to nitriles. ... Liberates ammonia at elevated temperatures and forms ... imidodisulfonates. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 951*

9 Has flame retardant properties because heat decomposition produced non-inflammable gases. [Peer Reviewed] *Spencer, E. Y. Guide to the Chemicals Used in Crop Protection. 7th ed. Publication 1093. Research Institute, Agriculture Canada, Ottawa, Canada: Information Canada, 1982. 16*

10 Forms addition products with formaldehyde and aldehydes in general. Readily oxidized by bromine and chlorine. [Peer Reviewed] *Spencer, E. Y. Guide to the Chemicals Used in Crop Protection. 7th ed. Publication 1093. Research Institute, Agriculture Canada, Ottawa, Canada: Information Canada, 1982. 16*

11 A 60% solution of ammonium sulfamate (pH above 4.5) will not undergo rapid hydrolysis below 200 deg C. Addition of acid (to pH 2) causes a runaway exothermic hydrolysis to set in at 130 deg C. Superheating and vigorous boiling can occur under appropriate physical conditions. [Peer Reviewed] *Bretherick, L. Handbook of Reactive Chemical Hazards. 3rd ed. Boston, MA: Butterworths, 1985. 1208*

12 Decomposes at 200 deg C (392 deg F) at 760 mm Hg [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

4.0 SAFETY AND HANDLING

EMERGENCY GUIDELINES

DOT Emergency Guidelines:

1 Fire or explosion: Some may burn but none ignite readily. Some may polymerize (P) explosively when heated or involved in a fire. Containers may explode when heated. Some may be transported hot. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

2 Health: Inhalation of material may be harmful. Contact may cause burns to skin and eyes. Inhalation of asbestos dust may have a damaging effect on the lungs. Fire may produce irritating, corrosive and/or toxic gases. Runoff from fire control may cause pollution. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

3 Public safety: CALL Emergency Response Telephone Number on Shipping Paper first. If Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover. Isolate spill or leak area immediately for at least 10 to 25 meters (30 to 80 feet) in all directions. Keep unauthorized personnel away. Stay upwind. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

4 Protective clothing: Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook.*

U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe

5 Evacuation: Fire: If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

6 Fire: Small fires: Dry chemical, CO2, water spray or regular foam. Large fires: Water spray, fog or regular foam. Move containers from fire area if you can do it without risk. Do not scatter spilled material with high pressure water streams. Dike fire-control water for later disposal. Fire involving tanks: Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from the ends of tanks. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

7 Spill or leak: Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent dust cloud. Avoid inhalation of asbestos dust. Small dry spills: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area. Small spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal. Large spills: Dike far ahead of liquid spill for later disposal. Cover powder spill with plastic sheet or tarp to minimize spreading. Prevent entry into waterways, sewers, basements or confined areas. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

8 First aid: Move victim to fresh air. Call emergency medical care. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. [QC Reviewed] *U.S. Department of Transportation. 1996 North American Emergency Response Guidebook. A Guidebook for First Responders During the Initial Phase of aHazardous Materials/Dangerous Goods Incident. U.S. Department of Transportation (U.S. DOT) Research and Spe*

FLAMMABLE PROPERTIES

Fire Potential:

NOT FLAMMABLE [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

FIRE FIGHTING INFORMATION

Fire Fighting Procedures:

1 /DURING FIRE FIGHTING/ WEAR GOGGLES & SELF-CONTAINED BREATHING APPARATUS. [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

2 If material involved in fire, extinguish fire using agent suitable for type of surrounding fire. Material itself does not burn, or burns with difficulty. [Peer Reviewed] *Association of American*

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Material itself does not burn, or burns with difficulty. [Peer Reviewed] *Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Assoc. of American Railroads,Hazardous Materials Systems (BOE), 1987. 42*

3 Fire Fighting: Any self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive pressure mode. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 4*

Toxic Combustion Products:

POISONOUS GASES MAY BE PRODUCED IN FIRE. [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

Explosive Limits and Potential:

SLIGHT, WHEN EXPOSED TO HEAT OR BY SPONTANEOUS CHEMICAL REACTION (HYDROLYSIS). [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 268*

HAZARDOUS REACTIONS

Reactivities and Incompatibilities:

1 IN HOT ACID SOLN THIS MATERIAL CAN UNDERGO SPONTANEOUS HYDROLYSIS, LIBERATING MUCH HEAT. [Peer Reviewed] *Sax, N.I. Dangerous Properties of Industrial Materials. 6th ed. New York, NY: Van Nostrand Reinhold, 1984. 268*

2 Incompatibilities: Contact with strong oxidizers may cause fires and explosions. Contact with hot water may cause formation of large amounts of steam. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

3 Acids, hot water [Note: Elevated temperature cause a highly exothermic reaction with water]. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

Decomposition:

1 Toxic gases and vapors (such as ... carbon monoxide) may be released when ammonium sulfamate decomposes. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

2 Thermal decomposition begins at 209 deg C; at 260 deg C, it produces sulfur dioxide, sulfur trioxide, nitrogen, water, and traces of other products, chiefly nitrogen compounds. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 951*

3 When heated to decomp ... emits very toxic fumes of /ammonia, nitrogen oxides and sulfur oxides/. [QC Reviewed] *Lewis, R.J. Sax's Dangerous Properties of Industrial Materials. 9th ed. Volumes 1-3. New York, NY: Van Nostrand Reinhold, 1996. 217*

WARNING PROPERTIES

Skin, Eye and Respiratory Irritations:

1 DUST IS IRRITATING TO EYES, NOSE & THROAT. IF INHALED WILL CAUSE COUGHING OR DIFFICULT BREATHING. ... SOLID IS IRRITATING TO SKIN & EYES. [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

2 Not irritating ... on cutaneous application ... [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-123*

PREVENTIVE MEASURES

Protective Equipment and Clothing:

1 Wear rubber gloves, large face shield and impervious clothing. If available use large body shield. [Peer Reviewed] *ITII. Toxic and Hazarous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982. 38*

2 Dust mask; goggles ... [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

3 Recommendations for respirator selection. Max concn for use: 50 mg/cu m. Respirator Class(es): Any dust and mist respirator. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

4 Recommendations for respirator selection. Max concn for use: 100 mg/cu m. Respirator Class(es): Any dust and mist respirator except single-use and quarter-mask respirators. Any supplied-air respirator. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office. June 1994. 16*

5 Recommendations for respirator selection. Max concn for use: 250 mg/cu m. Respirator Class(es): Any supplied-air respirator operated in a continuous flow mode. Any powered, air-purifying respirator with a dust and mist filter. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

6 Recommendations for respirator selection. Max concn for use: 500 mg/cu m. Respirator Class(es): Any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode. Any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter. Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter. Any self-contained breathing apparatus with a full facepiece. Any supplied-air respirator with a full facepiece. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

7 Recommendations for respirator selection. Max concn for use: 1500 mg/cu m. Respirator Class(es): Any supplied-air respirator operated in a pressure-demand or other positive mode. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

8 Recommendations for respirator selection. Condition: Emergency or planned entry into unknown concn or IDLH conditions: Respirator Class(es): Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive pressure mode. Any supplied-air respirator that has a full face piece and is operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

9 Recommendations for respirator selection. Condition: Escape from suddenly occurring

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respiratory hazards: Respirator Class(es): Any air-purifying, full-facepiece respirator with a high-efficiency particulate filter. Any appropriate escape-type, self-contained breathing apparatus. [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

Other Preventative Measures:

1 AVOID PROLONGED CONTACT OF SKIN WITH STRONG SOLN. IN CASE OF CONTACT, WASH OFF WITH PLENTY OF WATER. [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.23 (1983)*

2 If material is not involved in fire, keep material out of water sources and sewers. Build dikes to contain flow as necessary. Keep upwind. Avoid breathing vapors or dusts. [Peer Reviewed] *Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Assoc. of American Railroads,Hazardous Materials Systems (BOE), 1987. 31*

3 Smoking, eating, and drinking before washing should be absolutely prohibited when any pesticide ... is being handled or used. /Pesticides/ [Peer Reviewed] *International Labour Office. Encyclopedia of Occupational Health and Safety. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983. 1619*

4 If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health. In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 2*

5 SRP: The scientific literature for the use of contact lenses inindustry is conflicting. The benefit or detrimental effects of wearing contact lenses depend not only upon the substance, but also on factors including the form of the substance, characteristics and duration of the exposure, the uses of other eye protection equipment, and the hygiene of the lenses. However, there may be individual substances whose irritating or corrosive properties are such that the wearing of contact lenses would be harmful to the eye. In those specific cases, contact lenses should not bewom. In any event, the usual eye protection equipment should be worn even when contact lenses are in place. [Peer Reviewed]

6 Contact lenses should not be worn when working with this chemical. [QC Reviewed] *NIOSH Pocket Guide to Chemical Hazards. 2nd Printing. DHHS (NIOSH) Publ. No. 85-114. Washington, D.C.: U.S. Dept. of Health and Human Services, NIOSH/Supt.of Documents, GPO, February 1987. 51*

OTHER SAFETY AND HANDLING

Stability/Shelf Life:

1 Undergoes negligible hydrolysis at ordinary temp and pH, but the rate incr at higher temp or under more acid conditions. [Peer Reviewed] *Worthing, C.R., S.B. Walker (eds.). The Pesticide Manual - A World Compendium. 7th ed. Lavenham, Suffolk, Great Britain: The Lavenham Press Limited, 1983. 15*

2 Stable in air, dil acid and dil alkali. [Peer Reviewed] *ITII. Toxic and Hazarous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982. 38*

3 Aqueous sulfamic acid solutions are quite stable at room temperature. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 951*

4 Highly stable up to its melting point. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical*

4 Highly stable up to its melting point. [Peer Reviewed] *Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 21(83) 951*

5 Elevated temperatures cause highly exothermic reaction with water; steam may cause container to burst. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

Storage Conditions:

1 Storage temp: ambient [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

2 Rooms used for storage only should be soundly constructed and fitted with secure locks. Floors should be kept clear, and the pesticides clearly identified. /Pesticides/ [Peer Reviewed] *International Labour Office. Encyclopedia of Occupational Health and Safety. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983. 1617*

Cleanup Methods:

1 Environmental considerations - Land spill: Dig a pit, pond, lagoon, or holding area to contain liquid or solid material. /SRP: If time permits, pits, ponds, lagoons, soak holes, or holding areas should be sealed with an impermeable flexible membrane liner./ Cover solids with a plastic sheet to prevent dissolving in rain or fire fighting water. [Peer Reviewed] *Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Assoc. of American Railroads,Hazardous Materials Systems (BOE), 1987. 42*

2 Environmental considerations - Water spill: Add calcium hypochlorite. Adjust pH to neutral (pH 7). Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates. [Peer Reviewed] *Association of American Railroads. Emergency Handling of Hazardous Materials in Surface Transportation. Washington, D.C.: Assoc. of American Railroads,Hazardous Materials Systems (BOE), 1987. 42*

3 Spillages of pesticides at any stage of their storage or handling should be treated with great care. Liquid formulations may be reduced to solid phase by evaporation. Dry sweeping of solids is always hazardous: these should be removed by vacuum cleaning, or by dissolving them in water, or other solvent in the factory environment. /Pesticides/ [Peer Reviewed] *International Labour Office. Encyclopedia of Occupational Health and Safety. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983. 1619*

4 Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed. If ammonium sulfamate is spilled, the following steps should be taken: 1. Ventilate area of spill. 2. Collect spilled material in the most convenient and safe manner and deposit in sealed containers. Liquid containing ammonium sulfamate should be absorbed in vermiculite, dry sand, earth, or similar material. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office. Jan. 1981. 3*

5 Transfer gradually into a large container of cold water while stirring. After completion of reaction, neutralize with either 3M-HCl or 6M-NH4OH according to the pH of the solution. [Peer Reviewed] *ITII. Toxic and Hazarous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982. 38*

Disposal Methods:

At the time of review, criteria for land treatment or burial (sanitary landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal

practices. [Peer Reviewed] *SRP*

5.0 TOXICITY/BIOMEDICAL EFFECTS

SUMMARY

Medical Surveillance:

Routine medical examinations should be made available to each employee who is exposed to ammonium sulfamate at potentially hazardous levels. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

TOXICITY EXCERPTS

Human Toxicity Excerpts:

1 INGESTION CAUSES GI DISTURBANCES. [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

2 Ammonium sulfamate is of low toxicity. ... Repeated application of a 4% solution to the anterior surface of one arm of each of 5 human subjects for 5 days caused no skin irritation. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

Non-Human Toxicity Excerpts:

1 ORAL DOSES AS HIGH AS 1.6 G/KG WERE NOT FATAL IN RATS. NOT IRRITATING ON SUBCUTANEOUS INJECTION IN RATS, ON RABBIT CONJUNCTIVA ... CIRCULATION AND RESPIRATION WERE NOT GREATLY AFFECTED AFTER IV INJECTION OF 100 MG/KG IN RATS. [Peer Reviewed] *Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-123*

2 A CONCN OF 30 PPM AMMONIUM SULFAMATE HAD NO EFFECT ON AQUATIC INVERTEBRATES & RAINBOW TROUT EXPOSED FOR AN UNKNOWN PERIOD. [Peer Reviewed] *MATIDA Y ET AL; TANSUIKU SUISAN KENKYUSHO KENKYU HOKOKU 25 (1): 55-62 (1975)*

3 AN AQ SOLN OF AMMONIUM SULFAMATE WAS APPLIED TO RABBIT SKIN (15% & 30%) & RAT SKIN (15%, 20%, & 30%) ONCE A DAY FOR 20 DAYS. IT CAUSED ONLY SLIGHT SKIN REACTIONS. [Peer Reviewed] *AOYAMA M; NAGOYA MED J 20 (1): 11-20 (1975)*

4 DEER THAT WERE PROVIDED AMMONIUM SULFAMATE IN CRYSTALLINE FORM OR WERE FED TREATED FOLIAGE OF SWEET GUM, POST OAK, WATER OAK, PERSIMMON, & BLACK CHERRY SUFFERED NO ILL EFFECTS FROM DIET. [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.24 (1983)*

5 IN 14 DAYS CONTINUOUS ADMIN TO QUAIL IN FEED, 150 & 590 MG/KG/DAY PRODUCED NO CHANGE IN BODY WT OR ANY OTHER NOTICEABLE CHANGES. FERTILITY OF QUAIL WAS NOT AFFECTED BY 2 PERIODS OF 10 DAYS CONTINUOUS ADMIN OF MIXED FEED CONTAINING AMMONIUM SULFAMATE AT RATE OF 150 MG/KG/DAY. MEDIAL TOLERANCE LIMIT (48 HR) TO YOUNG CARP IS 1,000-2,000 PPM (NO DEATHS AT 500 PPM). [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.24 (1983)*

6 CONTINUOUS FEEDING OF 1% (10,000 PPM) AMMONIUM SULFAMATE IN DIET OF RATS FOR 105 DAYS PRODUCED NO CLINICAL SIGNS OF TOXICITY NOR

6 RATS FOR 105 DAYS PRODUCED NO CLINICAL SIGNS OF TOXICITY NOR HISTOLOGICAL CHANGES; 2% IN DIET (20,000 PPM) RESULTED IN GROWTH INHIBITION, BUT NO HISTOLOGICAL EFFECTS. REPEATED APPLICATIONS OF 20% OR 50% AQ SOLN OF AMMONIUM SULFAMATE TO SHAVED SKIN OF RATS CAUSED NO IRRITATION, AND NO SIGNS OF SYSTEMIC TOXICITY. [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.25 (1983)*

7 RATS WERE EXPOSED TO 100, 250, OR 500 MG/KG DOSES OVER 90 DAYS ON A 6 DAY A WK SCHEDULE. AT 60 DAYS BODY WT IN ADULTS WERE LESS THAN CONTROLS & FOOD INTAKE DECR IN ALL GROUPS. NON-SIGNIFICANT INCR IN NEUTROPHILS IN ADULT & MALE WEANLING RATS NOTED @ 90 DAYS. ORGANS APPEARED NORMAL. [Peer Reviewed] *GUPTA BN ET AL; TOXICOLOGY 13 (1): 45-9 (1979)*

8 Instillation of 0.5 ml of a 4% solution in water in the conjunctival sac of rabbits, ammonium sulfamate produced no irritaion. [Peer Reviewed] *Grant, W.M. Toxicology of the Eye. 3rd ed. Springfield, IL: Charles C. Thomas Publisher, 1986. 93*

9 In rats, the ip injection of 0.8 g/kg caused the death of 6 to 10 animals; effects were stimulation of respiration and prostration. [Peer Reviewed] *Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) PublicationNo. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981. 1*

10 Strongly phytotoxic [Peer Reviewed] *Spencer, E. Y. Guide to the Chemicals Used in Crop Protection. 7th ed. Publication 1093. Research Institute, Agriculture Canada, Ottawa, Canada: Information Canada, 1982. 16*

PHARMACOKINETICS

Absorption, Distribution and Excretion:

RAPIDLY ABSORBED THROUGH FOLIAGE & GREEN STEMS ... TRANSLOCATION HAS BEEN DEMONSTRATED IN WOODY PLANTS ... [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.23 (1983)*

7.0 ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

POLLUTION SOURCES

Artificial Sources:

The use of urea-formaldehyde resins as temporary binders in the firing of refractories and ceramics at high temperatures can lead to the formation of substantial deposits of ammonium sulfamate in the cooler parts of kilns, should a fuel oil containing appreciable amount of sulfur be used for firing. Ammonia from decomposition of the resin combines with sulfur trioxide to form ammonium sulfamate which accumulates as either a solidified deposit in flues or as a white deposit on walls. . . [Peer Reviewed] *Bretherick, L. Handbook of Reactive Chemical Hazards. 3rd ed. Boston, MA: Butterworths, 1985. 1208*

ENVIRONMENTAL TRANSFORMATIONS

Biodegradation:

STRAINS OF AUREOBASIDUM (PULLULARIA) PULLULANS, APHALOSPORIUM ACREMONIUM, & 2 UNIDENTIFIED SPECIES OF ACHROMOBACTER & FLAVOBACTERIUM USED SULFAMIC

& 2 UNIDENTIFIED SPECIES OF ACHROMOBACTER & FLAVOBACTERIUM USED SULFAMIC ACID (SODIUM SALT) AS SOURCE OF NITROGEN. BOTH FUNGI & BACTERIA CONVERTED SULFAMATE TO SULFATE IN APPROX EQUIMOLAR PROP TO AMT OF NITROGEN ASSIMILATED. [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.24 (1983)*

ENVIRONMENTAL TRANSPORT

Bioconcentration:

Food chain concn potential: none [Peer Reviewed] *U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.*

Soil Adsorption/Mobility:

FROM ITS LACK OF RESPONSE TO SOIL TYPE & ITS BEHAVIOR IN FIELD PLOTS ... /IT WAS/ CONCLUDED THAT AMS IS NOT RETAINED IN SOIL, BUT MOVES WITH SOIL MOISTURE LIKE CHLORATE. [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.23 (1983)*

HUMAN EXPOSURE

Probable Routes of Human Exposure:

Inhalation, ingestion, skin, and eye contact. [Peer Reviewed] *Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985. 76*

8.0 EXPOSURE STANDARDS AND REGULATIONS

STANDARDS AND REGULATIONS

Immediately Dangerous to Life or Health: 1500 mg/cu m [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

Allowable Tolerances:

A tolerance of 5 ppm is established for residues to the herbicide ammonium sulfamate in or on apples or pears. [Peer Reviewed] *40 CFR 180.188 (7/1/87)*

OCCUPATIONAL PERMISSIBLE LEVELS

OSHA Standards:

8-hr time-weighted average: 15 mg/cu m. [Peer Reviewed] *29 CFR 1910.1000 (7/1/87)*

NIOSH Recommendations:

1 10 hr Time-Weighted avg: 10 mg/cu m (total particulate). [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

D.C.: U.S. Government Printing Office, June 1994. 16

2 10 hr Time-Weighted avg: 5 mg/cu m (respirable fraction). [QC Reviewed] *NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116. Washington, D.C.: U.S. Government Printing Office, June 1994. 16*

Threshold Limit Values:

1 8 hr Time Weighted Avg (TWA) 10 mg/cu m (1986) [QC Reviewed] *American Conference of Governmental Industrial Hygienists. Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and BiologicalExposure Indices (BEIs) for 1995-1996. Cincinnati, OH: ACGIH, 1995. 13*

2 Excursion Limit Recommendation: Excursions in worker exposure levels may exceed three times the TLV-TWA for no more than a total of 30 min during a work day, and under no circumstances should they exceed five times the TLV-TWA, provided that the TLV-TWA is not exceeded. [QC Reviewed] *American Conference of Governmental Industrial Hygienists. Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and BiologicalExposure Indices (BEIs) for 1995-1996. Cincinnati, OH: ACGIH, 1995. 5*

OTHER STANDARDS AND REGULATIONS

Federal Drinking Water Guidelines: EPA 2000 ug/l *USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC). Summary of State and Federal Drinking Water Standards and Guidelines (11/93)*

State Drinking Water Guidelines: (ME) MAINE 1500 ug/l *USEPA/Office of Water; Federal-State Toxicology and Risk Analysis Committee (FSTRAC). Summary of State and Federal Drinking Water Standards and Guidelines (11/93)*

Clean Water Act Requirements:

Designated as a hazardous substance under section 311(b)(2)(A) of the Federal Water Pollution Control Act and further regulated by the Clean Water Act Amendments of 1977 and 1978. These regulations apply to discharges of this substance. *40 CFR 116.4 (7/1/87)*

CERCLA Reportable Quantities:

Persons in charge of vessels or facilities are required to notify the National Response Center (NRC) immediately, when there is a release of this designated hazardous substance, in an amount equal to or greater than its reportable quantity of 5,000 lb or 2270 kg. The toll free telephone number of the NRC is (800) 424-8802; in the Washington metropolitan area (202) 426-2675. The rule for determining when notification is required is stated in 40 CFR 302.6 (see section IV. D.3.b). [Peer Reviewed] *50 FR 13456 (4/4/85)*

FIFRA Requirements:

A tolerance is established for residues of the herbicide ammonium sulfamate in or on apples or pears. [Peer Reviewed] *40 CFR 180.188 (7/1/87)*

FDA Requirements:

Ammonium sulfamate is an indirect food additive for use only as a component of adhesives. [Peer Reviewed] *21 CFR 175.105 (4/1/86)*

9.0 MONITORING AND ANALYSIS METHODS

Sampling Procedures:

MATRIX: AIR; PROCEDURE: FILTER COLLECTION, EXTRACTION WITH WATER [Peer Reviewed] *U.S. Department of Health, Education Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety Health. NIOSH Manual ofAnalytical Methods. 2nd ed. Volumes 1-7. Washington, DC: U.S. Government Printing Office, 1*

Analytical Laboratory Methods:

1 MATRIX: AIR; PROCEDURE: ION CHROMATOGRAPHY; RANGE: 6.4-27.3 MG/CU M; PRECISION (COEFFICIENT OF VARIATION): 0.056 [Peer Reviewed] *U.S. Department of Health, Education Welfare, Public Health Service. Center for Disease Control, National Institute for Occupational Safety Health. NIOSH Manual ofAnalytical Methods. 2nd ed Volumes 1-7. Washington, DC: U.S. Government Printing Office, 1*

2 DETERMINATION OF AMMONIUM SULFAMATE RESIDUES IN CERTAIN FRUITS CAN BE MADE BY SPECTROPHOTOMETRIC METHOD, ABSORPTION PEAK BEING AT 655 NM (PEASE, HARLAN L 1966. DETERMINATION OF SULFAMATE RESIDUES. J AGR FOOD CHEM 14: 140-2). [Peer Reviewed] *HERBICIDE HANDBOOK OF THE WEED SOCIETY OF AMERICA 5TH ED p.25 (1983)*

10.0 ADDITIONAL REFERENCES

Special Reports:

Information regarding reregistration of pesticide products containing ammonium sulfamate, including how to register under a registration std, regulatory position & rationale, & summaries of data requirements & data gaps is presented. Also, included is a bibliography containing citations of all studies reviewed by the EPA in arriving at the positions & conclusions contained in the standard. *USEPA; Ammonium Sulfamate: Pesticide Registration Standard; Report: 115 pages (1981) Iss EPA-540/RS-81/012; Order No PB82-133570*

Ammonium sulfamate

IRIS - Integrated Risk Information System

0007 Ammonium sulfamate; CASRN 7773-06-0 (10/01/97)

Health assessment information on a chemical substance is included in IRIS only after a comprehensive review of chronic toxicity data by U.S. EPA health scientists from several Program Offices and the Office of Research and Development. The summaries presented in Sections I and II represent a consensus reached in the review process. Background information and explanations of the methods used to derive the values given in IRIS are provided in the Background Documents.

STATUS OF DATA FOR Ammonium sulfamate

File On-Line 01/31/87

Category (section)	Status	Last Revised
Oral RfD Assessment (I.A.)	on-line	03/01/91
Inhalation RfC Assessment (I.B.)	no data	
Carcinogenicity Assessment (II.)	no data	

I. CHRONIC HEALTH HAZARD ASSESSMENTS FOR NONCARCINOGENIC EFFECTS

I.A. REFERENCE DOSE FOR CHRONIC ORAL EXPOSURE (RfD)

Substance Name -- Ammonium sulfamate
CASRN -- 7773-06-0
Last Revised -- 03/01/91
The oral Reference Dose (RfD) is based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis. It is expressed in units of mg/kg-day. In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Please refer to the Background Document for an elaboration of these concepts. RfDs can also be derived for the noncarcinogenic health effects of substances that are also carcinogens. Therefore, it is essential to refer to other sources of information concerning the carcinogenicity of this substance. If the U.S. EPA has evaluated this substance for potential human carcinogenicity, a summary of that evaluation will be contained in Section II of this file.

I.A.1. ORAL RfD SUMMARY

Critical Effect	Experimental Doses*	UF	MF	RfD
Decrease in body weights 90-Day Rat Feeding Study Gupta et al., 1979	NOEL: 214.3 mg/kg/day LEL: 428.6 mg/kg/day	1000	1	2E-1 mg/kg/day

*Conversion Factors: Actual dose tested x 6/7 (6 days/week)

I.A.2. PRINCIPAL AND SUPPORTING STUDIES (ORAL RfD)

Gupta, B.N., R.N. Khanna and K.K. Datta. 1979. Toxicological studies of ammonium sulfamate in rat after repeated oral administration. Toxicology. 13(1): 45-49.

Rats were administered ammonium sulfamate 6 days/week for 90 days at the following dose levels: 0 (group 1), 100 (group 2), 250 (group 3) and 500 mg/kg/day (group 4) [Dose Conversion: 85.7, 214.3, and 428.6). No adverse effects were observed in respect of appearance, behavior or survival of animals. No significant difference in the body weights of rats was observed except in case of adult rats (group 4) where the body weight was significantly less than the controls after the end of 60 days. Results included gradually reduced food intake and increased water intake. No significant change in relative organ weights were noticed in all groups of rats.

I.A.3. UNCERTAINTY AND MODIFYING FACTORS (ORAL RfD)

UF -- An uncertainty factor of 100 was to account for the inter- and intraspecies differences. An additional UF of 10 was used to account for the fact that the most sensitive toxicological endpoint has not been determined; i.e. the lack of chronic exposure studies.

MF -- None

I.A.4. ADDITIONAL COMMENTS (ORAL RfD)

Data Considered for Establishing the RfD

1) 90-Day Feeding - rat: Principal study - see previous description; no core grade

2) 3-Generation Reproduction - rat: Reproduction NOEL=500 ppm (25 mg/kg/day); no core grade (du Pont, 1966)

3) 105-Day Feeding - rat: NOEL=10,000 ppm (500 mg/kg/day) (1%); LEL=20,000 ppm (1000 mg/kg/day) (inhibited growth weights and induced a slight cathartic action); no core grade (Rosen et al., 1965)

4) 6-Day Feeding - dog: Dogs fed 1 g of test material for 6 days; No systemic effects were observed: no core grade (Ambrose, 1943)

Data Gap(s): Chronic Rat Feeding Study; Chronic Dog Feeding Study; Rat Teratology Study; Rabbit Teratology

I.A.5. CONFIDENCE IN THE ORAL RfD

Study -- Medium
Data Base -- Low
RfD -- Low
The critical study is of fair quality and is given a medium confidence rating. Since there are major data gaps existing for ammonium sulfamate, the data base is given a low confidence rating. Low confidence in the RfD follows.

I.A.6. EPA DOCUMENTATION AND REVIEW OF THE ORAL RfD

Pesticide Registration Files

Agency Work Group Review -- 06/24/86, 07/20/88
Verification Date -- 07/20/88

I.A.7. EPA CONTACTS (ORAL RfD)

Please contact the Risk Information Hotline for all questions concerning this assessment or IRIS, in general, at (513)569-7254 (phone), (513)569-7159 (FAX) or RIH.IRIS@EPAMAIL.EPA.GOV (internet address).

I.B. REFERENCE CONCENTRATION FOR CHRONIC INHALATION EXPOSURE (RfC)

Substance Name -- Ammonium sulfamate
CASRN -- 7773-06-0
Not available at this time.

II. CARCINOGENICITY ASSESSMENT FOR LIFETIME EXPOSURE

Substance Name -- Ammonium sulfamate
CASRN -- 7773-06-0
Not available at this time.

VI. BIBLIOGRAPHY

Substance Name -- Ammonium sulfamate
CASRN -- 7773-06-0
Last Revised -- 03/01/91

VI.A. ORAL RfD REFERENCES

Ambrose, A.M. 1943. Studies on the physiological effects of sulfamic acid and ammonium sulfamate. J. Ind. Hyg. Toxicol. 25(1): 26-28.

E.I. du Pont de Nemours & Company, Inc. 1966. MRID No. 00092903, 00143472, 00145269. Available from EPA. Write to FOI, EPA, Washington, DC 20460.

Gupta, B.N., R.N. Khanna and K.K. Datta. 1979. Toxicological studies of ammonium sulfamate in rat after repeated oral administration. Toxicology. 13(1): 45-49.

Rosen, D.E., C.J. Krister, H. Sherman, E.F. Stula. 1965. Toxicity studies on ammonium sulfamate. The Toxicologist. Fourth Ann. Meeting Society of Toxicology, Williamsburg, Va. March 8-10.

VI.B. INHALATION RfC REFERENCES

None

VI.C. CARCINOGENICITY ASSESSMENT REFERENCES

None

VII. REVISION HISTORY

Substance Name -- Ammonium sulfamate
CASRN -- 7773-06-0

Date	Section	Description
03/01/88	I.A.1.	Critical effect identified, LOAEL specified
03/01/88	I.A.2.	Principal study citation corrected
03/01/88	I.A.2.	Text revised
12/01/88	I.A.	Withdrawn; new RfD verified (in preparation)
01/01/89	I.A.	Oral RfD summary replaced; RfD changed
03/01/91	I.A.4.	Citations added
03/01/91	III.A.	Health Adviosry on-line
03/01/91	VI.	Bibliography on-line
06/01/91	III.A.4.	70-kg 'child' corrected to 70-kg adult in assumptions
01/01/92	IV.	Regulatory actions updated

SYNONYMS

Substance Name -- Ammonium sulfamate
CASRN -- 7773-06-0
Last Revised -- 01/31/87

7773-06-0
AMCIDE
AMICIDE
AMMAT
AMMATE
AMMATE X
AMMONIUM AMIDOSULFONATE
AMMONIUM AMIDOSULPHATE
AMMONIUMSALZ DER AMIDOSULFONSAURE
Ammonium Sulfamate
AMMONIUM SULPHAMATE
AMS
IKURIN
MONOAMMONIUM SULFAMATE
NA 9089
SULFAMATE, AMMONIUM
SULFAMIC ACID, MONOAMMONIUM SALT
SULFAMINSAURE