

INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

Health and Safety Guide No. 76

H11H  
NO 10  
146

# 1,3-DICHLOROPROPENE, 1,2-DICHLOROPROPANE

AND MIXTURES

## HEALTH AND SAFETY GUIDE



UNEP

UNITED NATIONS  
ENVIRONMENT PROGRAMME



INTERNATIONAL  
LABOUR ORGANISATION



WORLD HEALTH  
ORGANIZATION

WORLD HEALTH ORGANIZATION, GENEVA 1992

# IPCS

Other HEALTH AND SAFETY GUIDES available:

1. Acrylonitrile
2. Kelevan
3. 1-Butanol
4. 2-Butanol
5. 2,4-Dichlorophenoxyacetic Acid (2,4-D)
6. Methylene Chloride
7. *tert*-Butanol
8. Epichlorohydrin
9. Isobutanol
10. Tetrachloroethylene
11. Tetradifon
12. Tecnazene
13. Chlordane
14. Heptachlor
15. Propylene Oxide
16. Ethylene Oxide
17. Endosulfan
18. Dichlorvos
19. Pentachlorophenol
20. Dimethoate
21. Aldrin and Dieldrin
22. Cypermethrin
23. Quintozene
24. Allethrin
25. Resmethrin
26. Pyrrolizidine Alkaloids
27. Magnetic Fields
28. Phosphine
29. Dimethyl Sulfate
30. Deltamethrin
31. Tetramethrin
32.  $\alpha$ -Phenothrin
33. Permethrin
34. Fenvalerate
35. Phosphorus Trichloride and Phosphorus Oxychloride
36. Vinylidene Chloride
37. Ammonia
38. Cyhalothrin and Lambda-Cyhalothrin
39. Mirex
40. Camphchlor
41. Chlordecone
42. Vanadium
43. Dimethylformamide
44. Beryllium
45. Acrylamide
46. Barium
47. Atrazine
48. Bentazone
49. Captafol
50. Captan
51. Paraquat
52. Diquat
53. Alpha- and Beta-Hexachlorocyclohexane
54. Lindane
55. 1,2-Dichloroethane
56. Hydrazine
57. Formaldehyde
58. Methyl Isobutyl Ketone
59. *n*-Hexane
60. Endrin
61. Isobenzan
62. Nickel, Nickel Carbonyl, and some Nickel Compounds
63. Hexachlorocyclopentadiene
64. Aldicarb
65. Fenitrothion
66. Trichlorfon
67. Acrolein
68. Polychlorinated biphenyls and polychlorinated terphenyls (PCBs and PCTs)
69. Dimethylarsinic acid, methanearsonic acid, and salts
70. Inorganic arsenic compounds other than arsine
71. Trimellitic anhydride
72. Folpet
73. Rotenone
74. Parathion
75. Methyl parathion

**IPCS**

Health and Safety Guide No. 76

**1,3-DICHLOROPROPENE,  
1,2-DICHLOROPROPANE  
AND MIXTURES  
HEALTH AND SAFETY  
GUIDE**

This is a companion volume to  
Environmental Health Criteria 146: Dichloropropene,  
Dichloropropane and mixtures

Published by the World Health Organization for the International  
Programme on Chemical Safety (a collaborative programme of the United  
Nations Environment Programme, the International Labour Organisation,  
and the World Health Organization)

**WORLD HEALTH ORGANIZATION, GENEVA 1992**

This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of the United Nations Environment Programme, the International Labour Organisation, or the World Health Organization

#### WHO Library Cataloguing in Publication Data

1,3-dichloropropene, 1,2-dichloropropane and mixtures: health and safety guide.

(Health and safety guide ; no. 76)

1. Allyl compounds - adverse effects 2. Allyl compounds - standards 3. Hydrocarbons, Chlorinated - standards 4. Hydrocarbons, Chlorinated - toxicity 5. Propane - analogs & derivatives 6. Propane - standards 7. Propane - toxicity 1. Series

ISBN 92 4 151076 5  
ISSN 0259-7268

(NLM Classification: QV 633)

The World Health Organization welcomes requests for permission to reproduce or translate its publications, in part or in full. Applications and enquiries should be addressed to the Office of Publications, World Health Organization, Geneva, Switzerland, which will be glad to provide the latest information on any changes made to the text, plans for new editions, and reprints and translations already available.

© World Health Organization 1992

Publications of the World Health Organization enjoy copyright protection in accordance with the provisions of Protocol 2 of the Universal Copyright Convention. All rights reserved.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

# CONTENTS

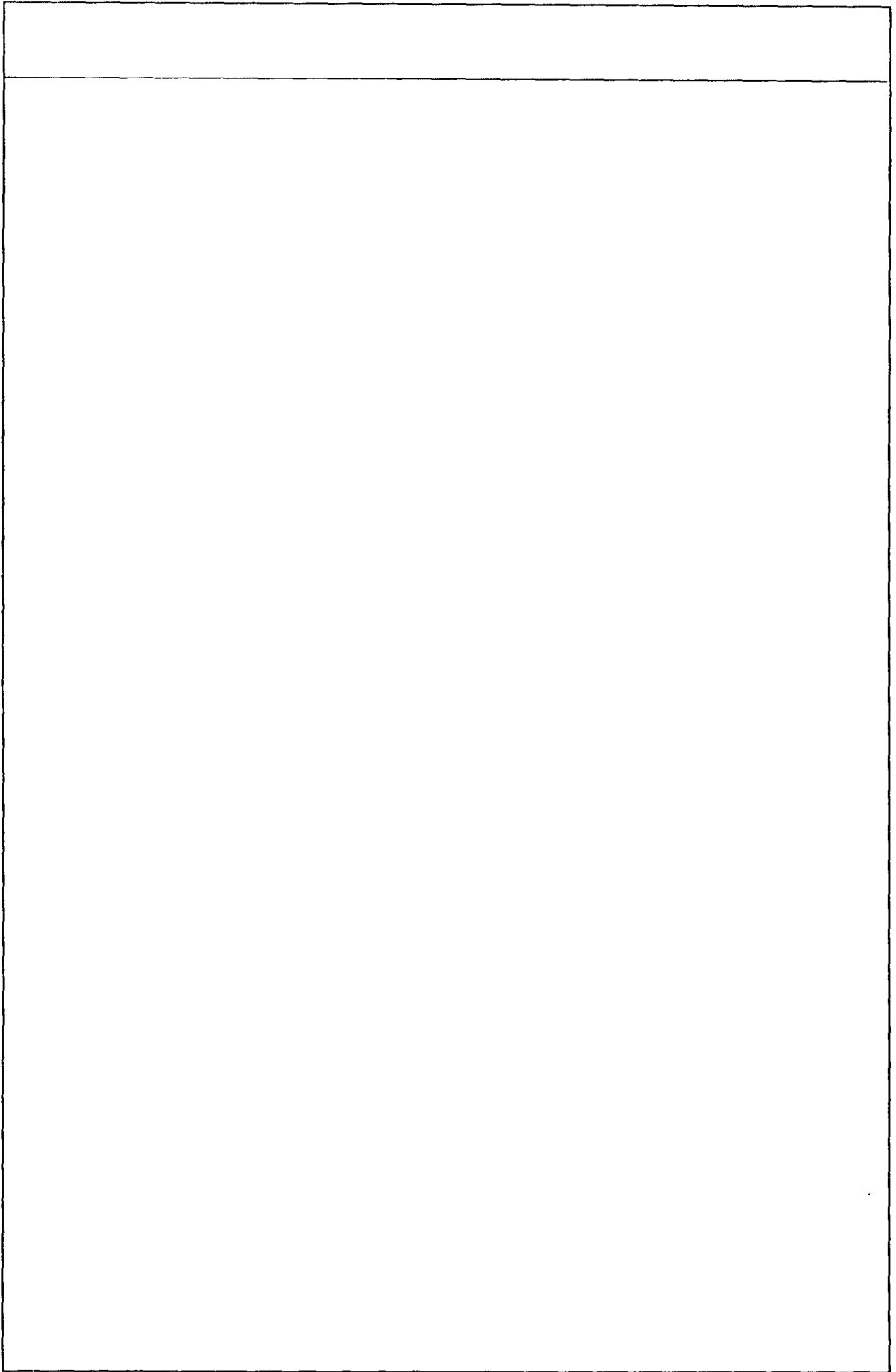
	Page
INTRODUCTION . . . . .	7
1. PRODUCT IDENTITY AND USES . . . . .	9
1.1 Identity . . . . .	9
1.1.1 1,3-Dichloropropene . . . . .	9
1.1.2 1,2-Dichloropropene . . . . .	10
1.1.3 Mixtures of 1,3-dichloropropene and 1,2-dichloropropene . . . . .	10
1.2 Physical and chemical properties . . . . .	11
1.2.1 1,3-Dichloropropene . . . . .	11
1.2.2 1,2-Dichloropropene . . . . .	11
1.2.3 "Mix D/D" . . . . .	12
1.3 Analytical methods . . . . .	13
1.4 Production and uses . . . . .	13
1.4.1 1,3-Dichloropropene . . . . .	13
1.4.2 1,2-Dichloropropene . . . . .	13
1.4.3 "Mix D/D" . . . . .	13
2. 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS . . . . .	14
2.1 Summary and evaluation . . . . .	14
2.1.1 Environmental fate . . . . .	14
2.1.2 Kinetics and metabolism . . . . .	15
2.1.3 Effects on organisms in the environment . . . . .	16
2.1.4 Effects on experimental animals and <i>in vitro</i> test systems . . . . .	16
2.1.2.1 Mode of action . . . . .	19
2.1.5 Effects on human beings . . . . .	20
2.2 Conclusions . . . . .	21
2.2.1 General population . . . . .	21
2.2.2 Occupational exposure . . . . .	21
2.2.3 Environment . . . . .	21
2.3 Recommendations . . . . .	21

# CONTENTS

3. 1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION	
CONCLUSIONS AND RECOMMENDATIONS . . . . .	22
3.1 Summary and evaluation . . . . .	22
3.1.1 Environmental fate and occurrence . . . . .	22
3.1.2 Kinetics and metabolism . . . . .	22
3.1.3 Effects on organisms in the environment . . . . .	23
3.1.4 Effects on experimental animals and <i>in vitro</i> test systems . . . . .	24
3.1.5 Effects on human beings . . . . .	25
3.2 Conclusions . . . . .	26
3.2.1 General population . . . . .	26
3.2.2 Occupational exposure . . . . .	26
3.2.3 Environment . . . . .	26
3.3 Recommendations . . . . .	27
4. "MIX D/D": SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS . . . . .	28
4.1 Summary and evaluation . . . . .	28
4.1.1 Environmental fate and occurrence . . . . .	28
4.1.2 Kinetics and metabolism . . . . .	28
4.1.3 Effects on organisms in the environment . . . . .	28
4.1.4 Effects on experimental animals and <i>in vitro</i> test systems . . . . .	29
4.1.5 Effects on humans beings . . . . .	30
4.2 Conclusions . . . . .	30
4.2.1 General population . . . . .	30
4.2.2 Occupational exposure . . . . .	30
4.2.3 Environment . . . . .	31
4.3 Recommendations . . . . .	31
5. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION . . . . .	32
5.1 Human health hazards, prevention and protection, first aid . . . . .	32
5.1.1 Advice to physicians . . . . .	32
5.1.1.1 Symptoms of poisoning . . . . .	32
5.1.1.2 First aid . . . . .	32

# CONTENTS

5.1.1.3 Medical advice . . . . .	35
5.1.2 Health surveillance advice . . . . .	35
5.1.3 Personal hygiene . . . . .	35
5.2 Explosion and fire hazards . . . . .	36
5.3 Storage . . . . .	36
5.4 Transport . . . . .	36
5.5 Spillage and disposal . . . . .	36
5.5.1 Spillage . . . . .	36
5.5.2 Disposal . . . . .	37
6. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION . . . . .	38
7. CURRENT REGULATIONS, GUIDELINES, AND STANDARDS . . . . .	39
7.1 Previous evaluations by international bodies . . . . .	39
7.2 Exposure limit values . . . . .	39
7.3 Specific restrictions . . . . .	39
7.4 Labelling, packaging, and transport . . . . .	42
7.5 Waste disposal . . . . .	43
BIBLIOGRAPHY . . . . .	44





# INTRODUCTION

The Environmental Health Criteria (EHC) documents produced by the International Programme on Chemical Safety include an assessment of the effects on the environment and on human health of exposure to a chemical or combinations of chemicals, or physical or biological agents. They also provide guidelines for setting exposure limits.

The purpose of a Health and Safety Guide is to facilitate the application of these guidelines in national chemical safety programmes. The first four sections of this Health and Safety Guide highlight the relevant technical information in the corresponding EHC. Section 5 includes advice on preventive and protective measures and emergency action; health workers should be thoroughly familiar with the medical information to ensure that they can act efficiently in an emergency. The section on regulatory information has been extracted from the legal file of the International Register of Potentially Toxic Chemicals (IRPTC) and from other United Nations sources.

The target readership includes occupational health services, those in ministries, governmental agencies, industry, and trade unions who are involved in the safe use of chemicals and the avoidance of environmental health hazards, and those wanting more information on this topic. An attempt has been made to use only terms that will be familiar to the intended user. However, sections 1 and 2 inevitably contain some technical terms. A bibliography has been included for readers who require further background information.

Revision of the information in this Guide will take place in due course, and the eventual aim is to use standardized terminology. Comments on any difficulties encountered in using the Guide would be very helpful and should be addressed to:

The Director  
International Programme on Chemical Safety  
World Health Organization  
1211 Geneva 27  
Switzerland

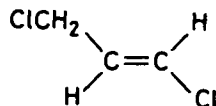
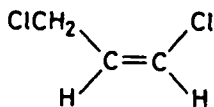
THE INFORMATION IN THIS GUIDE  
SHOULD BE CONSIDERED AS A  
STARTING POINT TO A COMPREHENSIVE  
HEALTH AND SAFETY PROGRAMME

# 1. PRODUCT IDENTITY AND USES

## 1.1 Identity

### 1.1.1 1,3-Dichloropropene

Chemical structure:



*cis*- or (Z) 1,3-dichloropropene

*trans*- or (E) 1,3-dichloropropene

Chemical formula: C<sub>3</sub>H<sub>4</sub>Cl<sub>2</sub>

Relative molecular mass: 110.98

Chemical name: 1,3-dichloropropene; dichloro-1,3-propene;  
1,3 dichloro-1-propene

Common synonyms: chloroallylchloride, 1,3-dichloropropylene

Trade name: Telone II<sup>®</sup>

CAS registry number: 542-75-6

*cis*-isomer: 10061-01-5

*trans*-isomer: 10061-02-6

RTECS registry number: UC8310000

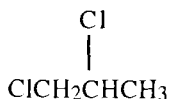
## PRODUCT IDENTITY AND USES

Commercial 1,3-dichloropropene is a mixture of *cis*- and *trans*- isomers and 92% pure. It may also be used in admixtures with 1,2-dibromoethane (Dorlonge<sup>®</sup>) or with 1,2-dichloropropane (D-D<sup>®</sup>, soil fumigant; Nemex<sup>®</sup>; Telone<sup>®</sup>, and Vidden D<sup>®</sup>); 1% epichlorohydrin is added in certain countries as a stabilizer.

Other names include: Dedisol C, Nematox II, D-D 95, Telone 2000 (Hayes 1982; Worthing & Hance, 1991).

### 1.1.2 1,2-Dichloropropane

Chemical structure:



Chemical formula:	C <sub>3</sub> H <sub>6</sub> Cl <sub>2</sub>
Relative molecular mass:	113.0
Chemical name;	1,2-dichloropropane, dichloro-1,2-propane
Common synonyms:	propylene dichloride
CAS registry number:	78-87-5
RTECS registry number:	TX9625000

### 1.1.3 Mixtures of 1,3-dichloropropene and 1,2-dichloropropane (in text abbreviated to "Mix D/D")

"D-D" is the internationally registered trademark for a mixture of chlorinated hydrocarbons containing not less than 50% 1,3-dichloropropene (*cis*- and *trans*-isomer), 20-35% 1,2-dichloropropane, and 15-30% 3,3-dichloropropene, 2,3-dichloropropene, and other related chlorinated hydrocarbons. It may also contain 1% epichlorohydrin as a stabilizer.

CAS registry number:	8003-19-8
----------------------	-----------

# PRODUCT IDENTITY AND USES

Major trade names: DD mixture, Nemaferne, Nemax, Vidden-D. Other formulations on the market are Ditrापex (a mixture of 1,2-dichloropropane, 1,3-dichloropropane and methylisothiocyanate), Ditrापex CP (the same mixture as Ditrापex with the addition of chloropicrin).

## 1.2 Physical and chemical properties

### 1.2.1 1,3-Dichloropropane

1,3-Dichloropropane is a white to amber coloured liquid with penetrating and irritating chloroform-like odour. The technical product is a 92% mixture of the *cis*- and *trans*-isomers. It is flammable; the vapour is heavier than air and may travel along the ground; distant ignition is possible. The substance decomposes in a flame or on a hot surface forming highly toxic (phosgene) and corrosive (hydrochloric acid) gases. It reacts with light metals, with the generation of heat. It reacts violently with strong oxidants, acids, and bases, causing a fire and explosion hazard.

Table 1. Physical properties of 1,3-dichloropropane

Boiling point (°C)	108
Flash point (°C)	25
Relative density (water = 1)	1.22
Relative vapour density (air = 1)	3.8
Vapour pressure (20 °C)	3.7 kPa
Explosive limits (vol. % in air)	5.3–14.5
Relative molecular mass	111.0
Log P <sub>ow</sub>	1.4–2.0
Solubility in water (20 °C)	2.0 g/kg
Miscible with:	acetone, benzene, carbon tetrachloride, heptane, and methanol
Conversion factor	1 ppm = 4.54 mg/m <sup>3</sup> (at 25 °C)

### 1.2.2 1,2-Dichloropropane

1,2-Dichloropropane is a colourless liquid with a characteristic odour. It is highly flammable; the vapour is heavier than air and may travel along the ground; distant ignition is possible. The substance decomposes in a flame or on a hot surface, forming highly toxic (phosgene) and corrosive

## PRODUCT IDENTITY AND USES

(hydrochloric acid) gases. It reacts with light metals with the generation of heat. The liquid degrades the skin. It reacts violently with strong oxidants, acids, and bases, causing a fire and explosion hazard. It is corrosive to aluminium alloys.

Table 2. Physical properties of 1,2-dichloropropane

Boiling point (°C)	96
Melting point (°C)	-100
Flash point (°C) (o.c.)	21
Autoignition temperature (°C)	557
Relative density (water = 1)	1.156
Relative vapour density (air = 1)	3.9
Vapour pressure (20 °C)	56 mbar
Explosive limits (vol. % in air)	3.4-14.5
Relative molecular mass	113.0
Log P <sub>ow</sub>	2.28
Solubility in water (20 °C)	2.7 g/kg
Soluble in:	ethanol and methyl ether
Conversion factors	1 ppm = 4.66 mg/m <sup>3</sup> 1 mg/m <sup>3</sup> = 0.214 ppm

### 1.2.3 "Mix D/D"

"Mix D/D" is an amber liquid with a pungent odour. It is flammable; the vapour is heavier than air and may travel along the ground; distant ignition is possible. The mixture is stable up to 500 °C but reacts with dilute organic bases, concentrated acids, halogens, and some metal salts. It is corrosive to some metals (e.g., aluminium, magnesium, and their alloys), and may remove lacquer from lacquer-lined containers. It is not corrosive to mild steel. The mixture decomposes in a flame or on a hot surface, forming highly toxic (phosgene) and corrosive (hydrochloric acid) gases. It degrades the skin.

Table 3. Physical properties of "Mix D/D"

Boiling point (°C)	59-115
Flash point (°C) (o.c.)	10
Relative density (g/m <sup>3</sup> ; 20 °C)	1.17-1.22
Vapour pressure (20 °C)	4.6 kPa
Solubility in water	2 g/kg
Soluble in:	hydrocarbon solvents, halogenated solvents, esters, ketones

## PRODUCT IDENTITY AND USES

### 1.3 Analytical methods

Current methods are based on gas chromatography (GC).

In the case of crops, water, and soil, special care should be taken in the handling of samples, because of the high volatility of these substances.

### 1.4 Production and uses

#### 1.4.1 *1,3-Dichloropropene*

1,3-Dichloropropene was introduced in 1956, as a soil fumigant for the control of nematodes in vegetables, potatoes, and tobacco. It is used worldwide and manufactured in ten thousands of tonnes/annum.

#### 1.4.2 *1,2-Dichloropropane*

1,2-Dichloropropane is a solvent for fats and oils and is used as a component of certain furniture finishes, dry cleaning fluids, and paint removers. It has also been used as an insecticidal fumigant on grain and soil and to control peach tree borers. Other uses are in gum processing, metal degreasing, oil processing, and organic chemical synthesis. It is a chemical intermediate for the production of tetrachloroethylene and carbon tetrachloride. It is a component of "Mix D/D".

#### 1.4.3 "*Mix D/D*"

"Mix D/D" is a preplant nematocide effective against soil nematodes including root knot, meadow, sting and dagger, spiral and sugar beet nematodes. "Mix D/D" is usually applied by injection into the soil or through tractor-drawn hollow tines, to a depth of 15–20 cm at a rate of 150–400 litre/ha (occasionally to a maximum of 1000 litre/ha), depending on the soil type and following crop. The soil surface is sealed by rolling. "Mix D/D" volatilizes and diffuses as a vapour, and, thus, its effectiveness depends on how readily this can occur. Because the components of "Mix D/D" are highly phytotoxic, it is essential that, after an application of 220 litre/ha or more, a period of not less than 14 days should elapse before planting or sowing.

## 2. 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

### 2.1 Summary and evaluation

#### 2.1.1 *Environmental fate*

In air, decomposition of 1,3-dichloropropene is mainly by reaction with free radicals and ozone. The half-lives for *cis*- and *trans*-isomers for the reaction with free radicals are 12 and 7 h, respectively, and for the reaction with ozone, 52 and 12 days. Direct phototransformation seems to be insignificant, but may be enhanced in the presence of atmospheric particles.

In water, 1,3-dichloropropene is likely to disappear rapidly, because of its relatively low water solubility and high volatility; reported half-lives are less than 5 h.

The distribution of 1,3-dichloropropene in soil compartments is dependent on the vapour pressure, diffusion coefficient, temperature, and moisture content of the soil. The persistence of 1,3-dichloropropene in soil is influenced by volatilization, chemical and biological transformation, photochemical transformation, and organism uptake. Volatilization and diffusion in the vapour phase are the most significant mechanisms for environmental dispersion and dilution.

Transformation of 1,3-dichloropropene is initially by hydrolysis to 3-chloroallyl alcohol and then by microbial transformation to 3-chloroacrolein and 3-chloroacrylic acid. In a laboratory study, the half-lives for the hydrolysis of *cis*- and *trans*-isomers of 1,3-dichloropropene at 15 °C and 29 °C were 11.0 and 2.0 days, respectively, for the *cis*-isomer and 13.0 and 2.0 days, respectively, for the *trans*-isomer. For soil at pH 7 and a temperature of 25 °C, the half-life for hydrolysis for both isomers was 4.6 days. Because of its relatively rapid disappearance from soil, residues are unlikely to accumulate when the fumigant is applied at the recommended rate and frequency.

1,3-Dichloropropene is potentially mobile in soil, especially in open-textured, sandy soils with a low moisture content. Downward movement is enhanced by deep cultivation of soils with low porosity. 1,3-Dichloropropene has been detected in "upper ground water" (up to 2 m



# 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

below the surface), but not in deep ground water, which is more likely to be used for drinking-water.

1,3-Dichloropropene can be taken up by crops. However, significant residues are unlikely to occur in edible crops, because these are not normally planted until most of the fumigant has dissipated.

Bioaccumulation of 1,3-dichloropropene is unlikely, because of its relatively high water solubility (> 1 g/kg), low log P octanol-water partition coefficient, and rapid elimination from mammals and other organisms.

## 2.1.2 Kinetics and metabolism

1,3-Dichloropropene administered orally to rodents is rapidly eliminated. The major route of elimination is in the urine where 81% of the *cis*-isomer and 56% of the *trans*-isomer are eliminated within 24 h of dosing. The half-life of elimination in the urine is 5–6 h. Faecal elimination is minor. Expired CO<sub>2</sub> accounts for 4 and 24% of the elimination of the *cis*- and *trans*-isomers of 1,3-dichloropropene, respectively. Tissue concentrations after oral administration are low; the highest residual concentrations are found in the stomach wall, followed by lower amounts in the kidneys, liver, and bladder.

Unchanged 1,3-dichloropropene is not found in the urine. The *cis*- and *trans*-isomers are substrates for hepatic glutathione-S-alkyl transferase, forming mercapturic acids, which are excreted in the urine. The *trans*-isomer is conjugated 4–5 times more slowly than the *cis*-isomer. The principal urinary metabolite in rats and mice is *N*-acetyl-S-(3-chloroprop-2-enyl)-L-cysteine, which can also be used for biological monitoring in man. A second, minor metabolic pathway has been identified for the *cis*-isomer involving mono-oxygenation to *cis*-1-dichloropropene oxide, which can also be conjugated with glutathione. The high proportion of the *trans*-isomer that occurs in expired air is a consequence of an alternative metabolic pathway to conjugation, which has a higher specificity for this isomer than for its *cis*-counterpart.

Inhalation exposure of rats to 1,3-dichloropropene did not lead to blood concentrations increasing proportionally with dose. At a dose of

## 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

408.6 mg/m<sup>3</sup> (90 ppm), respiratory frequency and respiratory minute volume were decreased and saturation of metabolism occurred at 1362 mg/m<sup>3</sup> (300 ppm). *Cis*- and *trans*-isomers were rapidly eliminated from the blood, the half-life of elimination being 3–6 minutes at concentrations below 1362 mg/m<sup>3</sup>, but considerably longer (33–43 minutes) at higher concentrations.

### 2.1.3 *Effects on organisms in the environment*

The EC<sub>50</sub> values for growth (96-h) for the freshwater algae *Selenastrum capricornutum* and the estuarine diatom *Skeletoneria costatum* are 4.95 mg/litre and 1 mg/litre, respectively. The acute toxicity (96-h LC<sub>50</sub>) of 1,3-dichloropropene for fish is of the order of 1–7.9 mg/litre. In an embryo-larval test with Fathead minnow, the maximum no-observed-effect level (NOEL) was 0.24 mg/litre. These data, and the fact that 1,3-dichloropropene is unlikely to persist in water, indicate that the hazard for fish lies in acute toxic effects, with little potential for additional effects resulting from long-term exposure.

1,3-Dichloropropene at dose levels of 30–60 mg/kg can reduce the abundance of fungi and the rate of microbial enzyme activity, but the effect is not usually long lasting (<7 days) and does not occur in all soil types. In some studies, there was a significant increase in microbial numbers following application.

1,3-Dichloropropene is phytotoxic. The toxicity of 1,3-dichloropropene for honey bees is low. Using a dusting technique, the 48-h LD<sub>50</sub> was 6.6 µg/bee. Birds are relatively non-sensitive to 1,3-dichloropropene. An LC<sub>50</sub> of > 10 g/kg was reported for Mallard duck and Bobwhite quail.

### 2.1.4 *Effects on experimental animals and in vitro test systems*

The acute oral toxicity of 1,3-dichloropropene for experimental animals is moderate to high. The LD<sub>50</sub> values reported in rats range between 127 and 713 mg/kg body weight. The oral LD<sub>50</sub> values in rats for the *cis*- and *trans*-isomers are 85 and 94 mg/kg body weight, respectively.

## 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

Acute toxicity through dermal exposure is moderate. The reported dermal LD<sub>50</sub> is 423 mg/kg body weight for the rat, and 504 mg/kg body weight for the rabbit. The dermal LD<sub>50</sub> values for the *cis*- and *trans*-isomers are 1090 and 1575 mg/kg body weight, respectively.

Inhalation exposure (4 h) to 1,3-dichloropropene in rats indicated a LC<sub>50</sub> of 3310 mg/m<sup>3</sup> (729 ppm); the LC<sub>50</sub> for the *cis*-isomer was 3042–3514 mg/m<sup>3</sup> (670–744 ppm), and that for the *trans*-isomer, 4880–5403 mg/m<sup>3</sup> (1075–1190 ppm).

Acute intoxication showed central nervous and respiratory system involvement.

In rabbit skin and eye irritation tests, there were severe reactions, but recovery occurred in 14–21 days. The results of skin sensitization tests on guinea-pigs were positive.

Several short-term inhalation toxicity studies have been conducted on mice, rats, guinea-pigs, rabbits, and dogs. In mice, the nasal mucosa and urinary bladder were the target organs. Degeneration of the olfactory epithelium and hyperplasia of the respiratory epithelium were observed. Moderate hyperplasia of the transitional epithelium in the urinary bladder was found. An NOEL of 136 mg/m<sup>3</sup> (30 ppm) was estimated for mice.

Similar degenerative changes of the olfactory epithelium and hyperplasia were demonstrated in rats. The reported NOEL value for 1,3-dichloropropene from a well-designed study was 45.4 mg/m<sup>3</sup>; an NOEL of 136 mg/m<sup>3</sup> was reported for the *cis*-isomer.

A 90-day, oral study on rats indicated an NOEL of 3 mg/kg body weight. The only observed effect at the next higher dose level of 10 mg/kg body weight was an increase in relative kidney weight in the male.

In a 2-generation, 2-litter, inhalation reproduction study on rats, doses of up to 408.6 mg/m<sup>3</sup> (90 ppm) did not show any adverse effects on the reproductive parameters examined. However, the highest dose level of 408.6 mg/m<sup>3</sup> induced maternal toxicity as evidenced by decreased growth and histopathological changes in the nasal mucosa. An NOEL of 136.2 mg/m<sup>3</sup> (30 ppm) was established for maternal toxicity.

## 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

Inhalation teratogenicity studies on rats and rabbits did not indicate any teratogenic potential for 1,3-dichloropropene at exposure levels up to  $1362 \text{ mg/m}^3$  (300 ppm). In the rat, exposure to  $1362 \text{ mg/m}^3$  resulted in embryotoxicity (reduction in litter size and increase in resorption rates). Maternal toxicity in both rats and rabbits was observed at dose levels of  $544.8 \text{ mg/m}^3$  (120 ppm) or more.

In most of the studies, *cis*- and *trans*-1,3-dichloropropene and the mixture were mutagenic in bacteria with, and without, metabolic activation. Pure 1,3-dichloropropene and pure *cis*-1,3-dichloropropene were negative in bacteria. Glutathione was shown to prevent the mutagenic activity of 1,3-dichloropropene in bacteria. *Cis*-1,3-dichloropropene was negative in a gene mutation assay with V79 Chinese hamster cells, as well as in the Chinese hamster ovary HPRT test.

*Cis*- and *trans*-1,3-dichloropropene induced unscheduled DNA synthesis in HeLa S3 cells. In rat hepatocytes, 1,3-dichloropropene did not elicit significant DNA repair. 1,3-Dichloropropene was positive in the *Bacillus subtilis* strain H17 microsome rec- assay with metabolic activation.

In Chinese hamster ovary cells, *cis*- and *trans*-1,3-dichloropropene induced chromosome damage in the presence of metabolic activation but, in another study, 1,3-dichloropropene was positive without metabolic activation. *Cis*-1,3-dichloropropene did not induce chromosomal damage in rat liver cells. 1,3-Dichloropropene induced sister chromatid exchange in Chinese hamster ovary cells with, and without, metabolic activation and in Chinese hamster V79 cells without metabolic activation.

1,3-Dichloropropene was negative in a bone marrow micronucleus test on mice and in a sex-linked recessive lethal assay on *Drosophila melanogaster*.

Carcinogenicity studies were carried out on mice and rats. Technical 1,3-dichloropropene (containing 1% epichlorohydrin) was administered by gavage for 2 years. In mice, a significant increase in epithelial hyperplasia and transitional cell carcinomas in the urinary bladder, an increase in lung tumours, a slight increase in tumours of the liver, and an increase in epithelial hyperplasia and squamous cell papillomas or carcinomas in the forestomach were found. In rats, there were increases in the incidences of

# 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

neoplastic nodules in the liver and of squamous cell papillomas or carcinomas of the forestomach.

Carcinogenicity studies were carried out on mice and rats exposed through inhalation to 1,3-dichloropropene (without epichlorohydrin) for 2 years. In mice, increased incidences of hyperplasia of the urinary bladder, of the forestomach, and of the nasal mucosa were observed. The only other response observed was an increase in the incidence of benign lung tumours. Some toxic changes in the olfactory mucosa of the nasal cavity were also seen in rats, but there was no increase in tumour incidence.

Epichlorohydrin has been shown to produce forestomach tumours in a gavage study and nasal cavity tumours in an inhalation study on rats. But a carcinogenic effect in the urinary bladder cannot be excluded for 1,3-dichloropropene, administered orally in mice.

## 2.1.2.1 *Mode of action*

Given that the major metabolic route of elimination of 1,3-dichloropropene is via conjugation with glutathione, it is to be expected that situations that affect tissue glutathione (non-protein sulphydryl) concentrations may modify the effects of the compound. 1,3-Dichloropropene itself depletes the glutathione content of a variety of tissues, especially those that are the initial points of entry into the body, i.e., predominantly the forestomach and liver following gavage administration and the nasal tissue after inhalation exposure. Decreases in nasal epithelium and forestomach glutathione occurred in mice after inhalation of 1,3-dichloropropene concentrations greater than  $22.7 \text{ mg/m}^3$  (5 ppm) and  $113.5 \text{ mg/m}^3$  (25 ppm), respectively.

The toxicity of 1,3-dichloropropene in animals occurs at exposures that deplete glutathione; prior reduction of tissue glutathione exacerbates 1,3-dichloropropene toxicity. Long-term inhalation of concentrations higher than  $90.8 \text{ mg/m}^3$  (60 ppm) causes degeneration of nasal tissue in rats.

The protective role of glutathione is further highlighted by studies that demonstrate that covalent binding of  $^{14}\text{C}$ -1,3-dichloropropene to mouse forestomach increases as the non-protein sulphydryl content decreases.

## 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

Similarly, the genotoxicity of 1,3-dichloropropene and its minor oxidative (cytochrome P-450) metabolite (1,3-dichloropropene oxide) in *in vitro* test systems is markedly ameliorated by glutathione.

### 2.1.5 *Effects on human beings*

The exposure of the general population through air, water, or food is unlikely.

Studies have shown that occupational exposures are generally below  $4.54 \text{ mg/m}^3$  (1 ppm), but higher levels have also been reported (up to  $18.3 \text{ mg/m}^3$  during filling or nozzle changing). Occupational exposure is likely to be through inhalation and via the skin. Irritation of the eyes and the upper respiratory mucosa appears promptly after exposure. Inhalation of air containing concentrations of  $> 6810 \text{ mg/m}^3$  ( $> 1500$  ppm) gave serious signs and symptoms of poisoning; at lower exposures, there was depression of the central nervous system and irritation of the respiratory system. Dermal exposure caused severe skin irritation.

In a group of 1,3-dichloropropene applicators, some liver and kidney function changes were reported at the end of the application season. The cause-effect relationship, however, has been contested.

Some poisoning incidents have occurred in which persons were hospitalized with signs and symptoms of irritation of the mucous membrane, chest discomfort, headache, nausea, vomiting, dizziness, and, occasionally, loss of consciousness and decreased libido. Three cases of haematological malignancies were attributed to earlier accidental overexposure to 1,3-dichloropropene, but the cause-effect relationship remains uncertain.

The fertility status of workers employed in the production of chlorinated three-carbon compounds was compared with a control group. No indication of an association between decreased fertility and exposure was found.

# 1,3-DICHLOROPROPENE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

## 2.2 Conclusions

### 2.2.1 *General population*

Exposure of the general population to 1,3-dichloropropene is low or non-existent, and its risk for the general population is negligible.

### 2.2.2 *Occupational exposure*

Filling operations and field applications may lead to operator exposures exceeding the maximum allowable concentration, when appropriate safety precautions have not been taken.

### 2.2.3 *Environment*

Provided that 1,3-dichloropropene is used at the recommended rate, it is unlikely to attain levels of environmental significance and is unlikely to have adverse effects on populations of terrestrial or aquatic organisms.

## 2.3 Recommendations

- Filling operations and field applications of 1,3-dichloropropene should only be conducted with appropriate safety precautions, in order to avoid exposures exceeding the maximum allowable concentrations of 1,3-dichloropropene.
- Do not apply near drinking-water sources.

### 3. 1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

#### 3.1 Summary and evaluation

##### 3.1.1 *Environmental fate and occurrence*

Concentrations of 1,2-dichloropropane in city air were determined to be  $1.2 \mu\text{g}/\text{m}^3$  (mean value),  $0.021\text{--}0.040 \mu\text{g}/\text{m}^3$ , and  $0.0065\text{--}1.4 \mu\text{g}/\text{m}^3$  in Philadelphia and Portland (USA), and in Japan, respectively. Decomposition in the atmosphere is slow; on the basis of reaction with hydroxyl radicals, the half-life of 1,2-dichloropropane was  $> 313$  days. Phototransformation is likely to be the dominant process for the decomposition. Adsorption on to particulate matter is necessary for appreciable phototransformation. Volatilization is likely to be the major route of loss from water.

In soil, the main routes of loss are volatilization and diffusion. 1,2-Dichloropropane is persistent in soil. More than 98% of the 1,2-dichloropropane applied to loam soil was recovered 12–20 weeks after treatment.

Leaching of 1,2-dichloropropane occurs from soil and can contaminate upper and deeper ground water in areas where "Mix D/D" has been used as a soil fumigant. In well water and ground water in the USA, concentrations of up to  $440 \mu\text{g}/\text{litre}$  and  $51 \mu\text{g}/\text{litre}$ , respectively, have been found. In the Netherlands, concentrations of up to  $160 \mu\text{g}/\text{litre}$  have been measured in well water and 1,2-dichloropropane has been found to a depth of 13 m.

1,2-Dichloropropane can be taken up by edible crops, but residues detected have been low ( $< 0.01 \text{ mg}/\text{kg}$ ) and are unlikely to be biologically significant.

Bioaccumulation of 1,2-dichloropropane is unlikely, because of its high water solubility ( $2.7 \text{ g}/\text{kg}$ ) and low  $\log P$  octanol–water partition coefficient.

##### 3.1.2 *Kinetics and metabolism*

1,2-Dichloropropane administered orally to rats is rapidly eliminated: 80–90% within 24 h. There are no major differences in kinetics or



## 1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

elimination between males and females. Urine is the major route of elimination, with up to half an oral dose being eliminated by this route within 24 h. Less than 10% is eliminated in the faeces. Approximately one-third is eliminated through expired air, both as carbon dioxide and as a mixture of volatile materials. Tissue concentrations are low, the highest concentration being found in the liver. Rapid elimination also occurs following inhalation exposure of rats; 55–65% of a dose is eliminated in the urine and 16–23% in expired air. The half-life of elimination from blood is 24–30 min.

Unchanged 1,2-dichloropropane is not found in urine. Three major urinary metabolites have been identified. These metabolites result from oxidative and conjugation pathways that yield the mercapturates, *N*-acetyl-*S*-(2-hydroxypropyl)-*L*-cysteine, *N*-acetyl-*S*-(2-oxypopyl)-*L*-cysteine, and *N*-acetyl-*S*-(1-carboxyethyl)-*L*-cysteine. 1,2-Dichloropropane can also be oxidized to lactate with resultant carbon dioxide or acetyl co-enzyme A production.

Oral administration of 1,2-dichloropropane (2 ml/kg) to rats significantly depleted tissue glutathione content. There is a correlation between tissue glutathione loss and expression of toxicity in the liver, kidney, and red blood cells. Prior depletion of intracellular glutathione exacerbates 1,2-dichloropropane toxicity, whereas pretreatment with precursors for glutathione synthesis reduces the toxicity. These results demonstrate the protective effect of glutathione on 1,2-dichloropropane toxicity.

### 3.1.3 *Effects on organisms in the environment*

EC<sub>50</sub> data for freshwater algae have not been calculated, because of difficulties with volatilization of the chemical from the test solution. The acute toxicity of 1,2-dichloropropane for aquatic invertebrates and fish is low to moderate; 48-h LC<sub>50</sub> values for invertebrates range between 52 and > 100 mg/litre and 96-h LC<sub>50</sub> values for fish lie between 61 and 320 mg/litre. A short-term toxicity test on Fathead minnows demonstrated a maximum NOEL of 82 mg/litre. A 32-day test on early life stage toxicity in the same species demonstrated that larval growth and survival were the most sensitive parameters. The estimated maximum acceptable toxicant

## 1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

concentration (MATC) was between 6 and 11 mg/litre. Growth inhibition has been noted in Sheephead minnows after exposure for 33 days to a 1,2-dichloropropane concentration of 164 mg/litre.

1,2-Dichloropropane is phytotoxic.

Contact tests on 4 species of earthworm showed an LC<sub>50</sub> of 44–84 µg/cm<sup>2</sup> (mean values) of filter paper. In artificial soil, the LC<sub>50</sub> values were 3880–5300 mg/kg soil (dry weight).

### 3.1.4 *Effects on experimental animals and in vitro test systems*

The acute oral toxicity of 1,2-dichloropropane in experimental animals is low. The oral LD<sub>50</sub> for the rat is 1.9 g/kg body weight, and the dermal LD<sub>50</sub> in rabbits is 8.75 ml/kg body weight.

Short-term, oral, toxicity studies of 1,2-dichloropropane in mice and rats showed growth inhibition, clinical toxic signs associated with central nervous system depression, and/or increased mortality, at dose levels of 250 mg/kg body weight per day or higher. In rats given 250 mg/kg per day for 10 days, there were changes in serum enzymes indicative of slight hepatotoxicity with a NOEL of 100 mg/kg per day.

In a 13-week mouse inhalation study (highest dose 681 mg/m<sup>3</sup> (150 ppm)), no adverse effects were observed. In a similar study on rats exposed to 68.1, 227, or 681 mg/m<sup>3</sup> (15, 50, or 150 ppm), a decrease in body weight and minimal damage to nasal tissues occurred in the 2 highest dose groups.

In a 2-generation reproduction study, rats exposed to 1,2-dichloropropane in the drinking-water at 0.024, 0.1, or 0.24% (equivalent to 33.6, 140, or 336 mg/kg body weight per day) resulted in lower maternal body weight gain and decreased water consumption at the mid- and high-dose levels. Neonatal body weights were lower at the high dose level. The NOAELs established for maternal and reproductive toxicity were 33.6 and 140 mg/kg body weight per day, respectively.

The results of studies did not indicate any teratogenic activity of 1,2-dichloropropane at oral dose levels up to 125 mg/kg body weight in the rat and 150 mg/kg body weight in the rabbit. However, at these dose levels,

## 1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

1,2-dichloropropane was maternally toxic and fetotoxic, as evidenced by central nervous system-associated clinical signs, decreased maternal body weight gain, and delayed ossification of bones in the fetuses. The NOELs for the rat and rabbit are 30 and 50 mg/kg body weight per day, respectively.

1,2-Dichloropropane was mutagenic in bacteria in most studies with, and without, metabolic activation, but very high dose levels were used, up to 10 mg/plate. In Chinese hamster ovary cells, 1,2-dichloropropane caused chromosome aberrations and sister chromatid exchange; in Chinese hamster V79 cells, it increased the sister chromatid exchange. In an *in vitro* system with human lymphocytes, the tritiated thymidine uptake and cell viability in cultures grown with, and without, rat liver metabolizing system, were similar to those in control cultures. A sex-linked recessive lethal test was negative in *Drosophila melanogaster*. A dominant lethal test in rats over 14 weeks via drinking-water containing 1,2-dichloropropane, followed by 2 weeks of mating, was negative.

In a carcinogenicity study on mice administered 125 or 250 mg 1,2-dichloropropane/kg body weight by gavage, a dose-related increase in the incidence of liver adenomas in the treated groups was higher than that in the concurrent control group, but was within the historical control range.

In rats administered dose levels of 125 and 250 mg/kg body weight (females) and 62 and 125 mg/kg body weight (males), by gavage, 5 days per week for 113 weeks, a slight increase in the incidence of mammary gland adenocarcinomas exceeding the historical range was observed in high-dose females.

### 3.1.5 Effects on human beings

Exposure of the general population to 1,2-dichloropropane via air and water is unlikely, except in areas where there is extensive use of 1,2-dichloropropane and "Mix D/D" in agriculture. Residues of 1,2-dichloropropane in edible crops are generally below the limit of detection. In view of these low exposures to 1,2-dichloropropane, the risk to the general population is negligible.

# 1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

Several cases of acute poisoning have been reported through accidental or intentional (suicide) overexposure to 1,2-dichloropropane. Effects are mainly on the central nervous system, liver, and kidney. Haemolytic anaemia and disseminated intravascular coagulation have also been reported. In one case, delirium progressed to irreversible shock, cardiac failure, and death.

Occupational exposures can be via both skin and inhalation. Several cases of dermatitis and skin sensitization have been reported in workers using solvent mixtures containing 1,2-dichloropropane.

## 3.2 Conclusions

### 3.2.1 *General population*

Exposure of the general population to 1,2-dichloropropane from air and food is low or non-existent. However, in certain areas, exposure may occur when ground water is contaminated.

### 3.2.2 *Occupational exposure*

With reasonable work practices, hygienic measures, and safety precautions, the use of 1,2-dichloropropane is unlikely to present a risk to those occupationally exposed to it.

### 3.2.3 *Environment*

1,2-Dichloropropane is unlikely to attain levels of environmental significance, when used at the recommended rate. It is unlikely to have adverse effects on populations of terrestrial and aquatic organisms.

# **1,2-DICHLOROPROPANE: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS**

## **3.3 Recommendations**

- Appropriate safety precautions should be taken when handling 1,2-dichloropropane, in order to avoid exposures exceeding the maximum allowable concentration.

## 4. "Mix D/D": SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Summary and evaluation

#### 4.1.1 *Environmental fate and occurrence*

The environmental transport, distribution, and fate of the major constituents of "Mix D/D" in air, water, and soil are described in sections 2.1.1 and 3.1.1 on 1,3-dichloropropene and on 1,2-dichloropropane.

There is a significant potential for "Mix D/D" derived 1,2-dichloropropane to leach from the soil and contaminate well water and ground water. In a 68-m deep irrigation bore in Western Europe, mean 1,2-dichloropropane concentrations at different depths ranged between 0.8 and 8.5  $\mu\text{g/litre}$  and the maximum concentration recorded was 165  $\mu\text{g/litre}$ .

Significant uptake of the constituents of "Mix D/D" by crops is unlikely. Bioaccumulation of the constituents of "Mix D/D" is also unlikely, because of their low log P octanol-water partition coefficient and relatively high water solubility.

#### 4.1.2 *Kinetics and metabolism*

There have not been any metabolic studies on "Mix D/D". The two major components, 1,3-dichloropropene and 1,2-dichloropropane, are rapidly eliminated, primarily through the urine and, to a lesser extent, via expired air. The components of "Mix D/D" are metabolized by oxidative and conjugation pathways. The major urinary metabolites are mercapturic acids.

#### 4.1.3 *Effects on organisms in the environment*

"Mix D/D" is moderately toxic for fish; 96-h LC50 values range between 1 and 6  $\text{mg/litre}$ . The toxicity largely resides in the 1,3-dichloropropene content of the "Mix D/D".

When used at recommended application rates, the main effects of "Mix D/D" are a transient (< 7 days) reduction in soil fungi and inhibition of the oxidation of ammonium to nitrate. "Mix D/D" is toxic to nitrifying

## “Mix D/D”: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS

bacteria, but soon after “Mix D/D” disappears from the soil, recolonization of bacteria takes place. In field trials, “Mix D/D” (applied at 600 litre/ha) killed soil invertebrates. Recolonization times ranged between 6 and 24 months.

“Mix D/D” is highly phytotoxic.

### 4.1.4 *Effects on experimental animals and in vitro test systems*

The acute toxicity of “Mix D/D” is moderate to high for laboratory animals. The oral LD<sub>50</sub> values in rats and mice range from 132 to 300 mg/kg body weight. The dermal LD<sub>50</sub> values for rats and rabbits are 779 and 2100 mg/kg body weight, respectively. The LC<sub>50</sub> (4-h) for rats is approximately 1000 mg/kg. Acute exposure results in clinical signs associated with central nervous system depression. “Mix D/D” is a severe eye and skin irritant and a moderate dermal sensitizer.

The available short-term toxicity studies on rats and dogs are not adequate to assess fully the toxicity potential of “Mix D/D”, because the dose levels tested have been relatively low and have not demonstrated any biologically significant effects.

Several short-term inhalation (whole-body) studies have been conducted on rats. “Mix D/D” at levels up to 145 mg/m<sup>3</sup> did not cause any toxic effects. Toxic effects associated with central nervous system depression were evident at levels of 1362 mg/m<sup>3</sup> (300 ppm) or more. Exposure to 443 mg/m<sup>3</sup> for 10 weeks led to reduced body weight gain and increased absolute kidney weight.

An oral teratogenicity study on rats was inadequate for the assessment of the teratogenic potential of “Mix D/D”.

In an inhalation study on male and female fertility in rats, no effects were found at dose levels up to 443 mg/m<sup>3</sup> for 10 weeks. Complete evaluation of the reproductive effects of “Mix D/D” was not possible because of the inadequacy of the protocol designs.

“Mix D/D” is mutagenic in *Salmonella typhimurium* strains TA100 and TA1535, as well as *Escherichia coli* WP2 HCR, without metabolic activation. It is negative in *Salmonella* strains TA98, TA1537, and TA1538.

## **“Mix D/D”: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS**

In a long-term study on rats fed diets containing up to 120 mg “Mix D/D” per kg (equivalent to 6 mg/kg body weight per day) for 2 years, no toxic or carcinogenic effects were seen.

### *4.1.5 Effects on humans beings*

As “Mix D/D” is no longer extensively used, exposure of the general population via air, water and food is therefore unlikely.

The levels of exposure of drum-filling operators and field applicators were generally below 4.54 mg/m<sup>3</sup> (1 ppm) 1,3-dichloropropene when recommended procedures were used, otherwise levels of up to 36.32 mg/m<sup>3</sup> (8 ppm) have been measured.

One case of acute fatal poisoning has been reported following the accidental ingestion of “Mix D/D”.

Several cases of contact dermatitis and skin sensitization have been reported following exposure to “Mix D/D”.

## **4.2 Conclusions**

### *4.2.1 General population*

As “Mix D/D” is no longer extensively used, exposure of the general population to 1,3-dichloropropene from air, water, and food, is negligible, but, in certain areas, exposure to 1,2-dichloropropane may occur when ground water is contaminated.

### *4.2.2 Occupational exposure*

Filling operations and field applications of “Mix D/D” can lead to operator exposures to 1,3-dichloropropene exceeding maximum allowable concentrations, especially under warm climatic conditions.



## **“Mix D/D”: SUMMARY AND EVALUATION, CONCLUSIONS AND RECOMMENDATIONS**

### **4.2.3 *Environment***

“Mix D/D” is unlikely to reach biologically significant levels in either the terrestrial or aquatic environment, when used at the recommended rate. Lasting adverse effects on organisms in the environment are unlikely to occur.

### **4.3 Recommendations**

- “Mix D/D” should not be used as a soil fumigant, because of potential leaching into ground water.

## 5. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

### 5.1 Human health hazards, prevention and protection, first aid

1,3-Dichloropropene and "Mix D/D" are volatile, severely irritant liquids that may cause skin burns. They are hazardous for humans and animals, if incorrectly or carelessly handled. The human health hazards associated with certain types of exposure to these substances, together with preventive and protective measures and first aid are listed in Table 4.

According to the International Agency for Research on Cancer (IARC Monographs Vol. 41, 1986; and Suppl. 7, 1987), there is sufficient evidence for carcinogenicity to animals in the case of technical grade 1,3-dichloropropene containing 1% epichlorohydrin, after oral administration to experimental animals.

1,2-Dichloropropane is less irritant than the above two substances. The human health hazards associated with certain types of exposure to 1,2-dichloropropane are listed in Table 5, together with preventive and protective measures and first aid.

#### 5.1.1 *Advice to physicians*

##### 5.1.1.1 *Symptoms of poisoning*

Inhalation of the vapour of these substances causes irritation to the eyes, nose, and throat, cough, shortness of breath, and pain in the chest. At higher concentrations, inhalation will cause chemical pneumonitis and pulmonary oedema. Ingestion causes abdominal pain, diarrhoea, and vomiting. During vomiting, aspiration into the lungs may occur, resulting in chemical pneumonitis. The possibility of delayed systemic effects (among others: hepatic and renal effects) should not be overlooked.

##### 5.1.1.2 *First aid*

If any of the above symptoms or signs occur, obtain medical attention immediately. If skin is contaminated, remove clothing and wash all affected parts with soap and water. If eyes are contaminated, flush with clean water for up to 15 minutes and obtain medical attention immediately. If

Table 4. 1,3-Dichloropropene and "Mix D/D": human health hazards, preventive and protective measures, and first aid

Hazards/Symptoms	Prevention and protection	First aid
SKIN: corrosive to the skin; sensitizer	Avoid contact, wear protective gloves and clothing, PVC or neoprene gloves, rubber boots	Remove contaminated clothing immediately and launder before reuse; wash skin with water and soap; destroy all contaminated leather goods
EYES: severe primary eye irritant	Wear face-shield or goggles	Flush eyes immediately with clean water for 15 minutes; obtain medical attention
INHALATION: Severe primary irritant to respiratory tract mucosa; excessive inhalation of vapour can cause pulmonary oedema and delayed systemic effects	Wear appropriate respiratory protection	Remove victim to fresh air immediately; keep at rest and warm; obtain medical attention immediately; give artificial respiration, if breathing has stopped
INGESTION: Corrosive to the digestive tract; nausea, abdominal pain, diarrhoea	Do not eat, drink, or smoke during work	Do not induce vomiting; give water to drink; obtain medical attention immediately

Table 5. 1,2-Dichloropropane: human health hazards, preventive and protective measures, and first aid

Hazards/symptoms	Prevention and protection	First aid
SKIN: irritant	Avoid contact, wear protective gloves and clothing, PVC or neoprene gloves, rubber boots	Remove contaminated clothing and launder before reuse; wash skin with plenty of water and soap
EYES: irritant	Wear face-shield or goggles	Flush eyes with clean water for 15 minutes; obtain medical attention
INHALATION: irritant; anorexia, diarrhoea, drowsiness, headache, (maybe delayed effect)	Wear appropriate respiratory protection	Remove victim to fresh air; keep at rest and warm; obtain medical attention
INGESTION: abdominal pain, vomiting, diarrhoea, drowsiness, headache	Do not eat, drink, or smoke during work	Do not induce vomiting; give water to drink; obtain medical attention

## HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

swallowed, obtain medical attention immediately. DO NOT INDUCE VOMITING.

### 5.1.1.3 *Medical advice*

Skin irritation and chemical burns should be treated symptomatically. In case of ingestion, carry out gastric lavage with care to prevent aspiration. Do not administer fatty substances, such as milk or oil. Check for any liver or kidney damage. In case of excessive inhalation, observe in hospital for 48 hours for signs of pulmonary oedema.

There is no special antidote—treatment is symptomatic and supportive.

### 5.1.2 *Health surveillance advice*

In view of the skin-sensitizing properties of "Mix D/D" (and to a lesser extent of 1,3-dichloropropene) and their systemic toxicity (liver, kidney), medical surveillance may be advisable at the discretion of a medical adviser, taking into account the frequency and degree of exposure.

### 5.1.3 *Personal hygiene*

Prevent all contact with the skin, eyes, nose, and mouth.

Wear goggles, cotton overalls, neoprene or polyethylene gloves, and rubber boots. Do not wear leather footwear.

Do not suck or blow on/into obstructed injection pipes by mouth.

In all situations where vapour concentrations in air do, or may, exceed maximum allowable concentrations (see section 7.2) appropriate respiratory protection must be used.

Wash off any skin contamination with soap and water. If eyes are contaminated, flush immediately with clean water for up to 15 minutes. Obtain medical attention.

If clothes or overalls become contaminated, remove them without delay and thoroughly wash before reuse. Contaminated leather shoes should be discarded, since they cannot be decontaminated.

## HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

Wash hands and exposed skin before eating, drinking, smoking, using the toilet, and after work.

### 5.2 Explosion and fire hazards

These substances are highly flammable and are not miscible with water. Vapour/air mixtures can be explosive. The vapours are heavier than air and may travel along the ground; distant ignition is possible. They can decompose in a flame or on a hot surface, forming toxic (e.g., phosgene) and corrosive (e.g., hydrochloric acid) gases. They react with light metals with the generation of heat. 1,3-Dichloropropene and "Mix D/D" may react violently with strong oxidants.

When dealing with fires or in situations where these substances are exposed to the atmosphere, self-contained breathing apparatus must be used. Fire service personnel should be advised that these chemicals and their mixtures are hazardous through skin contact and inhalation.

Extinguish fires with alcohol-resistant foam or powder. The use of water spray should be confined to the cooling of unaffected stock, to avoid polluted run-off from the site.

### 5.3 Storage

These substances should be stored in locked, well-ventilated buildings. Do not expose to direct sunlight. Keep products out of reach of children and unauthorized personnel. Do not store near animal feed or food. Separate from bases, strong oxidants, and acids.

### 5.4 Transport

Comply with any local regulations regarding the movement of hazardous goods. Do not load with animal feed or food. Check that containers are sound and labels undamaged, before despatch.

### 5.5 Spillage and disposal

#### 5.5.1 Spillage

Stay upwind, avoid skin contamination and inhalation of vapour.

## HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

Keep spectators away from leaking product and prevent all smoking or use of naked flames.

When dealing with spillage, approved respiratory protective equipment must be used in addition to the protective clothing advised under personal hygiene (section 5.1.3).

Absorb spillage with sawdust, sand, or earth, sweep up and place in a closeable, impervious container. Ensure that container is tightly closed and suitably labelled before transfer to a safe place for disposal.

Prevent liquid from spreading and contaminating other cargo, vegetation, or waterways with a barrier of the most suitable material available, e.g., earth or sand.

Empty any of the product remaining in the damaged/leaking container into a clean empty container, which should then be tightly closed and suitably labelled.

### 5.5.2 *Disposal*

Contaminated absorbents, containers, surplus product, etc., should be burnt in a proper incinerator at high temperatures, in a unit with effluent gas scrubbing. When no incinerator is available, bury in an approved dump, or in an area where there is no risk of contamination of surface or ground water. Punch holes and crush empty containers to prevent reuse. Comply with any local legislation.

## 6. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

1,3-Dichloropropene and "Mix D/D" are moderately toxic for most forms of aquatic and terrestrial life. On direct application to water or soil they severely (but temporarily) disturb the local ecosystem.

The toxicity of 1,2-dichloropropane is 1-2 orders of magnitude less.

Avoid contamination of soil, water, and the atmosphere by proper methods of storage, transport, handling, and waste disposal. Avoid application near drinking-water sources.

In case of spillage, use the methods advised in section 5.5.1.



## 7. CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The information given in this section has been extracted from the International Register of Potentially Toxic Chemicals (IRPTC) legal file and other United Nations sources. A full reference to the original national document from which the information was extracted can be obtained from IRPTC.

The reader should be aware that regulatory decisions about chemicals taken in a certain country can only be fully understood in the framework of the legislation of that country. Furthermore, the regulations and guidelines of all countries are subject to change and should always be verified with the appropriate regulatory authorities before application.

### 7.1 Previous evaluations by international bodies

The International Agency for Research on Cancer (IARC) evaluated technical grade 1,3-dichloropropene (containing 1% epichlorohydrin) in 1986 and 1987 and concluded that there is sufficient evidence for its carcinogenicity to animals and inadequate evidence for its carcinogenicity to humans (group 2B).

The IPCS and the CEC have issued an International Chemical Safety Card on 1,2-dichloropropane (ICSC No. 0441).

### 7.2 Exposure limit values

Some exposure limit values for 1,3-dichloropropene and 1,2-dichloropropane are given in Tables 6 and 7, respectively. For "Mix D/D", both tables apply.

### 7.3 Specific restrictions

1,3-Dichloropropene, 1,2-dichloropropane, and "Mix D/D" have been registered for use as pesticides (nematocides) in many countries; in each country specific uses are defined as well as limitations and precautions.

Table 6. Exposure limit values for 1,3-dichloropropene

Medium	Specification	Country/ organization	Exposure limit description	Value	Effective date
AIR	Workplace	Germany	Maximum work-site concentration (MAK) Carcinogenic in animals, therefore no MAK established	-	1991
			Recommended limit (RECL) - 8-h time-weighted average (TWA) - Short-term (10-min) exposure level (STEL)	5 mg/m <sup>3</sup> <sup>a</sup> 50 mg/m <sup>3</sup>	1985
	USA (ACGIH)	Threshold limit value (TLV) - Time-weighted average (TWA)	5 mg/m <sup>3</sup> <sup>a</sup>	1986	
		Maximum allowable concentration (MAC) - Ceiling value (CLV)	5 mg/m <sup>3</sup>	1977	
AIR	Ambient	USSR	Maximum allowable concentration (MAC) (average per day) (1 × 1 day)	0.01 mg/m <sup>3</sup> 0.1 mg/m <sup>3</sup>	1984
FOOD	Plant	Germany	Maximum residue limit (MRL) (all plant products)	0.05 mg/kg	1989
WATER	Surface	USSR	Maximum acceptable concentration	0.4 mg/litre	1983

<sup>a</sup> Skin absorption

Table 7. Exposure limit values for 1,2-dichloropropane

Medium	Specification	Country/ organization	Exposure limit description	Value	Effective date
AIR	Workplace	Brazil	Acceptable limit (AL)	275 mg/m <sup>3</sup>	1980
			- Time-weighted average (TWA)		
			Maximum work-site concentration (MAK)		
		Germany	- Time-weighted average (TWA)	350 mg/m <sup>3</sup>	1991
			- 30-min short-term exposure limit (STEL)	700 mg/m <sup>3</sup>	
			Maximum allowable concentration (MAC)		
Hungary	- 8-h time-weighted average (TWA)	50 mg/m <sup>3</sup>	1988		
	- Short-term exposure level (30 min)	100 mg/m <sup>3</sup>	1988		
	Permissible exposure limit (PEL)				
USA/OSHA	- Time-weighted average (TWA)	350g/m <sup>3</sup>	1974		
	Threshold limit value (TLV)				
	- Time-weighted average (TWA)	347 mg/m <sup>3</sup>	1990		
USA (ACGIH)	- Short-term exposure limit (STEL)	508 mg/m <sup>3</sup>			
	Maximum allowable concentration (MAC)				
	- Ceiling value	10 mg/m <sup>3</sup>	1976		
AIR	Ambient	USSR	Maximum allowable concentration (MAC) (average per day)	0.18 mg/m <sup>3</sup>	1984

# CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

## 7.4 Labelling, packaging, and transport

The following applies to 1,3-dichloropropene, 1,2-dichloropropane, and "Mix D/D".

The United Nations Committee of Experts on the Transport of Dangerous Goods classifies these compounds in:

Hazard Class 3: flammable liquid;

Packing Group II: a substance presenting medium danger.

The label should be as follows:



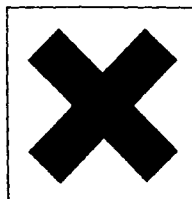
The European Economic Community legislation requires labelling as a flammable and harmful substance using the symbols:

F



\* ES: Fácilmente inflamable  
DA: Let antændelig  
DE: Leichtentzündlich  
EL: Διαν εύφλεκτο  
EN: Highly flammable  
FR: Facilement inflammable  
IT: Facilmente infiammabile  
NL: Licht ontvlambaar  
\* PT: Fácilmente inflamável

Xn



\* ES: Nocivo  
DA: Sundhedsskadelig  
DE: Mindergiftig  
  
EL: Επιβλαβές  
EN: Harmful  
FR: Nocif  
IT: Nocivo  
NL: Schadelijk  
\* PT: Nocivo

## CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The label must read:

*Highly flammable; harmful by inhalation; keep container in a well-ventilated place; keep away from sources of ignition—no smoking; do not empty into drains; take precautionary measures against static discharges; (it must be stated on the label whether the substance is a specific isomer or a mixture of isomers).*

### 7.5 Waste disposal

In the USA, any non-domestic waste containing 1,3-dichloropropene or 1,2-dichloropropane is considered a toxic waste, subject to handling, transport, storage, and disposal regulations and permit and notification requirements. An owner or operator of a hazardous waste incinerator must achieve 99.99% destruction and removal efficiency for these substances.

## BIBLIOGRAPHY

CEC (1987) Legislation on dangerous substances - Classification and labelling in the European Communities. Vol. 1 & 2, Commission of the European Communities, London, Graham & Trotman Ltd.

FAO (1985a) Guidelines for the packaging and storage of pesticides. Rome, Food and Agriculture Organization of the United Nations.

FAO (1985b) Guidelines for the disposal of waste pesticides and pesticide containers on the farm. Rome, Food and Agriculture Organization of the United Nations.

FAO (1985c) Guidelines on good labelling practice for pesticides. Rome, Food and Agriculture Organization of the United Nations.

FAO (1986) International code of conduct on the distribution and use of pesticides. Rome, Food and Agriculture Organization of the United Nations.

FAO/WHO (1986) Guide to Codex recommendations concerning pesticide residues. Part 8. Recommendations for methods of analysis of pesticide residues. 3rd ed. Rome, Codex Committee on Pesticide Residues.

GIFAP (1982) Guidelines for the safe handling of pesticides during their formulation, packing, storage, and transport. Brussels, Groupement International des Associations Nationales des Fabricants de Produits Agrochimiques.

GIFAP (1983) Guidelines for the safe and effective use of pesticides. Brussels, Groupement International des Associations Nationales des Fabricants de Produits Agrochimiques.

GIFAP (1984) Guidelines for emergency measures in cases of pesticide poisoning. Brussels, Groupement International des Associations Nationales des Fabricants de Produits Agrochimiques.

GIFAP (1987) Guidelines for the safe transport of pesticides. Brussels, Groupement International des Associations Nationales des Fabricants de Produits Agrochimiques.

## BIBLIOGRAPHY

HAYES, W.J. Jr & LAWS, E.R. Jr (1991) Handbook of pesticide toxicology, 3 Vol. New York, Academic Press.

IARC (1972-present) IARC Monographs on the evaluation of carcinogenic risk of chemicals to man. Lyon, International Agency for Research on Cancer.

ILO (1991) Safety and health in the use of agro-chemicals—a guide. Geneva, International Labour Office.

IRPTC (1985) IRPTC file on treatment and disposal methods for waste chemicals. Geneva, International Register for Potentially Toxic Chemicals, United Nations Environment Programme.

IRPTC (1987) IRPTC legal file 1986. Geneva, International Register for Potentially Toxic Chemicals, United Nations Environment Programme.

PLESTINA, R. (1984) Prevention, diagnosis, and treatment of insecticide poisoning. Geneva, World Health Organization (Unpublished document No. VBC/84.889).

SAX, N.I. (1984) Dangerous properties of industrial materials. New York, Van Nostrand Reinhold Company, Inc.

UNEP/IEO (1990) Storage of hazardous materials : a technical guide for safe warehousing of hazardous materials. Paris, United Nations Environment Programme - Industry and Environment Office, 80 pp.

UNITED NATIONS (1989) Recommendations on the transport of dangerous goods. 6th ed. New York, United Nations.

UNITED NATIONS (1989) Consolidated list of products whose consumption and/or sale have been banned, withdrawn, severely restricted or not approved by governments. 2nd ed. New York, United Nations, New York.

US NIOSH/OSHA (1981) Occupational health guidelines for chemical hazards. 3 Vol., Washington DC, US Department of Health and Human Services, US Department of Labor (Publication No. DHHS (NIOSH) 01-123).

WHO (In preparation) EHC No. 146: 1,3-Dichloropropene, 1,2-dichloropropane, and mixtures. Geneva, World Health Organization.

## BIBLIOGRAPHY

WORTHING, C.R. & HANCE, R.J. (1991) The pesticide manual. 9th ed. Old Woking, United Kingdom, Unwin Brothers Ltd.



HILH

No. 10

146

Price: Sw. fr. 5.-

Price in developing countries: Sw. fr. 3.50

ISBN 92 4 151076 5